Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
The Covid-19 pandemic and meat supply chains

Jill E. Hobbs

Department of Agricultural and Resource Economics, University of Saskatchewan, 51 Campus Drive (3D34.1), Saskatoon S7N 5A8, Canada

ARTICLE INFO

Keywords:
Resiliency
Demand and supply shocks
Economies of scale
Automation
Digitalization
Food values

ABSTRACT

The Covid-19 pandemic has upended societies, economic activity, and business environments. With a focus on the meat processing sector, this paper considers the short, medium, and potential long-term implications of the pandemic for food supply chains. A series of short-run demand and supply shocks affected the food system. The pandemic has generated a lively discourse around the adaptability and resilience of food supply chains in the medium to longer term. Scale and scope economies in meat processing offer significant cost and efficiency advantages, while a more dispersed industry structure can be more flexible. The pandemic is likely to accelerate the adoption of automation and digitalization within food supply chains. The Covid-19 pandemic also focused consumer attention on the food system and the nature of food supply chains. Consumers’ underlying food values may shape their response to uncertainty during a pandemic. The pandemic offers lessons for the food industry in proactively identifying and addressing points of vulnerability within supply chains.

1. Introduction

The Covid-19 pandemic represented a significant ‘black swan’ event, generating wide-ranging public health, economic, and social impacts. The unprecedented global disruption to health care systems, work environments, lifestyles and livelihoods was hard to imagine as 2019 drew to a close. The World Health Organization (WHO) declared Covid-19 a pandemic on March 11, 2020. At the time of writing, almost eight months into the pandemic, the initial short-run impacts of the pandemic on food supply chains are apparent, with medium-term effects taking shape. Harder to discern are the potential longer-term implications for agri-food supply chains and the adaptive strategies that may emerge to foster resilience. This paper examines the short, medium, and potential long-term implications of the Covid-19 pandemic for meat supply chains.

While the focus of the paper is on the meat processing sector, a central consideration is the need to adopt a systems perspective, recognizing that the food processing sector influences, and is influenced by, developments throughout the supply chain. The pandemic brought this reality into sharp focus with respect to the demand and supply shocks that reverberated through meat supply chains in spring and summer, 2020. Supply chain interdependencies are no less important in unpacking potential longer-term implications of the pandemic.

The paper also explores the extent to which the pandemic altered consumer perceptions and attitudes toward the origin and authenticity of food, as well as food safety and security, and whether these are transient changes or represent a deeper shift in attitudes. Finally, the paper explores the policy dialogue around Covid-19 adaptations and supply chain resilience in the meat processing sector, arguing that this dialogue needs to be grounded in a thorough understanding of the underlying economics of the sector.

The paper is organized as follows: Section 2 outlines the short-run demand and supply shocks with which food supply chains contended at the onset of the pandemic. Section 3 explores the emerging discourse around supply chain resilience and adaptability in the medium to longer-term. Section 4 considers the potential implications of the pandemic for consumer confidence in food supply chains, while Section 5 presents conclusions with respect to the broader industry and policy implications of the pandemic.

2. Short-run demand and supply shocks

During the early stages of the pandemic, as various countries imposed lockdowns to slow the spread of the virus, food supply chains were subject to a set of sudden, exogenous demand and supply shocks. Prior to the pandemic, food-away-from-home expenditures accounted for a significant portion of food purchases. In the U.S. food-away-from-home expenditures accounted for just over half of consumers’ food expenditures (Luckstead, Nayga Jr., & Snell, 2020), while in Canada they accounted for around a third of food expenditures prior to the pandemic (Goddard, 2020). With the temporary closure of restaurants and other food service outlets under lockdown rules, food-away-from-home
purchases plummeted, and these food expenditures suddenly switched to supermarkets and other food retail outlets. The effect of the shift in food demand to retail outlets was exacerbated by panic buying and stockpiling behaviours among consumers, leading to short-run stockouts (Hobbs, 2020; Lusk & McCluskey, 2020). Large-scale supermarket retailers dominate the food retail sector in many countries and operate on a just-in-time delivery system. Sophisticated inventory management and planning processes take into account normal supply and demand trends, ensuring that grocery store shelves remain stocked on an ongoing basis. The system is efficient and effective under normal circumstances, but was placed under significant strain by the unprecedented nature of the demand shock. These effects, while severe in some jurisdictions, were largely short-lived during the first wave of the pandemic.

