Case Study

Economic Dynamics in the Beef Food Supply Chain under Pandemic Conditions

Grace Melo[a], Luis Peña-Lévano[b], and Kori Luengo[c]
Texas A&M University[a], University of Wisconsin–River Falls[b], and Pontificia Universidad Católica de Chile[c]

JEL Codes: A22, A23, A30, Q13, Q11
Keywords: Case study, beef, processed food, meat supply, marketing channel, multi-sector model

Abstract: This case study discusses the potential effects of COVID-19 pandemic on the U.S. beef market during the first half of 2020. This sector confronted significant economic distortions caused by the increasing rate of infection in meat processing and packaging plants. We illustrate the COVID-19 related effects on the beef industry by using cattle-meat marketing channel framework, which comprises of two markets: cattle raw meat cuts supplied by farmers, and retailed processed meat sold by retailers and wholesale markets to final consumers as packed and processed products. The case study discusses different supply and demand shocks affecting the meat market system during and after the lockdown period. The article also explores the potential changes in equilibrium prices in alternative meat markets and how these could affect prices in conventional meat products. The teaching note discusses the objectives and provides further recommendations on the delivery of the case study, including a team peer evaluation.

1 The U.S. Beef Market During the COVID-19 Pandemic

As of May 2020, the meat industry faced significant economic distortions caused by the COVID-19 pandemic. From the demand side, demand declined as major clients, such as restaurants and schools, ceased operations during the lockdown (Peña-Lévano, Burney, and Adams 2020a; Cowles 2020; Reuters 2020). In addition, household beef demand in 2020 was expected to decline due to the perception of an imminent recession (Corkery and Yaffe-Bellany 2020). This is partly because income-constrained consumers usually shift away from ruminant meat products during recessions in favor of cheaper commodities such as chicken, turkey, or plant-based proteins (Plumer 2020). From the supply side, large processing plants closed operations as workers' COVID-19 infection numbers rose. Farmers were unable to sell their animals, which forced farmers to hold them for a longer period than originally scheduled (Plumer 2020).

2 Learning Objectives

This case study discusses the potential effects of the COVID-19 pandemic on the U.S. beef market during the first half of 2020, using a marketing model structure developed by Norwood and Lusk (2018), which shows graphically the effects of the pandemic on both U.S. production and demand, making it suitable for upper undergraduate and graduate courses in agricultural marketing and price analysis.

The case study intends to offer students a real-world application through collaborative group discussions, which have been shown to improve students' analytical abilities (Kiesel et al. 2020). Experiential learning through case studies also helps to sharpen metacognitive skills such as their ability to organize and process information (Melo et al. 2021). Likewise, in order to enrich the students' learning experience, it is recommended to use online tools, such as discussion boards, to provide a personalized assessment (Peña-Lévano 2020) and motivate instructor-student interactions (Peña-Lévano and Melo 2022).

The specific learning objectives (LO) of this case study are:

LO1. Graphically represent the equilibrium in the U.S. beef market without distortions. Understand how the cattle-meat marketing channel can be affected by changes in macroeconomic conditions.

LO2. Determine the equilibrium price and quantity of each market in the multisector models based on market information provided.

LO3. Forecast the direction of change for equilibrium prices and quantities due to economic distortions induced by the pandemic in a marketing channel model.

3 The Cattle-Meat Marketing Model

The beef industry can be modeled graphically through the ***cattle-meat marketing channel framework***, developed by Norwood and Lusk (2018). This structure illustrates the supply and demand of two related markets (i.e., intermediate and final product) within the same industry. In this case, these two products are: (1) ***Cattle raw meat cuts***—supplied by farmers, processed at slaughterhouses, and sold to restaurants, schools, and grocery stores. The raw ***meat*** supply is represented by the line $\boldsymbol{S^M}$, and derived demand is $\boldsymbol{DD^0}$. (2) ***Retail processed meat***—sold by retailers and wholesale markets to final consumers as packed and processed products. The ***retail*** meat supply is displayed by line $\boldsymbol{S^R}$, with its respective demand $\boldsymbol{D^0}$. The marketing-channel framework assumes ***fixed proportions technologies***: the proportion of cattle raw meat used in processed meat is constant in the short term. In other words, the retail meat supplied $\boldsymbol{Q}$ is a fixed fraction $\boldsymbol{k}$ of the farm raw meat $\boldsymbol{Q_M}$ (i.e., $Q = kQ_M$). These markets are represented in Figure 1, with pre-coronavirus equilibrium price $\boldsymbol{P^{M^0}}$ for the raw ***meat*** market and equilibrium retail meat price $\boldsymbol{P^{R^0}}$ with equilibrium quantity $\boldsymbol{Q}$ of meat in the market.

