CAPI
THE CANADIAN AGRI-FOOD POLICY INSTITUTE

Resilience versus Efficiency:

The feasibility of small local meatpacking plants in Canada

Paper prepared for CAPI

by

James Rude, University of Alberta

November 2020

The Canadian Agri-Food Policy Institute

960 Carling Avenue, CEF Building 60

Ottawa, ON K1A 0C6

Telephone: 613-759-1027

www.capi-icpa.ca

Resilience versus Efficiency: The feasibility of small local meatpacking plants in Canada

November 2020

Author
James Rude, University of Alberta

Contents

1. Introduction

It has been argued that the COVID-19 pandemic has exposed the vulnerability of large, regionalized beef and pork slaughter plants. What began as COVID-19 demand disruptions, then quickly deteriorated because of the emergence of very large and significant supply chain constraints. Between the end of March and mid-June 2020 a series of over 40 shutdowns occurred across Canada and the US (McCarthy and Danley, 2020). Slaughter plant shutdowns depressed the demand for livestock, thereby reducing farm prices and at the same time less meat was produced resulting in much higher wholesale prices. While most meat processing facilities that had closed due to COVID-19 are open again, residual problems remain. The outstanding question is how the red meats industry could have been better situated to adjust to the disruptions and how the sector can be more resilient going forward. Major challenges included getting employees to return to work, anti-trust complaints against certain processors in the US, complaints that the regulators were inflexible and producer complaints about slaughter backlogs. One consistent complaint has been that the packing sector is too regionally concentrated, with too few owners, and that plants are too large. As a result of this high level of concentration the entire meat sector was vulnerable, and at the peak of the disruptions there was a fear that the shutdowns would result in meat shortages. So, the argument has been made that smaller more regionally dispersed plants would have reduced the probability of the spread of COVID-19 and resulted in a more secure meat supply.

The strongest counter-argument is that there are natural forces within the industry that limit slaughter to regions where the livestock is raised and that significant scale advantages limit the total number of slaughter plants across North America. The objective of this study is to examine the credibility of these arguments, and to consider alternative market structures which might make the sector less vulnerable to shocks, similar to COVID-19, and more resilient in

recovering from them. Alternative structures include introducing i) more slack in the system by reducing capacity utilization, ii) introducing robotics, and iii) reintroducing smaller more regionally distributed packers. The objective is to determine the relative feasibility of each market structure and to anticipate other modalities to limit future slaughter disruptions. The paper will begin with a description of the history of the structure and concentration of the North American meatpacking industry, the current structure of the Canadian industry, the impact COVID-19 had on the sector, measures to make the sector more resilient by discussing three alternative structure scenarios, ending with a summary and recommendations.

2. History of the structure and concentration of North American meatpacking

The red meatpacking industry is integrated across the Canada-US border and as such, has to be analyzed as one entity. Concern over the degree of concentration in North American meatpacking is nothing new. In fact, during the last pandemic (1918-19) the US Department of Justice initiated anti-trust action against the big five packers, resulting in a consent decree that divested company assets to reduce concentration, in 1920. In 1921, Congress enacted the US *Packers and Stockyard Act* which regulates the industry today (Azzam 1998). MacLachlan (2001) tells a similar story for Canadian beef, when the *Canada Packers Company* was formed through a complex series of acquisitions during the same time period.[1] The big four firms in each country were different players which are different from today's dominant firms.

Starting in the 1960s Iowa Beef Processors (IBP) introduced new technical practices which pioneered large scale *boxed beef* production that resulted in significant economies from labour specialization and the substitution of labour for capital (Azzam 1998). Packing plants

[1] The meat industry in Canada has been slowly concentrating since 1927 when Canada Packers was formed by the merger of Gunns Limited, the Canadian Packing Company, Harris Abattoir and William Davies,

were transformed from multi-species, multi-story facilities to specialized linear operations where old line packers were integrated into large conglomerates. By the late 1970s declines in consumption and production of red meats left the industry with excess capacity and even more consolidation. Therefore, by the late 1980s the US beef packing industry had consolidated dramatically (MacDonald and Ollinger, 2005).

The main driving forces for change in the North American meatpacking sector included the introduction of boxed beef which moved meat cutting operations back to the plant away from retailers. Second, a series of wage renegotiations brought down labour costs (Melton and Huffman, 1995). Third, a move away from traditional labour schedules increased shift times and eventually lead to a second daily shift that dramatically reduced labour costs (Ward and Faminow, 1992). These changes required a constant flow of livestock, and a reliable supply of labour, leading to significant consolidation in the industry.

Consolidation in the Canadian industry lagged somewhat, but by the late 1980s two beef packers (Cargill – High River and Lakeside – Brooks) had established large operations in the centre of Alberta's feedlot industry. With respect to pork processing, the 1991 merger between Canada Packers and Maple Leaf Mills accelerated packing plant consolidations across the country.[2] This resulted in a market that is shared between Maple Leaf Foods and the Quebec cooperative Olymel. While Canadian beef packing is concentrated in Alberta, pork processing is more evenly distributed across Quebec, Ontario, Manitoba and Alberta. So, the industry has evolved, changed locations, changed technical practices, increased plant size, but ultimately remained relatively concentrated.

[2] This followed the decision of Canada Packers to withdraw from beef packing and concentrate on pork and poultry. Merger negotiations, although already underway were accelerated with the entry of Wallace McCain and the Ontario Teachers Pension Fund into negotiation to purchase Maple Leaf Foods.

A dramatic change in Canadian beef packing followed the May 2003 discovery of a Canadian case of BSE. At that time international borders were closed to exports of Canadian beef and live cattle.[3] Prior to this closure, Canada was heavily dependent upon the US as a market for its slaughter cattle: 17% of Canadian fed cattle were slaughtered in the US and 44% of cull cattle were exported for slaughter (Rude and Carlberg, 2006). Given Canada's reliance on US slaughter capacity there was a sudden need for the development of new slaughter facilities here at home. In western Canada more than 20 groups investigated the feasibility of developing new slaughter plants. Both federal and provincial governments introduced programs that encouraged plant capacity expansion through equity investments or assistance to undertake business and feasibility studies for expansion of slaughter facilities (Treasury Board Secretariat 2007).

By 2006 planned expansions to Canadian slaughter capacity increased capacity from 70% of Canadian production to 90% (MNP 2004). Total planned investment exceeded $625 million and just over 70% of the additions were small (less than 500 head/week) and medium (500-1000 head/week) sized plants (MacArthur, Briere, and Bell, 2005). Most of the planned investments involved a collection of cattle producers who had little or no prior meatpacking experience, and several of the investments involved decommissioned plants. These enterprises faced considerable challenges and many of the plants never came to fruition. Those that were implemented eventually ceased operation.