Food supply chains geared up to supply food service outlets needed time to adjust to supplying the food retail sector: establishing new contracts, changing packaging sizes, meeting food retailing labelling requirements, etc. Different product requirements for food service markets created particular short-run challenges for meat supply chains. For example, in an assessment of the impact of COVID-19 on the U.S. broiler industry (Maples, Thompson, Anderson, & Anderson, 2020) point out that whole bird, deboned, and cut-up chicken markets have different bird size specifications, with processing plants and growers specializing in supplying different markets (retail vs. food service). Malone, Schaefer, and Lusk (2020) and Weersink et al. (2021) highlight the disruptions experienced in the egg market, with supply chains either specializing in supplying breaker eggs to the food service market or table eggs to the retail market. Products destined for the food service market may be ill-suited to the retail market. A good example is chicken wings in North America, which are commonly consumed in restaurants and bars but are less likely to be purchased for home preparation. The shuttering of the bar and restaurant sector, combined with the suspension of professional sports tournaments, in April 2020 led to widely reported surpluses of chicken wings on the U.S. market (Bogage, 2020).

Given the biological nature of agricultural production systems there is an inevitable lag in the ability of food supply chains to adjust to a sudden change in market conditions. The length of that lag is determined by the biological nature of the breeding cycle for the particular species (e.g. shorter for broilers, considerably longer for cattle), as well as sunk investments in production systems tailored to specific end markets. Supply-side disruptions to food supply chains also included labour shortages due to illness or worker availability, and changes to food manufacturing processes to implement workforce social distancing measures. Labour-intensive food processing plants were particularly vulnerable to workforce outbreaks of Covid-19. Outbreaks at meat processing plants were reported across a number of countries, including the U.S., Canada, Brazil, and in Europe (Aday & Aday, 2020; Hobbs, 2020; Luckstead et al., 2020; Tonsor & Schulz, 2020; Weersink et al., 2021). Typically, meat processing plants are crowded, noisy workspaces, with workers standing side-by-side and, as noted by Aday and Aday (2020), the cold and humid environment within food processing facilities may facilitate the spread of the virus.

Temporary plant closures due to workforce outbreaks severely disrupted livestock/meat supply chains. Lusk, Tonsor, and Schulz (2020) report that through the last week of April and first week of May, 2020, daily processing volumes for beef and pork in the U.S. were both about 40% below 2019 levels. They also observe that for the two month period from early April through early June, federally inspected cattle slaughter volumes overall were 22% below the same period in 2019, while hog slaughter was down 13% on the previous year. In an effort to help increase U.S. meat supply during this unprecedented situation, the U.S. Food Safety Inspection Service (FSIS) temporarily allowed increased processing speeds at beef, pork, and poultry processing facilities (Luckstead et al., 2020). The U.S. Food and Drug Administration also issued temporary exemptions from certain food safety standards to enable supply chains to shift from food service to retail (Malone et al., 2020). While relaxing regulatory constraints related to food safety inspection and processing line speeds may assist in boosting supply in the short-run, the downside risks are consequential, including the potential to compromise food safety, exacerbate Covid-19 workplace risks for employees in food processing plants, and weaken consumer confidence.

In Canada, temporary closures of meat processing plants in the province of Alberta reportedly caused disruptions across 75% of the Canadian beef supply chain (Keogh & Hand, 2020). The union representing federal government food safety inspectors union initially refused to allow its members to enter meat processing plants experiencing Covid-19 outbreaks (Keogh & Hand, 2020). Had this move persisted it would have been a highly disruptive development since, without access to inspection services, operations at federally inspected processing plants would have to be suspended.

The challenges facing the meat processing sector in North America in the initial stages of the pandemic highlight two salient points: the concentrated nature of the sector and vulnerability to exogenous shocks, and the interdependencies within these supply chain systems. Both have implications for supply chain resilience, but paradoxically, may also be a source of strength and adaptability. These issues are discussed in more detail in the next section.

3. Adaptability and long-run resilience

The pandemic has stimulated a discourse around the structure of food supply chains; namely, the extent to which food supply chains dominated by large-scale, concentrated food processors/retailers are more or less resilient than food supply chains characterized by dispersed small-scale firms serving localized markets. The tension between these two worldviews with respect to food supply chains is not new, but was brought into sharp relief by the immediate impacts of the pandemic. In addressing this question, it is useful to separate short-run effects from longer-run adjustments.