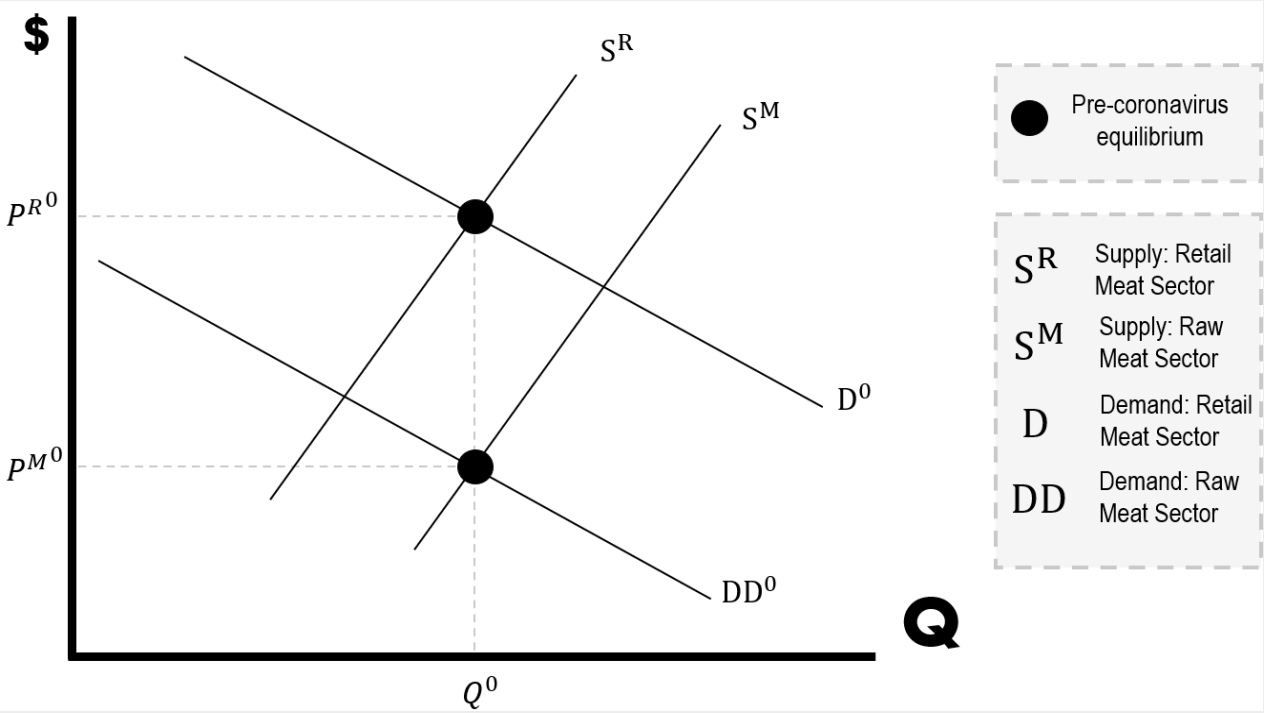

Figure 1. Baseline of the Cattle-Meat Marketing Channel

4 Disturbances in the Meat Market Channel

COVID-19 pandemic has two distinctive periods, delineated by the stay-at-home mandate:

- ***Period 1*:** Stay-at-home orders are imposed in mid-March 2020, with **high infection rates** in most states. This period ended in mid-May 2020 with partial opening of operations.