There are several reasons why the start-up facilities were not successful. First, by the time the US border completely reopened to all types of cattle in 2007, exports of live slaughter cattle had returned to pre-BSE levels (the five year average post-2007 export average was only

[3] The border remained closed until July 2005 for exports of fed steers and heifers that were less than 30 months of age. The border remained closed until November 2007 for older culled cattle.

3% lower than the 5-year average prior to 2003). Second, in the period since 2005 the Canadian beef herd had contracted by 25% (Statistics Canada, 2020). So with less cattle demand, the need for additional slaughter facilities subsided. Even Cargill and Lakeside packers, which each had planned to expand daily slaughter by 1000 head, eventually returned to pre-BSE slaughter capacity. Finally, the Canadian Cattlemen's Association (CCA)'s Masswohl argues that 2007 regulatory changes, with respect to specified risk materials, created higher costs which lead to the exit of mid-sized enterprises (Edmiston, 2020).[4]

3. Current Structure of the Canadian Industry

Table 1 summarizes the degree of concentration in the industry over the last decade. During this time period, relatively little consolidation has occurred compared to prior decades. The 4-firm concentration ratio (CR-4) is a common method to determine the extent of market control through market share of the four largest firms. In theory, the higher the CR-4 the greater the likelihood that the four largest firms are exercising market power. In terms of beef, Cargill's High River and Guelph plants, JBS-Lakeside's (Brooks, Alberta) and the much smaller Harmony (Balzac, Alberta) plant make up the top four plants.[5] This CR-4 remains highly concentrated but stable over the past decade. However, in a Canadian context, feedlots and other producers have the option to export their live animals for slaughter in the US. Domowitz, Hubbard and Peterson (1986) adjust the CR-4 to account for trade. When this adjustment is made for slaughter cattle exports, the resulting CR-4 Adj is smaller than the CR-4 but shows a modest increase in concentration over the last decade. Cargill-High River and JBS Brooks each process over 1.1 million animals a year which is comparable to large plants operating in the US.[6] The

[4] Efficiency considerations along with these extra costs resulted in consolidation
[5] The 2020 Canfax (2020a) annual report lists all 20 of Canada's federally inspected packing plants and their capacities
[6] In 2006 the US had 14 plants that process more than 1 million cattle per year (Ward, 2010)

concentration of animals delivered to these two plants averages 66% of total slaughter. The other form of concentration is with respect to the regional distribution of meatpacking plants across Canada. Cattle slaughter is centered in Alberta, where most of the feedlot capacity is located, and accounts for 74% of the Canadian market.

Table 1 Concentration of Canadian Beef and Pork Packers

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Cattle										
# of plants	26	22	20	19	21	21	20	21	20	20
CR-4	95%	94%	95%	98%	98%	98%	98%	96%	95%	96%
CR-4 Adj[7]	71%	76%	73%	69%	65%	73%	76%	79%	79%	78%
Share plant size > 1 mil[8]	64%	59%	64%	67%	66%	66%	69%	65%	65%	66%
Alberta share[4]	72%	68%	65%	69%	67%	68%	70%	72%	72%	74%
Hogs										
# of plants	34	32	30	29	29	26	27	28	28	27
CR-4	73%	66%	65%	63%	65%	67%	67%	71%	71%	71%
CR-4 Adj[4]	70%	63%	62%	60%	62%	64%	64%	68%	69%	68%
Share Ontario/Quebec[4]	59%	%9%	58%	58%	58%	58%	58%	58%	59%	59%

Olymel and Maple Leaf Foods dominate hog slaughter with most of the operations centered in Quebec followed by roughly equal production capacity in Ontario, Manitoba, and Alberta (McEwen, 2010). The hog *CR-4* is lower than for beef, but stable over the past decade. Considerably fewer market hogs are exported from Canada to the US compared to slaughter cattle, so the hog *CR-4 Adj* is only marginally smaller than the unadjusted concentration measure. Two plants- Olymel (Red Deer, Alberta) and Maple Leaf (Brandon, Manitoba) process over 4.5 million animals a year, but the size discrepancy between these plants and other plants is much smaller than in beef packing (McKewen, 2010).[9] Dispersion of hog processing is much more regionally distributed, but Quebec and Ontario still account for roughly 60% of the market.

[7] The adjusted concentration ratio is CR-4*(1-exports/marketings) with data supplied by AAFC (2020a).
[8] Source Canfax (2020a)
[9] A large plant in Tar Heel, North Carolina processes 32,000 hogs per day.

Given the structure and concentration of the Canadian meatpacking sector, it is important to understand how efficient the sector is and how resilient it is to market shocks and disruptions. History explains much of the consolidation and centralization of the industry, but if being resilient in the face of large labour disruptions requires less centralization, what considerations affect this adjustment while still ensuring an efficient sector?

Economic efficiency includes both technical (minimizing inputs per unit of output) and allocative (choosing the optimal input mix) efficiency. These forms of efficiency interact with each other and ultimately determine the performance and conduct of the industry. Technical efficiency can be decomposed into pure technical efficiency, input congestion (over utilization of inputs), and scale efficiency components (Weersink *et al.*, 1990). Economies of scale dominate meatpacking and numerous studies have found significant scale economies for both beef and pork processing (MacDonald *et al*., 2000). It is for this reason that economies of scale will largely determine any future adjustments that take place in the industry.

The trend towards fewer and larger plants was driven by the enhanced economic efficiency and cost management associated with operating larger firms. Minimum efficient scale is the size of the plant at which average total cost is at a minimum. Ward (2010) and MacDonald *et al.* (2000) estimated that minimum efficient scale for US beef packing was in the 1 to 1.1 million animals per year range. Koontz (2020) identified typical US commercial slaughter plants as processing 1.3 to 1.8 million animals per year. Similar volumes apply to Canada. MacDonald *et al.* (2000) found that processing costs for large meatpacking plants were 12% lower than for medium sized plants and 25% to 40% lower than for small plants.