One view holds that a concentrated industry, dominated by a small number of large firms (an oligopoly) creates a potential choke-point within the supply chain, with a failure at that point causing widespread disruption across the system. Covid-19 workforce outbreaks that cause sudden disruptions or temporary closures at food processing plants servicing a significant portion of a market create ripple effects throughout the supply chain. The vulnerability of the concentrated meat packing sector in North America to these types of short-run disruptions was apparent in the first wave of the pandemic. The ripple effects included disruptions in downstream markets (retail), but more significant impacts to the upstream supply chain (livestock producers). The sudden loss of slaughter capacity severely disrupted the market for live cattle and hogs in the short-run. The notion that consumers in rich developed countries would somehow run out of food because of these disruptions was misguided.1 By and large there was plenty of food in the system, with many substitutes available: if a consumer could not find their favourite cut of meat they could buy a substitute. A more pertinent concern is the effects on prices, and the extent to which any rise in retail prices (fall in producer prices) was a result of natural demand and supply conditions or a signal of anti-competitive behaviour by firms with market power.

In the U.S. beef and pork sector, widening spreads between wholesale and retail prices (which increased) and livestock prices (which fell) during the early stages of the pandemic generated a great deal of attention. Were these widening price spreads evidence of anti-competitive behaviour within the concentrated meat packing sector?

---

1 The situation for citizens of developing countries relying on international food assistance is quite different. See Cardwell and Ghazalian (2020) for a discussion of how Covid-19 has affected the demand and supply of international food assistance, including challenges with export restrictions and disrupted supply chains.
Lusk et al. (2020) suggest that this was not the case. As discussed in Section 2, the pandemic unleashed a combination of demand and supply shocks on food supply chains. With packing plants closing, demand for livestock fell, pushing down cattle and hog prices. The closure of large packing plants also meant that smaller quantities of meat and processed meat products were being produced. With the fall in meat supply, retailers and other downstream purchasers of meat are competing for reduced quantities of meat, bidding up wholesale prices. As Lusk et al. (2020) argue, the combined effect of rising wholesale meat prices and falling livestock prices leads to the widening price spread, and this would occur even without anti-competitive behaviour by processors: it is a natural outcome of the forces of supply and demand within these supply chains. Further analysis is needed to determine whether these effects were exacerbated by the market power of meat processors. Weersink et al. (2021) report that retail beef prices had returned to pre-Covid-19 levels by June, 2020.

Nevertheless, the size of the disruption, and the resulting knock-on effects on wholesale and farm prices, is dictated by the proportion of processing capacity taken offline during a pandemic. The system-wide vulnerabilities to short-run shocks are likely to be greater in a highly concentrated sector. In Canada, for example, two packing plants account for around 70% of federally inspected beef processing capacity. Obviously, the temporary loss of one of these plants would create largescale disruptions in the sector. Would a more dispersed, smaller-scale sector build in more resilience? The answer is: it depends. It depends on what we mean by resilience, and it depends on how we value the trade-offs of large-scale, efficient production systems, with smaller-scale, higher cost, but potentially more flexible production systems.

Some local and regional food systems actors were flexible and able to pivot nimbly to new market channels and buyers during the pandemic (Thilmany, Canales, Low, & Boys, 2020). Shorter supply chains enable the development of personal relationships and networks, which these firms leveraged to secure inputs and new buyers. In the U.S., the ramping up or redirecting of supplies within local and regional food systems was facilitated by temporary relaxation of federal and some state regulations pertaining to food safety and certification. Large scale food processing plants benefit from economies of scale and scope. This means that they can spread their fixed costs (e.g. equipment, infrastructure) over a larger output (scale economies) and a larger range of products (scope economies), lowering their average costs. They may also benefit from economies of scale and scope in labour. Scale economies provide a significant cost advantage, enabling firms to operate more efficiently. Consumers benefit from the cost advantages generated by scale and scope economies through lower prices. In contrast, a widely dispersed, small-scale food processing sector may be less vulnerable to systemic failures from a single plant going offline, but will be a higher cost, less efficient system, resulting in higher prices for consumers. As Lusk et al. (2020) note: “There is a tradeoff between a system that provides efficiency and affordable meat for consumers in ‘normal times’ and the costs associated with adding capacity, flexibility, and resiliency to a sector for ‘abnormal’ times.” Furthermore, if significant scale economies exist with respect to labour, an industry with a large number of smaller processing plants by definition requires more labour, which hampers rather than helps supply chain resiliency during a human health crisis.²

Beyond the short-run shock scenario that unfolded at the start of the pandemic, a deeper consideration is the adaptability of food supply chains in the medium to long run, particularly in the face of uncertainty. The pandemic creates a number of uncertainties for food businesses, not least of which is its duration and severity. The economic downturn and unemployment caused by the pandemic reduces consumer incomes, with the potential to reduce demand and cause substitution between product categories (to cheaper substitutes). We generally expect income elasticity of demand for food to be less than one (i.e., a proportionally smaller reduction in demand than the proportional reduction in income) (Cranfield, 2020), although these effects will be more pronounced for lower income consumers. Thus, a prolonged economic downturn can be expected to affect the bundle of goods purchased by households, and may lead to substitution away from higher priced cuts of meat to cheaper substitutes. Nevertheless, the effects of the pandemic across households are strikingly uneven, exacerbating social inequalities. Some households (e.g. those remaining fully employed) find themselves with a larger pool of wealth due to reduced expenditures on travel, commuting, restaurant meals, etc., while households that are more vulnerable face unemployment and significant loss of income. Predicting the medium-term demand effects of an ongoing pandemic is fraught with difficulty.