- ***Period 2*:** Occurring after mid-May 2020—end of the first pandemic wave. Lockdown **restrictions** are being **relaxed** in most states in the U.S., with **infection curve flattening** (and/or decreasing in June depending on the state). Considering the information from this case study is based on news from June 2020 (just months after the reopening), Period 2 is a *predictive situation*. This case is later updated with subsequent information learned in May 2021, discussed in Section 6 (Questions).

4.1 Market Predictions During Stay-at-Home Orders in Period 1

The pandemic's first stage is characterized by an increasing infection rate and stay-at-home orders in most states. The beef industry suffered changes in dynamics, driving an overall decrease in output (**from Q^0 to Q^1**) due to the following reasons (represented orderly in Figure 2):

(1) ***Retail meat supply*** **decreased** due to disruptions in slaughterhouse and large processing plant operations after many workers contracted the virus (Plumer 2020) and raised the processing cost of consumer-ready meat products (Ledbetter 2021). In addition, labor shortages persisted despite cash incentives from companies to lure workers back to work (Peña-Lévano et al. 2020b; Restuccia and Bunge 2020). As a result, beef production for the last week of April 2020 was 25 percent lower compared to the same week in the previous year (Restuccia and Bunge 2020).

(2) Farmers and ranchers were unable to sell their animals because slaughterhouses, restaurants, and schools were temporarily closed, leading to **slumping demand for *raw meat*** (Plumer 2020). Only few restaurants were open under pick-up or delivery options. Rabobank estimated about a 30 percent fall in U.S. meat demand during March 2020 (Reuters 2020). Holding livestock inventory for a period longer than planned increased feeding and maintenance costs. Millions of pounds of frozen beef were stored waiting to be sold in the market (Plumer 2020), creating an oversupply that **pushed down *raw meat*** **prices** (Ledbetter 2021), graphically, $P^{M^0} \rightarrow P^{M^1}$.

(3) However, there was a **spike in *retail*** packed and processed meat sales as (i) home cooking and takeout or drive-through sales increased (Searcey 2020), (ii) consumers anticipated an imminent meat shortage, motivating panicked buying of products (Corkery and Yaffe-Bellany 2020), and (iii) a fraction of COVID-19 relief payments were used to buy staple groceries (Skidmore 2020). This spike in meat consumption, along with disruptions in meat-packing plants, induced ***retail meat*** **prices to rise** (Ledbetter 2021), **from P^{R^0} to P^{R^1}**. This increase in retail price with the decrease in raw meat price induced an increase in the margin (i.e., the price difference between final consumer price P^{R^1} and farm price P^{M^1}), displayed in Figure 2.