The sources of the scale economies are many and diverse including the division of labour, ownership of centralized distribution systems, and utilization of animal by-products. The

one unchanging factor is the presence of large, fixed costs which must be spread over more units of output to be efficient and optimize profitability. The fixed costs can include direct costs such as machinery and animal procurement, and other indirect administrative costs.[10] Scale economies may also result from fixities which are imbedded in the technology because of lumpiness of capital equipment which requires high rates of utilization (Morrison Paul, 2000). So, plant capacity utilization also significantly affects operating costs. Although the larger-scale plants can achieve lower per head costs, they must operate at high levels of capacity utilization. A larger plant with a lower capacity utilization rate may have higher unit costs than a smaller plant that operates near full capacity (Ward, 2000). Consequently, larger plants have lower unit costs than smaller plants both because they are larger and because they operate at higher capacity utilization.

Over time, technologies have improved, including slaughter technology, resulting in changes in plant styles, their optimal location and specialization within species. While technological explanations of consolidation are persuasive, they are not necessarily definitive. Complementary organizational arrangements between growers (feedlots or hog finishers) and processors provide the packers with a steady flow of livestock necessary to realize economies of size (MacDonald and Ollinger, 2005). This requires that growers and packers be located within the same region. A worrying trend is the decline of the pasture-based cow-calf sector in western Canada. Close competition for the acquisition of prime cattle typically takes place within regional areas of approximately 400 km from a point of sale (Australian Competition and Consumer Commission, 2017). Large packers are best suited to process undifferentiated products because they do not have the flexibility to produce niche products or frequently change

[10] The majority of a packer's expenses are for the physical facility, equipment, management, portions of the meat sales force and company management (Koontz, 2020).

products mixes. Finally, declining North American beef demand over the last five decades, combined with larger plant sizes, have also driven industry consolidation and concentration.

Classical views of Industrial Organization suggested a causal relation between industry concentration and the exercise of market power. With increasing returns to scale for each unit of output, average cost always exceeds marginal cost and because of this costing relationship it is not possible to marginal cost price. Put more succinctly, competitive pricing is not possible. The ability to control input and output prices has important implications for potential entrants. Not only do incumbents have a cost advantage, but they can also change their procurement prices to draw livestock away from potential entrants. If incumbents can adjust their prices to dissuade entry, then the prospects for developing mid-sized regionally distributed plants are greatly diminished. This problem already arises where nearby US plants draw just enough animals to fill a late shift making it uneconomic for a Canadian plant to expand slaughter. This pricing flexibility and other advantages of incumbency may limit the industry's ability to adjust to a more resilient structure that is both more dispersed across regions and firms.

There has been significant research on the pricing competitiveness of the sector with respect to input markets (that is how much are procurement prices set below competitive levels) and in output markets (how much are wholesale prices set above competitive levels). Azzam (1998) surveyed early research on the exercise of market power and found a mixture of outcomes with slightly more studies finding statistically significant evidence of the exercise of oligopsony power by beef packers. Morrison Paul (2001) examined input and output markets and found statistically significant, but not substantive, market power which was mostly associated with the output market. Furthermore, she found significant scale economies and concluded that the cost savings counteracted any market power. Sexton (2000) concluded that market power estimates

in meatpacking are modest and structural changes on balance are probably beneficial from an efficiency viewpoint. Rude, Harrison and Carlberg (2008) tested for market power in Canadian beef packing and could not find evidence of oligopsonistic power except when the US border was closed.

On balance there are more studies that could not find consistent evidence of the existence of sustained substantial market power with respect to the purchase of cattle. However, there is some evidence that pricing within fed cattle markets has periods of intense competition and periods where competition is softer (Cai, Steigert, and Koontz, 2011). These studies identified cooperative and non-cooperative short-term phases of pricing conduct. The implication is that this switching behaviour could dissuade potential entry into the industry. Even with small price changes, meatpacking is a margin-driven business where firms buy livestock at prices within a small range around the market average price (Ward 2010). Seemingly small impacts in price can make a substantial difference to rival meatpacking firms operating at the margin for remaining viable or being forced to exit an industry. So even limited exercise of market power could affect industry structure and the ability of the industry to adjust towards a less concentrated structure.

4. Impact of COVID-19

Across North America, a series of shutdowns and slowdowns stretching from late March to mid-June occurred as COVID-19 infected 9% of US meat plant workers (Center for Disease Control, 2020). At its peak in late April, US weekly beef production declined by one third (USDA AMS, 2020). In terms of Canadian beef packers, Cargill's High River plant was responsible for the single largest COVID-19 outbreak (almost 900 employees were infected) for North American meat packers. At the JBS Brooks Alberta plant, more than 500 of the 2,600 employees had contracted COVID-19 (Ross, 2020). As a result, the Cargill plant had to close and the JBS plant

faced significant slowdowns. Domestic beef slaughter declined by 54% between the average slaughter for first quarter of 2020 and the peak disruption in late May (see Figure 1).[11] Pork slaughter facilities faced smaller and more sporadic shutdowns in Quebec and Ontario. Domestic hog slaughter declined by 23% between the average slaughter for first quarter of 2020 and the peak disruption in late April (see Figure 1).

Given reduced slaughter across North America, there was reduced demand for fed livestock and a corresponding decline in the wholesale supply of meat. The workings of the market ensured that wholesale prices increased and that farm prices declined. This increase in the margin would have occurred in a competitive market and did not require any exercise of market power. At the peak of the crisis, wholesale boxed beef primal prices (see Figure 2) more than doubled (127%) from the prices in the first quarter of 2020 because of the COVID-19 induced production slowdowns. A similar increase (see Figure 2) in wholesale pork (butt) prices resulted in a 46% increase from first quarter 2020 prices (USDA-AMS, 2020).

The slaughter backlog led to reduced demand for fed cattle resulting in a 36% lower Alberta fed steer price between the first quarter of 2020 and the price in late May (see Figure 3). At its peak in late April, the backlog of western Canadian cattle was 133,000 head (Grant, 2020). Because of the backlog, feedlots faced higher input costs where rations had to be adjusted to hold cattle on feed longer while at the same time trying to minimize weight gain. Processors penalize producers for animals that are heavier than average. To date, the Canadian backlog has been reduced by almost 30% with further reductions expected (Grant, 2020). Very large backlogs continue to be a problem for US plants. Finished hog prices also declined by 18% between the

[11] Canadian processing plants have recently been delisted by China due to Covid-19 cases within these plants. This has reduced our competitiveness relative to competing US firms.

first quarter of 2020 and late May (see Figure 3). Hogs cannot be held on maintenance rations for more than two weeks. The hold back on placements had the largest effect on weaner pigs, with a dramatic effect on prices. There was also an issue, with respect to Quebec slaughter plants, that gave priority to Quebec hogs relative to those from Ontario and the Maritimes.