The other major source of uncertainty for food supply chains is the potential for renewed lockdowns in areas facing rising cases of Covid-19. Where these lockdowns require the closure of food service outlets, the supply chains servicing these outlets face further disruption. This was the scenario during the second wave of the pandemic in Fall 2020 through to 2021, with the reintroduction of regional and national lockdowns, in a bid to slow the spread of the virus. In many jurisdictions, restaurants, cafés, and bars were again required to close, albeit with take out and delivery services sometimes allowed to continue. Arguably, this should not have come as a surprise to businesses in these food supply chains, given the resurgence of Covid-19 infections, although the timing and duration of these regulatory interventions remains a source of uncertainty for food businesses.

A key component of resilience is adaptability. The extent to which food supply chains supplying the food service sector have been able to adapt and forward plan for a second (or third) wave of the pandemic is an indicator of resiliency. For example, diversifying their customer base, adapting to supply the retail (grocery) market, and building flexibility into supply chain contracts. Chenarides, Manfredo, and Richards (2020) argue that prior to the pandemic food supply chains, particularly for highly perishable foods, ignored the potential value of flexibility. They show how supply chain resilience is enhanced through a real options approach to decision-making. Real options arise when a firm has the right, but not the obligation, to make an investment that could pay off in the future (Chenarides et al., 2020). A real options approach to supply chain resilience suggests there is value in investing in flexibility, particularly with respect to alternative distribution channels and suppliers.

Covid-19 has also underscored the importance of human health as a core consideration in assessing supply chain resiliency. For food processors, future waves of the pandemic (or future pandemics), raise the spectre of disruptions due to sporadic workforce disease outbreaks. Unlike the situation in early spring, 2020, however, there has been time to adapt procedures within food manufacturing facilities to mitigate these risks. Attention to hygiene practices and social distancing measures within manufacturing plants reduce the risks of spread within the workforce, helping to protect the health and welfare of workers. Additional adaptive strategies include automation and digitization.

The use of robotics can help reduce transmission of viruses (and other micro-organisms) between workers (Aday & Aday, 2020). In many food processing plants, loading/unloading and packaging activities, are already fully automated, with robotics also used in quality control. Particular challenges in implementing further automation in meat processing plants include the wide variety in carcass shapes and sizes (Venceslau et al., 2020). Nevertheless, advancements in machine learning offer potential for expanded use of robotics in food manufacturing, and it is likely that the Covid-19 pandemic will accelerate the push toward greater automation. Beyond the technological feasibility of robotics and increased automation in food processing, the economic feasibility is a key decision-factor for an individual firm. The cost-effectiveness of increased automation will depend on the extent to which robotics increase productivity, improve quality control, and lower food safety risks. The pandemic may have added to this calcul.us
the need for labour-intensive plants to operate at lower processing line speeds to protect worker health, and the desire to avoid significant revenue losses if production is disrupted or suspended due to illness within the workforce.

Digitalization within food supply chains is an ongoing trend that may also accelerate as a result of the pandemic. Technologies that facilitate contactless electronic transactions over paper-based transactions become more attractive to facilitate physical distancing, and as remote working and reduced business travel become the ‘new normal’ (at least for the duration of the pandemic). The development of common data standards, for example, for sharing customs data or traceability data, can facilitate transactions in cross-border supply chains (Jonasson, Board, Clemens, van der Wilden, & Voorspuij, 2020). The GS1 System is an example of a common data standard related to item identification, barcoding, data capture, electronic messaging and data synchronization. The Australian meat industry developed the “MeatMessaging” system, using GS1 standards, as a means of transmitting the required information about meat products destined for export. This information assists regulatory authorities with verifying the authenticity and traceability of meat products. Similar initiatives were already in place in other sectors prior to the pandemic. Technologies that facilitate transactions within supply chains (particularly those that reduce non-tariff barrier frictions in cross-border supply chains), are likely to gain further traction with the renewed attention to supply chain resiliency amidst the pandemic.