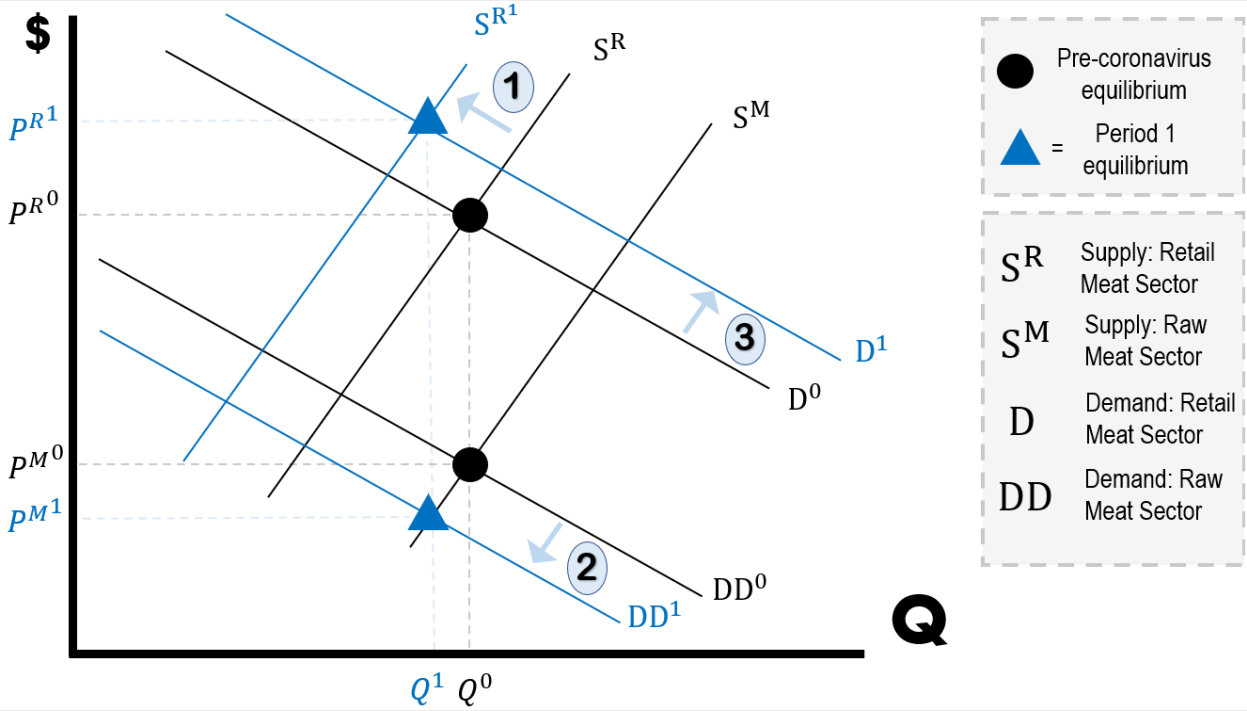

Figure 2. Dynamic Changes During *Period 1* in the Cattle-Meat Marketing Channel

4.2 Market Predictions for Situation after May 2020: Predictive Situation in Period 2

Many states gradually reopened activities in May 2020 as the peak of the infection curve seemed to have passed (Mervosh et al. 2020). However, the lockdown triggered a recession, as many companies shut down operations leaving more than thirty million Americans unemployed and mostly dependent on unemployment benefits (Chaney and King 2020). As a result, the U.S. economy shrank by 4.8 percent in the first quarter of 2020, and the looming recession was expected to be worse than the Great Recession of 2008 (Crutsinger 2020). This information allows to make short-term **predictions** regarding the meat market situation after reopening operations. Thus, Period 2 forecasts a fall in beef output (from $\boldsymbol{Q^1}$ to $\boldsymbol{Q^2}$) as a post-effect of the stay-at-home mandate, given the following considerations (represented orderly in Figure 3):

(1) Restaurants were required to resume operations partially (Mervosh et al. 2020). Processing plants were encouraged to continue production under the Defense Production Act. Nonetheless, the infection rates among workers remained high (Restuccia and Bunge 2020). A second wave of infection could intensify labor shortages, causing a negative production shock (i.e., **left-upward shift of *retail meat* supply**). Meat shortages might worsen as consumers continue buying beef products, and meat inventories could be exhausted (Groves 2020; Johansson 2020).

(2) As trends from the 2008 financial crisis, households tend to purchase less red meat and shift toward a more diversified protein diet under declining disposable incomes (Yang, Raper, and Pruitt 2019). Moreover, polls indicate that consumers tend to eat less meat in post-recession periods (Gabbett 2017). The long-term exposure to the pandemic event might stimulate meat safety fears, shifting away from overconsumption of animal protein (McFadden et al. 2020). Thus, ***retail meat* demand** is expected to **fall** in *Period 2*, possibly lower than the initial equilibrium quantity price (pre-coronavirus era).