The packing industry was forced to make a number of adjustments in response to COVID-19. First, the high degree of infections of packing plant workers caused the plants to adjust their capacity utilization. Constrained labour availability forced plants to make major adjustments which included introduction of safety screens, barriers, physical-distancing in lunchrooms, restrictions on car pooling and other measures to try to prevent additional COVID-19 outbreaks. Economic incentives are for the packing sector to operate at as high a capacity as possible. Incorporating distancing and shielding between workers often required changing the plant layout, slowing processing line speeds, and cutting shifts. Some plants were forced to shut down and do major clean-ups. These adjustments had an immediate impact on capacity utilization. Whereas commercial packers typically operate at 95% or better capacity utilization, some plants fell to operating at below 30% of potential capacity (Koontz, 2020). Plants operating at such low levels of capacity no longer benefit from scale economies and face significantly higher operating costs per animal slaughtered.

5. Measures to make the sector more resilient

What is resilience? The usual definition relates to the capacity to recover quickly from difficulties by being adaptable and nimble. The knock against the current packing industry structure is not that it is big, but that it is fragile, and the downside of the fragility is the impact on the supply chain and ultimately the consumer. Vulnerabilities arose from the health and availability of workers and their impact in terms of shut-downs and reduced capacity utilization,

as well as regulatory rigidities. These rigidities associated with labeling, packaging and inspection slowed the movement of meat between sectors (for example between the shut-down food service sector and grocers).

The broader implications of making the sector more resilient involves improved risk management. The gamut of risks range from border closures and trade challenges to disease outbreaks to labour disruptions to buyer resistance for consuming animal proteins. Certainly, there is no one-sized fits-all strategy to manage these risks.[12] Diversification across regions and plant types will address some risks but not others. There is a trade-off between efficiencies (scale and otherwise) and general stress-time resilience. Any adjustment in the system must account for these trade-offs. To begin the process of adjustment in the future will require a number of steps. First, many of the current plants, particularly in beef, need to be retrofitted to ensure worker safety. Second, additional regulations need to be introduced to protect the health of workers and the security of the food supply. Unfortunately, increased regulation has the unintended consequence of increasing fixed costs, therefore contributing to additional scale economies that would further entrench the existing industry structure. So further steps will have to consider future industry structure. In addition to refining our definition of resilience, it is necessary to develop indicators or criteria for which alternative industry structures would have helped. The first criteria is whether an alternative industry structure would have resulted in the same impacts. The second criteria is whether the new structure is flexible enough to adjust to unforeseen, low probability emergencies. We will consider three possible industry structure scenarios. The first scenario would retain the existing industry structure but build in excess

[12] The largest pork plants in Canada are currently unable to ship to China because they are *delisted*, as approve importers, due to COVID-19 despite an international consensus that COVID-19 is not a food risk. It remains to be seen if diversification through smaller plants would make the industry more resilient to these trade disruptions.

capacity or slack to account for low probability emergencies. The second scenario would rapidly adopt robotics to protect human health and reduce the frequency of shutdowns. The third scenario would introduce small and medium sized plants that are more evenly distributed across regions.

5.1 Scenario 1: Introducing slack in the system

While commercial meatpacking plants are physically configured to optimize efficiency, they are not configured to account for risks to human health from working in close proximity. Increased regulation will likely require all meatpacking plants to provide extra space in their facilities to allow workers to maintain social distancing (e.g. common areas, bathrooms etc.). This will have the effect of slowing down line speeds and reducing capacity utilization. Additional increases in overall system capacity introduce further slack into the system and reduce the probability of future unanticipated supply shortages but do not affect worker health. Again, the effect of increased capacity is reduced capacity utilization, increased costs, and if the US followed a similar approach, ultimately higher prices for consumers.

In the US, commercial plants operate two shifts per day, six days a week, and typically process 25,000 to 35,000 head of cattle per week (Koontz, 2020). Koontz argues that increasing excess capacity by 20%, increases per animal costs by 7%-10% and doubling that slack, increases operating costs per animal by 15%-20% relative to potential costs at full capacity (Koontz, 2020). The most expensive-to-operate commercial beef plants, when operated at reduced capacity, incur costs of about $300- $350 per head (Koontz, 2020). While commercial operating costs would increase substantially under this scenario, these per head costs are still lower than the costs faced by small start-up packing plants (see below). Introducing slack into the system dramatically increases costs which will be passed on to a retail consumer who is used to competitively-priced protein sources. Regardless of the adjustments made, consumer meat

prices will increase because of higher wages, slower line speeds, and the reallocation of meat processing costs forward from packers to retailers.

5.2 Scenario 2: The potential for robotics

Going forward, aside from a vaccine, robotics offers the greatest potential to limit the spread of COVID-19 while reducing floor space and waste, and producing a more uniform, higher quality hygienic product. Robotic systems exploit artificial intelligence (machine learning) to replace many labour-intensive operations. Each time the robots receive a carcass, they utilize X-ray and Computerized Tomography (CT) scans to map the carcass and decide how to most efficiently cut the primal (Wilson, 2018). However, the meat industry is not as conducive to robotics as other sectors and automation requires large financial investments, with the payback slow, and the necessary volumes, large. Robotic components are not always compatible with sanitary requirements for working surfaces that come into contact with the meat. Teaching robots to cut and sort meat involves "soft material and variability" and creates a challenging operational environment (Bunge and Newman, 2020). The process of hand cutting meat is more tactile than visual (Radke, 2018). To date, labour is still cheaper than robotics, and humans can do skilled jobs (e.g. deboning) much better than machines with less potential to waste high valued meat. However, the difficulty of acquiring labour, high annual turn-over rates (40-70%) and increasing wages all make robotics more attractive. Furthermore, as the day progresses, human meat cutters tire and become less consistent. And robots have the advantage of not getting sick.

In 2020, JBS-USA plans to spend $1 billion in capital expenditures for technology and automation (Bunge and Newman, 2020). In 2015, JBS bought a controlling share of New Zealand-based Scott Technology, an automation and robotics company (Wilson, 2018 HBS). This investment was attractive because lambs have a uniform carcass, which makes it easier to apply robotics, and most lamb meat is sold bone-in, which is not the case for beef and pork.

Similarly, over the past three years, Tyson has invested roughly $500 million in technology and automation (Bunge and Newman, 2020).