The application of blockchain technology within agri-food systems is gaining increasing interest as a means to verify information (including authenticity), enhance traceability and transparency, and facilitate supply chain collaboration. A blockchain is a distributed ledger in which transactions are recorded, in chronological order, to create permanent, tamper-proof records across multiple stakeholders (Rejeb, Keogh, Zailani, Treiblmaier, & Rejeb, 2020). The data that comprise these records must still be generated and be scientifically valid for a blockchain to be useful. The salient point is that, once data are added to a blockchain that data cannot be altered by downstream supply chain participants. Blockchain technology can be useful in facilitating traceability systems to trace back products in the event of a food safety problem, thus reducing the scope and scale of the problem. The technology can also facilitate tracking of attributes forward in the supply chain to verify quality and authenticity. The difference between traceability as a risk reduction strategy and ‘traceability’ as a means to verify quality and authenticity is an important distinction (Hobbs, 2004).

Whether blockchain technology could enhance the responsiveness and resilience of food supply chains to exogenous shocks, such as Covid-19, through bolstering supply chain collaboration remains an open question. Where supply chain rigidities result from paperwork delays and information flows (Rejeb et al., 2020). The data that comprise these records must still be generated and be scientifically valid for a blockchain to be useful. The salient point is that, once data are added to a blockchain that data cannot be altered by downstream supply chain participants. Blockchain technology can be useful in facilitating traceability systems to trace back products in the event of a food safety problem, thus reducing the scope and scale of the problem. The technology can also facilitate tracking of attributes forward in the supply chain to verify quality and authenticity. The difference between traceability as a risk reduction strategy and ‘traceability’ as a means to verify quality and authenticity is an important distinction (Hobbs, 2004).

Whether blockchain technology could enhance the responsiveness and resilience of food supply chains to exogenous shocks, such as Covid-19, through bolstering supply chain collaboration remains an open question. Where supply chain rigidities result from paperwork delays and fragmented procedures, the application of blockchain technologies facilitates automation of organizational processes and improves information flows (Rejeb et al., 2020). The benefits of blockchain in the context of the pandemic largely lie in improving supply chain logistics and collaboration in the face of disruption. Nevertheless, the technology is not a panacea, and it is difficult to see how it could address other potential supply chain disruptions, such as labour shortages.

4. Consumer confidence

Beyond the initial short-run behavioural response from some consumers who engaged in panic-buying and hoarding behaviours, the extent to which the Covid-19 pandemic has shifted consumer perceptions about the food system is an interesting question. Certainly, the pandemic focused attention on perceived vulnerabilities (real or otherwise) of the food system, and the structure of food supply chains. It likely came as a surprise to many consumers in the U.S. and Canada to learn of the levels of concentration in the meat packing sector within their respective countries. The importance of international trade and open borders to the smooth operation of global food supply chains was also apparent, with governments taking steps to ensure that closures of international borders to non-essential travel did not impede the movement of food and other essential goods.

In the widespread uncertainty created by the pandemic, it is perhaps natural for consumers to seek reassurances that their food supply is secure, and for some to equate food security with (domestic or regional) self-sufficiency. The benefits of international trade in providing consumers with access to a wide range of food products, and at lower prices, however, is well established. An important lesson from the pandemic is to move quickly in preventing the establishment of new barriers to trade in food products and restrictions on the movement of food across regional and national boundaries. For example, despite the closure of the U.S.-Canadian border to non-essential travel in spring, 2020, steps were taken to ensure that food supply chains still functioned effectively across the border, as was the case between countries in the European Union.

Has the pandemic altered consumer attitudes toward food in general, including what is important to them in their food consumption decisions, and if so, what are the implications for the food sector? At this stage, it is too early to tell, but it is worth considering how these responses might unfold. A body of literature examines the underlying values that motivate food purchase decisions. Prominent among these contributions is Lusk and Briggeman (2009) who identify a set of (eleven) food values related to food consumption, including: naturalness, taste, price, safety, convenience, nutrition, novelty, origin, fairness, appearance, and environmental impact. Subsequent empirical analysis has evaluated the relative importance of these (and other) food values to food purchase decisions in various contexts. Lister, Tonssor, Brix, Schroeter, and Yang (2017) examine U.S. consumers’ food values with respect to livestock products (adding animal welfare and traceability as food values). Bazzani, Gustavsen, Nayga, and Rickertsen (2018) compare the relative importance of Lusk and Briggeman’s 11 food values (plus animal welfare) across a sample of U.S. and Norwegian consumers. Yang and Hobbs (2020) examine heterogeneity in consumer food values across a sample of Canadian consumers, and show how food values frame consumer responses to the use of nanotechnology in food products.