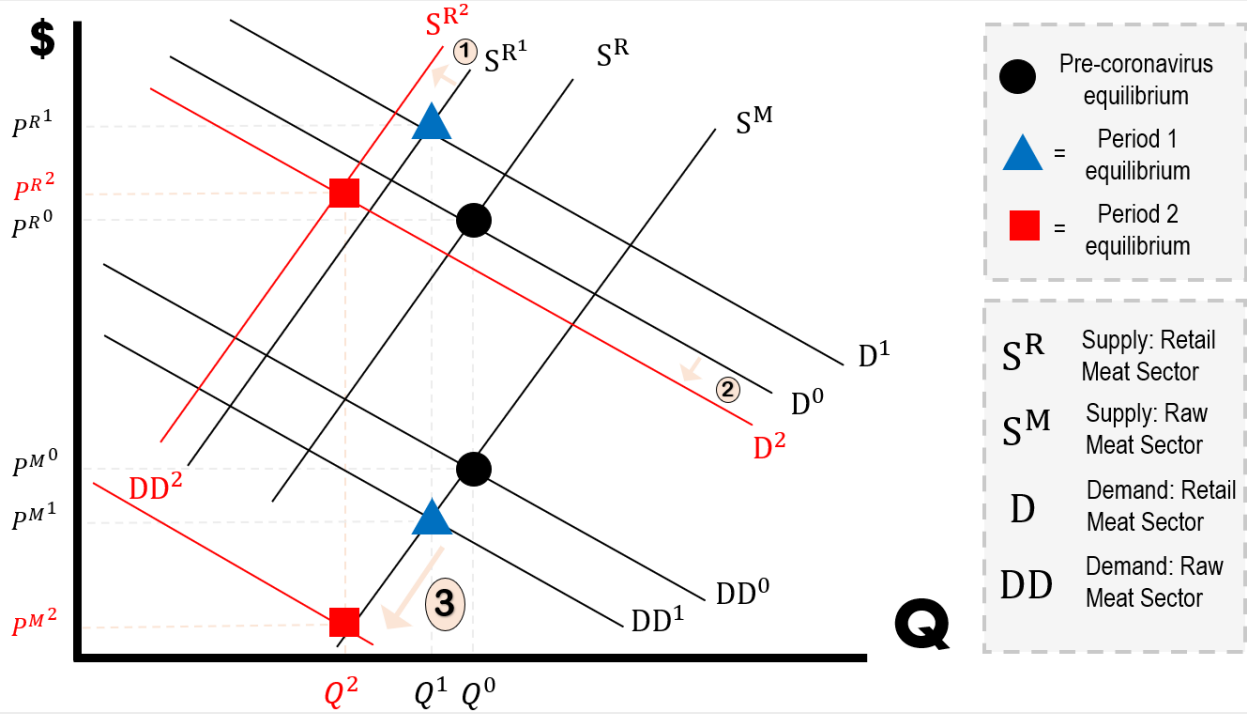

Figure 3. Dynamic Changes During *Period 2* in the Cattle-Meat Marketing Channel

(3) The decline in meat demand and labor shortages in processing plants, mainly due to concerns about health conditions in meat plants (Irwin 2021), could shift **cattle *raw meat* demand downward**. Given the rise of alternative meat product supply by both plant-based and meat-based companies following the pandemic, it might be possible for consumers to meet their demand for protein foods by also consuming meat alternatives (Plumer 2020; Yaffe-Bellany 2019). Lower farm cattle demand will likely **depress the price of cattle** ($\boldsymbol{P^{M^1} \rightarrow P^{M^2}}$), and the lower meat supply will **ergo impact meat price** ($\boldsymbol{P^{R^1} \rightarrow P^{R^2}}$; Pitt 2020).

5 Summary of the Situation in the Case Study

The pandemic's lockdown restrictions put pressure on the meat industry in many forms: (1) labor shortages lead to closing of and reduced plant operations, (2) diminished demand from traditional clients (restaurants and schools) that closed or are operating at partial capacity, and (3) farmers suffering economic losses as animal inventory holding periods are longer than expected, increasing production costs, and reducing revenue generation potential. All these led to a decrease in cattle raw cut prices and an increase in meat prices at the beginning of the pandemic.

Over time, uncertainty in the effective containment of the pandemic or prognoses of permanently improving meat-processing employee safety measures may maintain higher consumer meat prices. At the same time, consumers may shift their diet toward alternative protein sources perceived to be healthier and safer than conventional animal proteins. These potential changes would likely influence other markets. Consequently, potential changes in equilibrium prices in alternative meat markets would affect future equilibrium prices of conventional meat products.