Automation along segments of the assembly line can replace arduous processes with machines rather than changing the whole production line. Primal cutting using robotics is a major challenge because of wide variations in the size and shape of carcasses and because robots have both limited motion and decision-making ability to deal with this heterogeneity. Pig carcasses are the most uniform large carcass animals and technologies have been developed to automate the complete slaughter line (Joshi *et al*., 2016). European packers have been early adopters of robotics. Japan has developed some very advanced pork boning robotics (Mayekawa, 2020). Beef is more heterogeneous across animals, and the opportunity cost of waste from inaccurate processing is higher than for other meats. However, rising wages, increased employee health concerns and the desire to keep up with technological advances, mean that the time is not that far away when all processes in meat processing, starting from primary processing, secondary processing, packing and despatch, will be fully automated (Joshi *et al*., 2016).

5.3 Scenario 3: Smaller plants

It is difficult to determine if the same degree of COVID-19 infections would have occurred if animal slaughter was regionally distributed across smaller and medium sized plants. There are two effects determining this overall potential impact for the spread of the virus. First, the cutting and deboning of carcasses takes place in a refrigerated assembly line which by the close contact nature of the work, and the method of aerosol exposure, is unlikely to be affected by plant scale (The Meating Place, 2020). The second factor relates to regional diversification and the probability that regions are not equally and simultaneously affected by COVID-19 (see Lusk

2020 for an illustration). Which of these effects dominates is an unanswered empirical question that needs to be further studied.

Let us begin by defining three types of cattle plants: small (20 head/week), medium (100 to 1000 head/week) and large (1000-5000 head/day).[13] Regardless of the size of the plant, there are some initial conditions that are necessary before an investor would even begin to consider establishing a packing plant. First, are there enough slaughter animals within a reasonable distance of where the plant is to be established so that the facility is able to procure a continuous flow of livestock?[14] Second, is there a sufficient labour force (including slack) to operate the plant? Most potential operations would be in rural areas and acquiring labour and plant inspectors could be a problem. Secondly, site location is also complicated by lack of an adequate water supply and water treatment facilities, and the associated regulatory hurdles. Many of the smaller and medium sized pants would be provincially inspected rather than federally-inspected.[15] Third, do the operators (and probably investors) have the practical expertise and technical knowledge required? Finally, is start-up financing available and will the project be financially feasible? These start-up costs will vary significantly depending on size, automation, and capacity. A small beef facility would require 3,000-4,000 square feet of space (HBS). Robert Maddock of North Dakota State University estimates that the investment for a small plant would cost $525 per square foot. So, a typical small plant would cost around $1.6 to $2.1 million (Wolf, 2020). The Australian Competition and Consumer Commission (2017 p50) has a unique perspective on the potential for new entrants and recommended “a minimum scale of 400

[13] Currently Canadian federally inspected slaughter is allowed among 43% small plants, 47% medium plants and 10% large plants (Canfax, 2020a).
[14] Close competition for the acquisition of prime cattle typically takes place within regional areas of approximately 400 km from a point of sale (ACCC, 2017).
[15] Over the last 5 years provincial slaughter has been 5.8% of total federally inspected slaughter (Grant, 2020).

head of cattle per day". Based on their estimates, a new plant of this scale would cost between $31 million and $47 million. There are not many recent North American packing plant feasibility studies available, but a quick survey of recent research suggests that the cost for a medium sized plant might begin at $39 million.

Gross margins are typically used to determine the financial feasibility of the meatpacking industry (Sweatt, Peel, and Ward, 1996). A gross margin is the difference between total revenue (meat sold plus by-products) less costs (live animal inputs). Koontz (2020) estimates that a typical commercial beef slaughter facility expenses run at approximately $235 to $295 per head. The operating cost for a small plant is two to three times a commercial plant cost per head. For example, very small packing operations that serve the freezer beef market incur costs of $790-$925 per animal (Koontz, 2020). Commercial packers provide a homogenous product in a market where they are largely price takers, so they have to compete based on cost efficiency (Sparling, Quadri and van Duren 2005). The numbers quoted above suggest that small and medium sized packers cannot compete on a cost basis with commercial operations. They will have to compete in niche markets through product differentiation so that they can command a premium price and strive for a somewhat comparable gross margin with the commercial sized operations. They need to be able to find new buyers to pass the extra costs on to by creating value-added benefits through process differentiation (local, natural, hormone free, organic) and branding of their products (Sparling, Quadri and van Duren 2005). Because of COVID-19, consumer behavior may also have changed in favor of local food if consumers view these sources of supply to be more resilient and reliable in uncertain markets (Hobbs, 2020). Interest has peaked for farm-to-consumer sales. The province of Alberta has even changed legislation so

that the meat from animals killed by mobile butchers and farmers licensed to carry out uninspected slaughter can be sold directly by farmers to the public.

6. Summary and Recommendations

While the North American meatpacking sector was severely disrupted by COVID-19 because of worker health problems and interruptions with respect to its labour force, the rest of the meat supply chain was remarkably unaffected by the virus directly, while indirect impacts have been felt through the market. The fact that the border remained open between the US and Canada served to stabilize supplies and prices to some degree. Canada provided the US with a steady supply of grinding meat imports while the US temporally provided Canada with more expensive cuts. Relative to the other types of disruptions that could have occurred - e.g. reportable diseases such as F*oot and Mouth Disease* in cattle or *African Swine Fever* - the impacts of Covid-19 have so far been relatively minor. Either disease would have shut the border to exports, disrupted interprovincial trade, and lead to drastic reductions in livestock herds and the associated adjustment costs.

The question remains whether the meatpacking sector is truly more vulnerable than other parts of the food supply chain, and if so, is it resilient to shocks? Temple Grandin, a professor of animal sciences at Colorado State University, argues "(t)he bottom line is, there will always be a trade-off. Big suppliers are low cost, efficient and fragile. More numerous local producers are more high cost and expensive, but the entire supply is more robust." (Grandin 2020). In a sense, having both structures serves as a risk mitigation strategy.

I have offered three alternative scenarios for reforms to the structure of the industry to make the sector more resilient. They are not mutually-exclusive and they interact with each other, affecting the relative feasibility of each. Introducing slack in the production process for

major packers increases their operating costs, making the smaller-sized processors potentially more competitive. However, this relative cost adjustment is unlikely to affect the development and expansion of the small-scale specialty processors. Conversely, a market with more small processors is unlikely to affect the operations of large packers. The large packers serve the commercial market for beef and pork, while the small processors generally serve niche markets most effectively with direct sales to consumers and sales of carcasses to retail butcher shops. In fact, one technological innovation that transformed the industry in the 1980s was boxed beef and this innovation changed the relationship between packer and retailers. Prior to this time, packers sold carcasses directly to retailers who would do most of the cutting. Subsequently, with packers doing more of the cutting, physical plant additions and more labour were required for the extra cutting done by the packer. This encouraged increased scale of the plants, moving them to rural locations closer to cattle supplies, and because of increased labour use, made the sector more susceptible to labour disruptions.