A striking result across all of these (and other) studies is the existence of a core set of food values that resonate most deeply with consumers. These values consistently rank among the most important for consumers, including taste, food safety, nutrition, and price, and represent basic expectations. Consumers are far more heterogeneous in the relative importance placed on food values related to how food is produced or its provenance, such as origin, naturalness, environmental impact, and animal welfare. For some consumers, these values matter, and they matter a lot, while to other consumers they are less important. Typically, these food values provide scope for product differentiation strategies within the food sector. Fig. 1 compares the relative importance of 11 (or 12) food values across four studies, in three countries: the U.S. (Lusk & Briggeman, 2009, and Bazzani et al., 2018), Canada (Yang & Hobbs, 2020) using a ranking and a rating method, and Norway (Bazzani et al., 2018). The Figure shows that taste, safety, nutrition, and price are core food values, whereas there exists greater variation in the relative importance placed on origin, fairness, naturalness, environmental impact, and animal welfare (included in two studies).

In terms of heterogeneity within populations, in the Canadian study, Yang and Hobbs (2020) find that males are more likely than females to consider price, convenience, taste, and appearance as important, and are less likely to emphasize naturalness, nutrition and origin. Older consumers were less likely to focus on price and more likely to consider food values such as safety, origin and fairness.

How might consumers’ food values shape their responses to the Covid-19 pandemic, or future pandemics? One hypothesis is that

---

3 See https://meatmessaging.com and https://meatmessaging.info/ots/mentu1_1.asp
consumers double-down on their core food values (e.g. taste, safety, price, nutrition) when faced with uncertainty and disequilibrium of the magnitude created by a pandemic. The prior work shows that these values have universal appeal, while consumers are far more heterogeneous in the extent to which food values related to credence attributes matter. It is also possible that the pandemic exacerbates this heterogeneity, with consumers for whom origin and fairness mattered prior to the pandemic placing even greater value on these values in a post-pandemic world. Evidence from the Meat Demand Monitor, a monthly survey tracking U.S. consumer demand for meat, suggests that during the early stages of the pandemic (February through June 2020), price increased in importance as a food value, while origin/traceability and animal welfare did not (MDM, 2020a). In an analysis of the U.S. egg market, Malone et al. (2020) find that premiums for organic and cage-free eggs fell during the early part of the pandemic (March-May 2020) relative to pre-pandemic levels, while there was a slight increase in premiums for Omega-3 enhanced eggs (a health attribute). The extent to which the pandemic alters how consumers perceive and interact with the food system is an interesting topic for further research.

Food safety is consistently ranked as an important food value to consumers, and Fig. 1 shows this to be the case across countries, across time, and across methods of measuring food values. There is currently no scientific evidence that the virus responsible for Covid-19 (SARS-CoV-2) is a food safety risk (Anelich, Lues, Farber, & Parreira, 2020) and the U.S. Centers for Disease Control and Prevention emphasizes that there is no evidence to suggest that handling or consuming food is associated with Covid-19 (CDC, 2020). As Anelich et al. (2020) point out, food hygiene practices (which include handwashing) are a core component of food safety management systems.

While there is no known food safety risk from SARS-CoV-2, the temporary relaxation of regulations for food processing plants in some jurisdictions during the early stages of the pandemic raises an interesting conundrum. These changes were intended to help food supply chains be more flexible and responsive in the face of unprecedented disruption, but how did consumers perceive these changes, and does this type of policy response risk weakening consumer confidence in food safety systems? Kecinski, Messer, McFadden, and Malone (2020) conducted consumer surveys in the U.S. in May and June, 2020 covering the relaxation of food safety and environmental regulations during the pandemic. They identify an uptick in consumer concerns regarding the relaxation of food safety regulations over this short period. Whether this was a short-run phenomenon or has longer lasting effects on consumer confidence is difficult to discern. Unpacking the underlying factors that cause consumers to retain or lose confidence in food safety systems during times of crisis requires further research. The extent to which consumers accept the trade-offs inherent in relaxing the regulatory environment to facilitate nimble adaptations in supply chains is unclear. Fundamentally, food safety regulations are in place to protect consumers (and firms). To the extent that these regulatory systems are the outcome of careful cost-benefit analysis, any relaxation of the rules risks undermining that process. Nevertheless, lessons from the pandemic suggest that the effect of the regulatory environment on the adaptability and resilience of food supply chains during time of crisis may be an additional dimension to consider when devising regulatory systems.