6 Discussion Questions

(1) In the case study, shifts in supply and/or demand on agricultural markets for ***Period 2*** were predicted based on events during the first quarter of 2020 (as of May 2020). The pandemic and economic conditions, however, have changed since then, with important implications for the cattle-meat marketing channel. Therefore, let us now consider additional information about events during the last three quarters of 2020. Below is some information (as of May 2021) that you will need in order to answer the questions provided next:

While the contracting U.S. economy was expected to reduce disposable income and cause consumers to buy less meat, instead real disposable income increased significantly because of various government stimulus programs (Federal Reserve Economic Data 2021). At the same time, meat-packing plants resumed operations after incurring additional costs to improve employee safety measures (Dixon and Rimmer 2021). As a result, in 2020, consumer prices for meat and other animal products slightly declined between June and November, while farm-level prices for animal products increased between April and November (Ledbetter 2021). While conditions are not back to their pre-coronavirus trends in the meat industry, they seem to have improved since the beginning of the lockdowns.

Based on the above information and any additional information you may investigate (optional), answer the following questions:

(1.1) Use a graph to illustrate the pandemic-induced shocks on the marketing channel for cattle raw meat and processed meat for an updated version of *Period 2*, that is, market predictions (in May 2021) for *Period 2*. What **changes in prices** would you predict to occur in *Period 2*?

(1.2) Can a complete release of lockdown restrictions and the end of the COVID-19 pandemic bring **prices back to the original trend**? Why or why not?
As shown in Figure 2, a reduction in beef production during *Period 1* raised the price of beef products. As a result, consumers may have substituted beef meat for other protein sources (Yaffe-Bellany 2019). In this problem, consider veggie burgers as a direct competitor to the meat industry. This vegetarian/vegan market has two products: peas grown on farms and veggie patties (made of peas). Assume that subsequent to *Period 1*, there was an increase in the demand for plant-based meat products and no short-term response in their respective supply.
Explain the effect of the COVID-19 pandemic on the veggie burger market using the two-sector marketing channel framework.

(2) Up to now, we have assumed that a shift in supply and/or demand in one market does not affect other market systems (i.e., by using partial equilibrium analysis). We will now relax this assumption and assume that economic shocks in the cattle-meat marketing channel do affect related markets. Use the information below regarding related markets and ***Table 1*** to answer the upcoming questions:

Table 1. Demand Elasticities for Beef and Plant-Based Alternatives During COVID-19

Elasticity Type	Elasticity Value
Own-price elasticity of demand for plant-based patties	-0.03
Own price elasticity of demand for beef	-0.08
Cross-price elasticity of demand for ground beef with respect to the price of plant-based patties (veggie burgers)	0.08
Cross-price elasticity of demand for pork with respect to the price of beef	0.24
Cross-price elasticity of demand for beef with respect to the price of pork	0.28

Source: Tonsor, Lusk, and Tonsor (2021); Lusk (2021)

U.S. sales of plant-based meat alternatives have increased, up by almost 200 percent in April 2020 compared to the same month in 2019. This contrasts with jumps of 30 percent over the same period for fresh meat (Terazano and Meyer 2020). Different factors explain this large increase in sales of meat substitutes such as meat supply shortage, amplified concern about food safety and health (McFadden et al. 2020), and advertisement of meat alternatives seeking to attract new consumers (Nierenberg 2020). Nevertheless, COVID-19 just added momentum to an already rapidly growing trend toward reduced animal-based food consumption (Haberman 2020).

(3.1) Draw the marketing channel for cattle raw meats and processed meat products in graph (*a*). Using a separate graph (*b*) (preferably draw these side by side), represent the food marketing channel of a meat substitute with two systems (retail and farm production). Draw the graphs for parts (*a*) and (*b*), and depict the differences in elasticities of supply and demand for each of the primary markets (e.g., beef).

(3.2) Assume that the supplies of beef and plant-based meat were equally affected by the pandemic in *Period 1* (e.g., both supplies shift to the left by the same proportion due to labor shortages). Based on the graphs in Question (**3.1**), explain how the markets were affected and whether there is a more significant impact on the price in one market compared to the other.

(3.3) Now suppose that there was a decrease in the **retail beef** supply, no change in the **supply of plant-based** meat, and upward pressure on the plant-based meat price due to gradual **increases in demand** for **animal meat alternatives**. Based on the graphs you produced for Question (**3.1**) and your knowledge on market equilibrium, illustrate in three separate graphs: (*a*) *Period 1*: the shift in the retail supply curve and derived demand for raw meat cuts in the cattle-meat marketing channel, (*b*) *Period 1*: how a higher beef price influences plant-based meat price in the marketing channel of meat substitutes, and (*c*) *Period 2*: the **feedback effect** from the new plant-based meat price on the beef price in the cattle-meat marketing channel.