Adoption of robotics will change the dynamics of the relationship between agents. Robotic carcass disassembly has the potential to reduce labour disruptions, but it will not reduce other disruptions like plant fires, floods, and/or electrical failures, etc. Although these automated systems are suitable for working in all kinds of harsh environments, they are not completely reliable and handling biological material, as is done in packing plants, increases complexities and associated uncertainties (Joshi *et al.*, 2016). Robotics are very likely to be adopted by the big four packers, but because of the large initial investments required, similar automation is not likely to be adopted by small and medium sized processors. To the extent that robotics reduce downtime, capacity utilization in large plants should increase and operating costs should decline.

This will make it even more difficult for small and medium plants to compete or enter the market.

The third scenario is to promote small and medium plants to increase supply chain resilience. Promoting alternative processors is at best challenging. The incumbents have significant cost and operational advantages. Grocers exercise considerable oligopsony power with respect to procurement from commercial processors. Stocking fees and fines for incomplete deliveries plague large processors and would represent an insurmountable barrier for new smaller entrants. To succeed, the entrants have to look to new opportunities – direct to consumer sales, specialized markets, and other niche markets. Any entry attempts involve regulatory hurdles. Waste disposal and water utilization regulations increase fixed costs, significantly contribute to scale economies and dissuade the start-up of smaller operations. Food safety statutes and regulations play a significant role in determining the structure of the agri-food system.[16] Political economy considerations play a large role in developing food safety regulations. Often the regulations benefit only particular groups within a sector and do not address the needs of others. Variation in size, age, and management of plants results in different food safety adoption costs with typically lower throughput plants having to pay more (Malcolm *et al.*, 2004).

Any meat or meat product sold in Canada must come from inspected sources. Cattle can be slaughtered in provincially licensed plants (under provincial statutes with provincial inspectors), in federally registered facilities (Meat Inspection Act and administered by CFIA) or from approved imported sources. Provincial inspection has been criticized for a lack of standardized procedures within and between provinces, the absence of HAACP standards, and a lack of frequent inspections (Fong et al., 2017). Most small start-ups would at least initially be

[16] Jenson, Unnevehr and Garcia (1998) find that additional food safety regulations expenses represent about 1 % of total processing costs for beef and pork. In some cases, these costs could rise to 10% of total costs.

provincially regulated because of the expense and complex process of becoming federally regulated. However, there are limitations for provincially-inspected meat. First, only federally inspected meat can be traded interprovincially or internationally. Second, major retailers may be reluctant to stock products that are provincially inspected because of a lack of standardization due to shared responsibility across regions and increased complexity for issues such as labelling. The COVID-19 experience was that the CFIA introduced certain regulatory flexibilities – including interprovincial movement of provincially-inspected meat and flexibility in certain labelling requirements for packaged foods to better facilitate the movement of foods within the supply chain and reduce waste. Longer-term flexibility can improve the efficiencies of smaller plants and make the industry more resilient.

Returning to the original question of whether industry could have been better situated to adjust to the disruption - the answer is yes. However, there is little evidence that a less concentrated, more geographically dispersed sector would have performed better. The question remains of how to make the sector more resilient going forward. There is no unique answer to this question because every new disruption is different, and there are significant trade-offs between alternative structures for the industry. Additional capacity could help buffer the system from future disruptions. However, this capacity comes at a high cost regardless of whether it is achieved by expanding existing capacity or adding new broadly dispersed packing capacity. Given the large degree of uncertainty and the large number of possible trade-offs it is only possible to make a few broad recommendations as to the ideal industry structure.

RECOMMENDATION 1: If smaller plants are to be built, then do not provide direct government support. Experience shows that even with government support, previous attempts to expand beef packing capacity were not successful and eventually the ventures failed. Instead, government participation should come indirectly through independent feasibility studies and other sources of independent market information. More

generally, an enhanced investment environment requires an improvement in the broader macroeconomic environment through competitive tax rates, and responsible fiscal and monetary policy.

RECOMMENDATION 2: If slack is to be built into the system, then there is a need for an *entire supply chain strategy*. The beef sector has been criticised for a lack of an explicit strategy and an absence of alignment between supply-chain stakeholders. Evidence suggests that the industry has come together to adjust to COVID-19, but there needs to be tangible evidence that these discussions will bear fruit. Hobbs (2020) argues that "(s)upply chain responsiveness is a key dimension of resilience, and future efforts to enhance resilience through strategic inventory management plans and flexible procurement strategies will be important."

RECOMMENDATION 3: A competitive and resilient processing sector depends on open borders and continued integration with the US market. Open borders discipline the use of market power in a concentrated market, incent innovation, and ensure a secure supply of meat when temporary shortages arise.

RECOMMENDATION 4: There is no one-size fits-all solution to improve resilience. Rather it depends on a learning process from the COVID-19 experience and adherence to risk management best practices.

References

Agriculture and Agri-Food Canada. (2020a). "Distribution of slaughtering activity" https://www.agr.gc.ca/eng/animal-industry/red-meat-and-livestock-market-information/slaughter/distribution-of-slaught"ering-activity/?id=1415860000049.

Agriculture and Agri-Food Canada. (2020b). Red meat and livestock slaughter reports. http://www.agr.gc.ca/eng/animal-industry/red-meat-and-livestock/red-meat-and-livestock-market-information/slaughter/?id=1415860000003.

Australian Competition and Consumer Commission. 2017. "Cattle and beef market study-Final report"https://www.accc.gov.au/system/files/ACCC%20Cattle%20and%20beef%20market%20study Final%20report.pdf.

Azzam A. 1998. "Competition in the US meatpacking industry: is it history? *Agricultural Economics*. 18: 107-126.

Bunge J and J. Newman. 2020. "Tyson Turns to Robot Butchers, Spurred by Coronavirus Outbreaks" Wall Street Journal, https://www.wsj.com/articles/meatpackers-covid-safety-automation-robots-coronavirus-11594303535.

Cai X., K. Stiegert and S. Koontz, 2011. "Regime switching and oligopsony power: the case of U.S. beef processing," Agricultural Economics, International Association of Agricultural Economists, vol. 42(1): 99-109.