As Covid-19 vaccination programs roll out, we can expect consumer confidence to grow, although it is difficult to predict how quickly and in what direction consumer behaviour will change. In the U.S. there are early indications that younger consumers (under 35 years of age), and more frequent meat (beef and pork) eaters are more likely to immediately increase the number of dine-in restaurant meals once a vaccine was available to them, while the majority of consumers would gradually increase the number of dine-in restaurant meals (MDM, 2020b). Given current uncertainties over the speed of vaccination programs and the likelihood of social distancing protocols remaining in place for some time, the food service sector remains vulnerable in the medium-term. In the longer term, a significant pent-up demand for travel, entertainment, and dining experiences promises a rebound in these sectors, albeit within the ‘new normal’ of a heightened focus on supply chain resilience and human health.

Fig. 1. Relative importance of food values across studies.
5. Conclusions

Access to safe, nutritious, and affordable food is a cornerstone of food security. The food system in developed countries largely appears to have performed well during the pandemic, despite initial disruptions. Pandemic-related food security concerns arise from income inequality and access, not from a fundamental problem with the food system as a whole. Governments have enacted various policies to address the significant income challenges created by the pandemic, with varying degrees of success. Taking steps to ensure food supply chains continue to function effectively has been important, such as decisive policy responses designating food businesses (processing, transportation and distribution, retailers, etc.) as essential services, and minimizing disruption to the flow of food products across international borders. From a broader policy perspective, the pandemic has reinforced the importance of a ‘One Health’ approach to managing animal and human diseases, and the critical need for international cooperation.

The Covid-19 pandemic has highlighted vulnerabilities at specific points in food supply chains, but has also revealed considerable adaptability within these systems. The unprecedented nature of the disruption caused disequilibrium in intermediary markets in the short-run, and focused attention on supply chain resiliency. In addressing supply chain resiliency over the medium to longer term, how resiliency is defined and measured matters. Resiliency has many dimensions and there are inherent tradeoffs between supply chains that function efficiently and effectively in ‘normal’ times versus the robustness and adaptability of those supply chains during ‘abnormal’ times. Understanding the fundamental underlying economics of the sector is critically important, including how industry structure shapes scale economies and productivity, and the implications for consumer and producer welfare.

The pandemic has also highlighted the nature of supply chain interdependencies and the need for ‘systems thinking’ in addressing resiliency. Supply chains characterized by higher degrees of collaboration and effective communication face lower transaction costs and tend to be more adaptable in the face of uncertainty. When the dust settles on the Covid-19 pandemic it should leave the industry better prepared to deal with major disruptions, having identified key sources of supply chain risk and strategies to mitigate these risks.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of Competing Interest

The author declares that there is no conflict of interest.