(3.4) Use the conclusions from Question (**3.3**) and elasticities from **Table 1** to refute the following statement: "*an increase in the supply of pork chops following the pandemic recovery is unlikely to affect the equilibrium price and quantity of the steak market*."

About the Authors: Grace Melo is an Accountability, Climate, Equity, and Scholarship (ACES) Faculty Fellow at Texas A&M University. Luis Peña-Lévano is an Assistant Professor at the University of Wisconsin–River Falls (Corresponding author: luis.penalevano@uwrf.edu). Kori Luengo is an Agronomic Engineer at the Pontificia Universidad Católica de Chile.

References

Chaney, S., and K. King. 2020. "Over 3.8 Million Americans Filed for Jobless Benefits Last Week as States Struggle With Coronavirus Claims Surge." *The Wall Street Journal.* https://www.wsj.com/articles/states-struggle-with-coronavirus-unemployment-claims-surge-11588239004

Corkery, M., and D. Yaffe-Bellany. 2020. "The Food Chain's Weakest Link: Slaughterhouses." *The New York Times.* https://www.nytimes.com/2020/04/18/business/coronavirus-meat-slaughterhouses.html

Cowles, C. 2020. "The Week in Business: Not Enough Meat, and Too Much Oil." *The New York Times.* https://www.nytimes.com/2020/04/26/business/the-week-in-business-coronavirus-jobs.html

Crutsinger, M. 2020. "Economists Agree: No Quick Rebound from Recession Is Likely." *The Associated Press.* https://apnews.com/article/virus-outbreak-us-news-business-ap-top-news-economy-e0d04987133c2f48992b98ace0a1e846

Dixon, P.B., and M.T. Rimmer. 2021. "Who Will Pay for Improved Health Standards in US Meat-Processing Plants? Simulation Results from the USAGE Model." Victoria University, Centre of Policy Studies/IMPACT Centre.

Federal Reserve Economic Data. 2021. "Personal Income." https://fred.stlouisfed.org/series/PI

Gabbett, R. 2017. "Protein Preferences in North America: Nielsen." *Meatingplace.* https://www.meatingplace.com/Member/Login?ReturnUrl=%2fIndustry%2fNews%2fDetails%2f75368

Groves, S. 2020. "Some Meat Plants Reopen, but Trump Order May Not Be Cure-All." *The Associated Press.* https://apnews.com/article/6c6711b16d68ebde1b2cd8060f431774

Haberman, C. 2020. "Plant-Based Meat Has Roots in the 1970s: Retro Report." *New York Times*. https://www.nytimes.com/2020/02/16/us/plant-based-meat-has-roots-in-the-1970s.html

Irwin, N. 2021. "Unemployment Is High. Why Are Businesses Struggling to Hire?" *The New York Times*. https://www.nytimes.com/2021/04/16/upshot/unemployment-pandemic-worker-shortages.html

Johansson, R. 2020. "Will COVID-19 Threaten Availability and Affordability of our Food?" https://www.usda.gov/media/blog/2020/04/16/will-covid-19-threaten-availability-and-affordability-our-food

Kiesel, K., N. Zuo, Z.T. Plakias, L.M. Peña-Lévano, A. Barkley, K. Lacy, E. Hanson, and J. Treme. 2020. "Enhancing Student Engagement in a Changing Academic Environment-Tested Innovations for Traditional Classes and Online Teaching." *Applied Economics Teaching Resources (AETR)* 2.

Ledbetter, K. 2021. "Animal Agriculture Markets Resilient Almost a Year into COVID-19 Pandemic." *AgriLife Today—Texas A&M*.

Lusk, J. 2021. "Trends in Demand for Plant-Based Meat." http://jaysonlusk.com/blog/2021/1/11/trends-in-demand-for-plant-based-meat

McFadden, B.R., T. Malone, M. Kecinski, and K.D. Messer. 2020. "COVID-19 Induced Stigma in U.S. Consumers: Evidence and Implications." *American Journal of Agricultural Economics*.