Canfax, 2020a, "Packer Directory – Canadian Federally Inspected Plants" Canfax-2019 Annual Report

Canfax 2020b, Special data request.

Domowitz I., G. Hubbard and B. Petersen (1986) "Business Cycles and the Relationship Between Price-Cost Margins" Rand Journal of Economics 17: 1-17.

Edmiston J. 2020 "Three meat-packing plants turn out 85% of Canada's beef. How did this happen?" Financial Post https://financialpost.com/commodities/agriculture/why-only-three-meat-packing-plants-process-the-vast-majority-of-canadas-beef.

Fong K., J. Faladeau, K. Rideout, L. Wilcott, D. Fong and S. Wang. 2017. "Opinions of Provincial Food Safety Specialists on Addressing Canada's Beef Processing Risks." *Food Protection Trends*. 37(5): 316-331

Grandin T. 2020. "Temple Grandin: Big Meat Supply Chains Are Fragile" Forbes https://www.forbes.com/sites/templegrandin/2020/05/03/temple-grandin-big-meat-supply-chains-are-fragile/#e861c06650c3.

Grant, B. 2020. Manager Canfax Research Services. Personal communication. August 7, 2020.

Hobbs, J. 2020. Food supply chains during the COVID-19 pandemic. Canadian Journal of Agricultural Economics 68:171–176. https://doi.org/10.1111/cjag.12237

Jensen, H., L. Unnevehr, and M. Gomez. 1998 "The Costs of Improving Food Safety in the Meat Sector." Journal of Agricultural and Applied Economics 30:83-94.

Joshi K., T. Norton, J. Frías, and B. Tiwari. 2012. "Robotics in meat processing." in *Emerging Technologies in Meat Processing: Production, Processing and Technology* (E. Cummins and J. Lyng, editors) John Wiley & Sons, Ltd.

Koontz S., 2020, "Economic Reasons for What was Observed in Fed Cattle and Beef Markets During the Spring of 2020" *Department of Agricultural & Resource Economics – Colorado State U.* http://www.themarketworks.org/sites/default/files/uploads/studies/Economic-Reasons-Koontz.pdf.

Lusk, J. (2020). Concentration and Resilience. Blogpost. August 4, 2020 http://jaysonlusk.com/blog/2020/8/4/concentration-and-resilience.

MacArthur, M., K. Briere, and I. Bell. 2005. Calculating capacities. The Western Producer, 31 March. Saskatoon, SK.

MacDonald, J., M. Ollinger, K. Nelson, and C. Handy. 2000. Consolidation in U.S. meatpacking. Agricultural Economic Report No. 875. Food and Rural Economics Division, Economic Research Service, United States Department of Agriculture. Washington, D.C.

MacDonald, J., and Ollinger, M. 2005. Technology, labor wars, and producer dynamics: Explaining consolidation in beefpacking. American Journal of Agricultural Economics. 87(4), 1020-1033.

MacLachlan. 2001. *Kill and Chill: Restructuring Canada's Beef Commodity Chain*. University of Toronto Press.

Malcolm, S.A., C.A. Narrod., T. Roberts and M. Ollinger (2004) "Evaluating the economics effectiveness of pathogen reduction technologies in cattle slaughter plants". Agribusiness, 20(1) P.93-123.

Mayekawa Global. 2020. "Deboning machines" https://www.mayekawa.com/products/deboning_machines/

McCarthy R. and S. Danley. 2020. "Map: COVID-19 meat plant closures." Meat + Poultry https://www.meatpoultry.com/articles/22993-covid-19-meat-plant-map

McEwen K. 2010. "Hog Processing in Canada" https://www.ridgetownc.com/research/documents/mcewan_Processing_Jan_2010.pdf.

Meatingplace. 2020. "The good, the bad and the ugly" August Edition http://library.meatingplace.com/publication/frame.php?i=669441&p=&pn=&ver=html5

Melton, B.E., W.E., Huffman. 1995. "Beef and Pork packing costs and input demand: Effect of unionization and technology" American Journal of Agriculture Economics. 77, 471-485.

MNP. 2004. "Beef Processing in Manitoba: Feasibility Analysis" prepared for Manitoba Agriculture, Food and Rural Initiatives Economic Development Initiatives Branch https://www.manitoba.ca/agriculture/livestock/pubs/beef-processing-final-report.pdf.

Morrison Paul, C. 2001. "Market and cost structure in the U.S. beef packing industry: A plant-level analysis". *American Journal of Agricultural Economics* 83(1), 64-76.

Ontario Pork, 2020, Ontario 100% formula 100 index price

Radke A. 2020. "Could robot butchers replace employees in packing plants?" https://www.beefmagazine.com/outlook/could-robot-butchers-replace-employees-packing-plants.

Reuters. 2020. "Canadian province of Alberta loosens animal slaughter rules after pandemic hit packers" https://ca.reuters.com/article/domesticNews/idCAKCN24U33L

Ross L. 2020. "With meat production, it's time to learn that bigger is not always better" https://rabble.ca/columnists/2020/05/meat-production-its-time-learn-bigger-not-always-better.

Rude J. and J. Carlberg. 2006. "Kill or Shill: Processing Capacity and Cattle Prices with a Closed Border." *Current Agriculture, Food and Resource Issues*. 7: 85-93.

Rude, J., D. Harrison, and J. Carlberg. 2011. "Market Power in Canadian Beef Packing." *Canadian Journal of Agricultural Economics* 59: 321-336.

Sweatt, E., D. Peel, and C. Ward. 1996. "ESTIMATING GROSS MARGINS IN MEATPACKING FOR BEEF, PORK, AND LAMB" Department of Agricultural Economics, Oklahoma State University.

Sexton, R.J. 2000) Industrialization and consolidation in the U.S. food sector: Implications for competition and welfare. American Journal of Agricultural Economics 82(5): 1087-1104.

Sparling D., T. Quadri and E. van Duren. 2005. "Consolidation in the Canadian Agri-food Sector and the Impact on Farm Incomes" Canadian Agricultural Policy Institute. https://capi-icpa.ca/wp-content/uploads/2005/06/Consolidation-in-the-Canadian-Agri-food-Sector-and-the-Impact-on-Farm-Incomes-2005.pdf.

Treasury Board Secretariat. 2007 "Section II - Analysis of Performance: Agriculture and Agrifood Canada" https://www.tbs-sct.gc.ca/dpr-rmr/2006-2007/inst/agr/agr02-eng.asp.