References

Ady, S., & Ady, M. S. (2020). Impacts of Covid-19 on food supply chain. Food Quality and Safety, 4(4), 167–180. https://doi.org/10.1093/fqfsaf/fyaa024.
Anelich, L. E. C. M., Lues, R., Faber, J. M., & Parreira, V. R. (2020). SARS-CoV-2 and risk to food safety. Frontiers in Nutrition, 7(November). https://doi.org/10.3389/fnut.2020.590551, article 580551.
Bazzani, C., Gustaven, G. W., Nayga, R. M., & Rickertsen, K. (2018). A comparative study of food values between the United States and Norway. European Review of Agricultural Economics, 45(2), 239–272.
Bogage, J. (2020). An unlikely side effect of coronavirus: A national surplus of chicken wings. The Washington Post, April 8. https://www.washingtonpost.com/business/2020/04/08/chicken-wings-coronavirus-march-madness/ (Accessed October 28, 2020).
Cardwell, R., & Ghazalian, P. L. (2020). Covid-19 and international food assistance: policy proposals to keep food flowing. World Development, 135, Article 105059.
CDC (2020). Food and coronavirus disease 2019 (COVID-19). Centers for Disease Control and Prevention, Department of Health and Human Services, U.S. Government, August 19. https://www.cdc.gov/coronavirus/2019-ncov/daily-lifecoping/food-and-COVID-19.html (Accessed November 4, 2020).
Cherles, L., Manfredo, M. J., & Richards, T. J. (2020). COVID-19 and food supply chains. Applied Economic Perspectives and Policy (forthcoming). https://doi.org/10.1002/aepp.13085.
Cranfield, J. (2020). Framing food demand responses to a viral pandemic. Canadian Journal of Agricultural Economics, 68(2), 154–156.
Godard, E. (2020). The impact of Covid-19 on food retail and food service in Canada: Preliminary assessment. Canadian Journal of Agricultural Economics, 68(2), 157–161.
Godard, E. (2021). The new normal in grocery and foodservice. In Presentation to the 11th Annual Canadian Agri-Food Policy Conference, January 18 2021.
Hobbs, J. E. (2004). Information asymmetry and the role of traceability systems. Agribusiness, 20(4), 397–415.
Hobbs, J. E. (2020). Food supply chains during the Covid-19 pandemic. Canadian Journal of Agricultural Economics, 68(2), 171–176.
Jonasson, P., Board, E., Clemens, R., van der Wilden, E., & Voorrips, J. (2020). Sustainable post-COVID-19 supply chain recovery through global data standards: Building a resilient supply chain through product identification and data sharing. In Submission to the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) policy hackathon on model provisions for trade in times of crisis and pandemic in regional and other trade agreements. https://www.unescap.org/sites/de foul/files/113%20Final%20Team%20March%20Jonasson-GS1.pdf.
Kecinski, M., Messer, K. D., McFadden, B. R., & Malone, T. (2020). Environmental and regulatory concerns during the COVID-19 pandemic: Results from the pandemic and food stigma survey. Environmental and Resource Economics, 76, 1139–1148.
Koehg, J. G., & Hand, K. J. (2020). How to prevent disruptions in food supply chains after Covid-19. In The Conversation. September 30 https://theconversation.com/how-to-prevent-disruptions-in-food-supply-chains-after-covid-19-144993.
Lister, G., Tsonor, G. T., Irix, M., Schroeter, T. C., & Yang, C. (2017). Food values applied to livestock products. Journal of Food Products Marketing, 23(1), 326–341.
Luckstead, J., Nayga, R. M., Jr., & Snell, H. A. (2020). Labor issues in the food supply chain amid the COVID-19 pandemic. Applied Economic Perspectives and Policy (forthcoming). https://doi.org/10.1002/aepp.13109.
Lusk, J., & McCleary, J. J. (2020). Consumer behavior during the pandemic. In Economic Impacts of COVID-19 on Food and Agricultural Markets. CAST Commentary QTA2020-3, June (pp. 11–13). https://www.cast-science.org/wp-content/uploads/2020/06/QTA2020-3-COVID-Impacts.pdf.
Lusk, J. L., & Briggeman, B. C. (2009). Food values. American Journal of Agricultural Economics, 91(1), 184–196.
Lusk, J. L., Tsonor, G. T., & Schulz, L. L. (2020). Beef and pork marketing margins and price spreads during Covid-19. Applied Economic Perspectives and Policy (forthcoming). https://doi.org/10.1002/aepp.13101.
Malone, T., Schafer, K. A., & Lusk, J. L. (2020). Unscrambling COVID-19 food supply chains. Working paper. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abs tract_id=3679216.
Maples, J. G., Thompson, J. M., Anderson, J. D., & Anderson, D. P. (2020). Estimating COVID-19 impacts on the broiler industry. Applied Economic Perspectives and Policy (special collection on Covid-19) (forthcoming). https://doi.org/10.1002/aepp.13089.
MDD: Meat Demand Monitor. (2020a). Multi-Month Summary Report. February–June 2020. July 2020 Summary Report. In Department of Agricultural Economics, Kansas State University (p. 24). https://agemanager.info/livestock-meat-meat-demand/monitor-meat-demand-monitor-survey-data.
MDD: Meat Demand Monitor. (2020b). Impact of Coronavirus (COVID-19) Vaccine on Food Service. November 16 Special Report (p. 6). Department of Agricultural Economics, Kansas State University. https://agemanager.info/livestock-meat-meat-demand/monitor-meat-demand-monitor-survey-data.
Rejeb, A., Koerich, J. G., Zailani, S., Treiblmaier, H., & Rejeb, K. (2020). Blockchain technology in the food industry: A review of potentials, challenges and future research directions. Logistics, 4, 0027. https://doi.org/10.3390/ logistics40004027.
Thilmany, D., Canales, E., Lov, S. A., & Boys, K. (2020). Local food supply chain dynamics and resilience during COVID-19. Applied Economic Perspectives and Policy, forthcoming. https://doi.org/10.1002/aepp.13121.
Tsonor, G., & Schulz, T. (2020). COVID-19 impacts on the meat processing sector. In Economic impacts of COVID-19 on food and agricultural markets. CAST commentary QTA2020-3, June (pp. 15–16). https://www.cast-science.org/wp-content/uploads/2020/06/QTA2020-3-COVID-Impacts.pdf.
Weerink, A., Von Massow, M., Banon, N., Iftt, J., Maples, J., McEwan, K., ... Wood, K. (2021). COVID-19 and the agri-food system in the United States and Canada. Cultural Systems, 18(1), Article no. 100039.
Yang, Y., & Hobbs, J. E. (2020). Food values and heterogeneous consumer responses to nanotechnology. Canadian Journal of Agricultural Economics, 68(3), 289–343. https://doi.org/10.1111/cjag.12225.