Melo, G., D. Sanhueza, S. Morales, and L. Peña-Lévano. 2021. "What Does the Pandemic Mean for Experiential Learning? Lessons from Latin America." *Applied Economics Teaching Resources (AETR)* 3(3):131–146.

Mervosh, S., J.C. Lee, L. Gamio, and N. Popovich. 2020. "See Which States Are Reopening and Which Are Still Shut Down." *The New York Times.* https://www.nytimes.com/interactive/2020/us/states-reopen-map-coronavirus.html

Nierenberg, A. 2020. "Plant-Based 'Meats' Catch On in the Pandemic." *New York Times*. https://www.nytimes.com/2020/05/22/dining/plant-based-meats-coronavirus.html

Norwood, F.B., and J.L. Lusk. 2018. *Agricultural Marketing and Price Analysis*. Long Grove IL: Waveland Press.

Pitt, D. 2020. "Virus Is Expected to Reduce Meat Selection and Raise Prices." *The Associated Press.* https://apnews.com/article/prices-mo-state-wire-in-state-wire-ia-state-wire-sd-state-wire-cb9fd324e9e3276dd56075a78223b7bb

Peña-Lévano, L., 2020. "Personalizing Online Classes: The Use of Evaluation and Participation Tools." *Applied Economics Teaching Resources (AETR)* 2(2):51–58.

Peña-Lévano, L., S. Burney, and C. Adams. 2020a. "Labor Disruptions Caused by COVID-19 in the U.S. Agriculture and Nonfarm Industries." *Choices* 35(3):1–12.

Peña-Lévano, L., S. Burney, G. Melo, and C. Escalante. 2020b. "COVID-19: Effects on US Labor, Supply Chains and Consumption Imagery Article." *Choices* 35(3).

Peña-Lévano, L., and G. Melo. 2022. "Adaptation of Teaching Strategies During the COVID-19 Pandemic." *Applied Economics Teaching Resources (AETR)* 4(1):12 – 27.

Plumer, B. 2020. "The Meat Business, a Big Contributor to Climate Change, Faces Major Tests." *The New York Times.* https://www.nytimes.com/2020/04/17/climate/meat-industry-climate-impact.html#:~:text=Studies%20have%20found%20that%20beef,proteins%20like%20soy%20or%20beans

Restuccia, A., and J. Bunge. 2020. "Trump Takes Executive Action to Keep Meat-Processing Plants Open." *Wall Street Journal.* https://www.wsj.com/articles/trump-to-take-executive-action-to-keep-meat-processing-plants-open-11588099443

Reuters. 2020. "Trump Administration Faces Pressure to Buy Food for the Needy, Avoid Waste." *The New York Times.* https://www.reuters.com/article/us-health-coronavirus-usa-food-idUSKCN21W2VW

Searcey, D. 2020. "Tight-Knit Company Towns Reel as Coronavirus Rolls Through." *The New York Times.* https://www.nytimes.com/2020/04/22/us/coronavirus-workplaces-midwest.html

Skidmore, S. 2020. "Relief Checks Are a Lifeline for Some, a Cushion for Others." *The Associated Press.* https://apnews.com/article/virus-outbreak-lifestyle-business-ap-top-news-250ff4425bce2ad0e0a7c67b7b1aca4d

Terazano, E., and G. Meyer. 2020. "Pandemic Accelerates Shift to Meat Substitutes." *Financial Times.* https://www.ft.com/content/0127984a-6def-4040-9bca-002b6ffd4e0a

Tonsor, G.T., J.L. Lusk, and S.L. Tonsor. 2021. "Meat Demand Monitor during COVID-19." *Animals* 11:1040.

Yaffe-Bellany, D. 2019. "The New Makers of Plant-Based Meat? Big Meat Companies." *New York Times.* https://www.nytimes.com/2019/10/14/business/the-new-makers-of-plant-based-meat-big-meat-companies.html

Yang, R., K.C. Raper, and J.R. Pruitt. 2019. "The Influence of Recession and Income Strata on Consumer Demand for Protein Sources." *Applied Economics* 51:4615–4628.

4(4) doi: 10.22004/ag.econ.324809