United States Department of Agriculture Agricultural Marketing Service (USDA AMS), 2020. National Weekly Cattle and Beef Summary. USDA Livestock, Poultry & Grain Market News. https://www.ams.usda.gov/mnreports/lswwcbs.pdf (accessed July 27, 2020).

Ward C. 2010. 2010. "Assessing Competition in the U.S. Beef Packing Industry Choices, Vol. 25, (2)

Ward, C.E. and M.D. Faminow (1992) "Competitiveness in livestock slaughtering and meat processing" Report for the Manitoba Read Meat Forum, Winnipeg, Manitoba

Weersink A., C. Turvey, A. Godah. 1990. "Decomposition Measures of Technical Efficiency for Ontario Dairy Farms" Canadian Journal of Agricultural Economics. 38(4) 1023-1023.

Wilson B. 2018 "JBS and Robot Butchers" https://digital.hbs.edu/platform-rctom/submission/jbs-and-robot-butchers/#.

Wolf M., 2018, "Meat plant to cost $20m" Watertown Daily Times, https://www.nny360.com/news/meat-plant-to-cost-20m/article_2c2ea535-6b01-5811-99db-71e284fdc346.html.

Figures

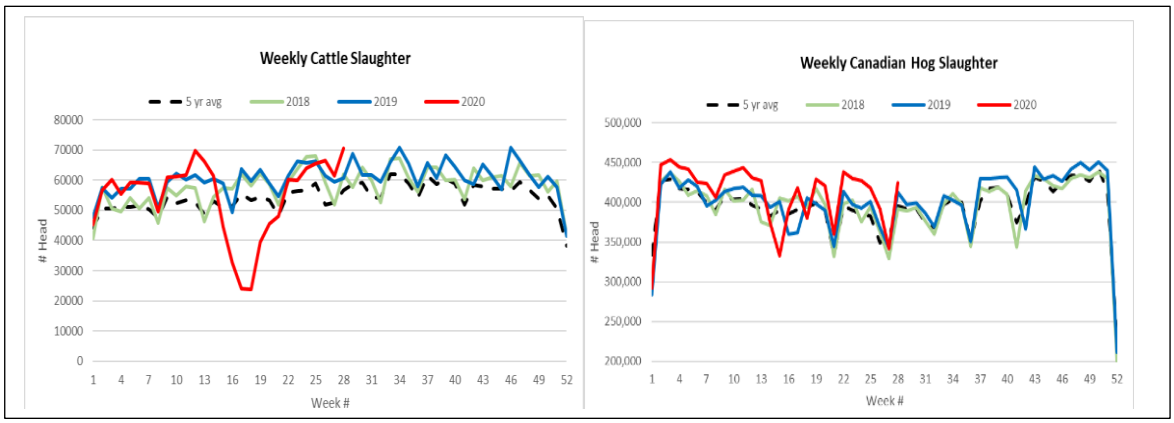

Figure 1: Weekly Slaughter by Animal type
Sources: panel (a) Canfax (2020b); panel (b) from Red Meats Division AAFC (2020b)

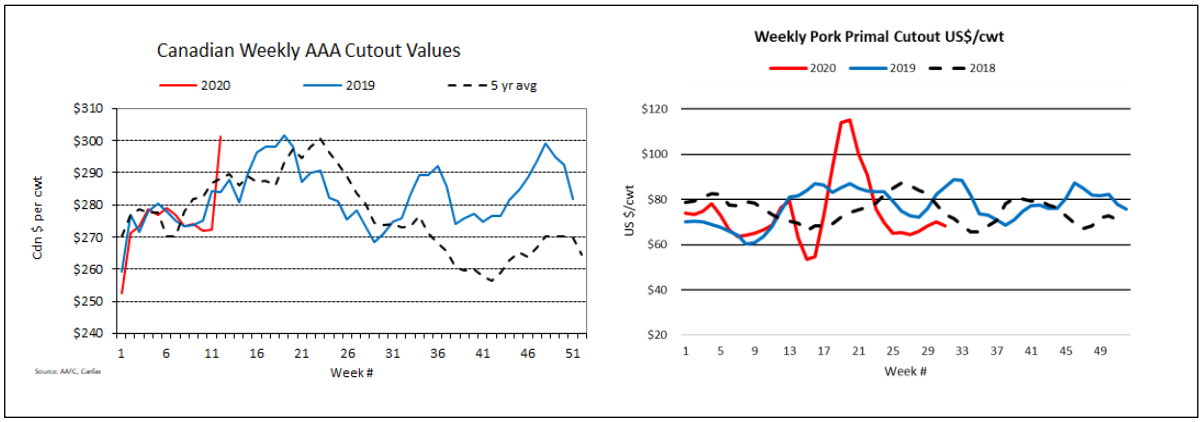

Figure 2: Wholesale prices by meat
Sources: panel (a) Canfax (2020b); panel (b) from McEwen (2020) Personal Communication

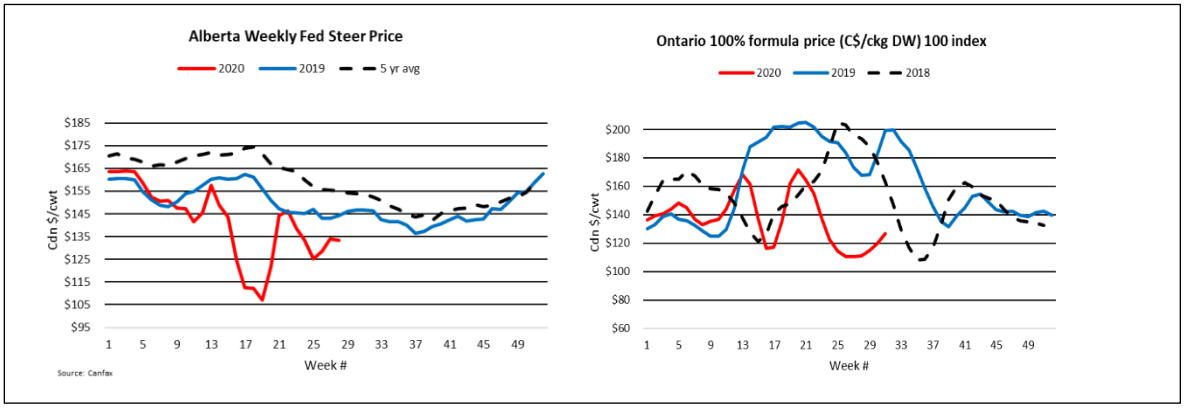

Figure 3: Weekly Fed Livestock Price
Sources: panel (a) from Canfax (2020b); panel (b) Ontario Pork (2020)