



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.



Perception versus reality of the COVID-19 pandemic in U.S. meat markets

Nicole Olynk Widmar^{a,*}, Nathanael M. Thompson^a, Courtney Bir^b,
Eugene Kwaku Mawutor Nuworsu^a

^a Department of Agricultural Economics, Purdue University, West Lafayette, IN 47907, USA

^b Department of Agricultural Economics, Oklahoma State University, Stillwater, OK 74078, USA

ARTICLE INFO

Keywords:

COVID-19
Consumer confidence
Food systems
Public perceptions
Meat markets

ABSTRACT

Disruptions to meat markets during the COVID-19 pandemic spurred mass media attention. While media deeming the U.S. food system ‘broken’ garnered a great deal of attention, the actual production and meat availability data does not support this conclusion. The U.S. meat supply chain, while certainly strained and with measurable consequence during periods of adjustment, proved ultimately resilient and rebounded quickly. Increased attention on meat supply chains may drive continued efforts to improve resiliency, but analyses of online media and U.S. production and cold storage data do not support a narrative that the system ‘broke’, but was perhaps ‘strained’ and ‘responded efficiently’. Findings indicate that public sentiment about U.S. meat supply overall was not as dominated by pandemic-era concerns as may be hypothesized.

1. Introduction

The World is interconnected both physically and virtually; webs of travel routes facilitate the movement of goods and people, and the World Wide Web spreads news and information contemporaneously. The COVID-19 pandemic is a testament to the level of our interconnectedness, physically and virtually, as both the virus and information (both correct and incorrect) has spread around the globe at rates previously unrecognized in conjunction with widespread disaster. The novel coronavirus (COVID-19) was reported in Wuhan China on December 31, 2019, when Chinese authorities confirmed they were treating dozens of cases.

What started as a health emergency has become an economic emergency for nations around the globe (Ozili & Arun, 2020). Households faced economic and social challenges as school cancellations left parents torn between child care and economic survival. COVID-19 has been tragic for households impacted medically and economically, while instigating adjustments in eating behaviors due to restaurant closures, less spending on food away from home, and fewer shopping trips for many people seeking to limit exposure. Supply chain adjustments also impacted short-term and/or local availability of specific products, which was especially true of perishable food items, such as dairy (Wolf, Novakovic, & Stephenson, 2021) and meat (Balagtas & Cooper, 2021). Grocery stores struggled to keep up with rapid increases in demand for certain products and media attention on grocery prices was persistent

throughout the pandemic as supply chains adjusted and prices for staple items increased (Wiener-Bronner, 2020). Agricultural economists dove into analyses surrounding food supply systems and pandemic responses, heavily focusing on meat markets which were impacted due to plant closures (Balagtas & Cooper, 2021; Bir, Peel, Halcomg, Raper, & Jones, 2021; Cowley, 2020; Hobbs, 2021; Lusk, Tonsor, & Schulz, 2020; Peel, 2021).

Further exacerbating immense pressure and external criticism, some meat industry leaders added fuel to the fire. For example, Tyson Foods board chairman John Tyson placed a full-page ad in the *New York Times*, *The Washington Post*, and the *Arkansas Democrat-Gazette* on Sunday April 26th, 2020, entitled “A Delicate Balance: Feeding the Nation and Keeping Our Employees Healthy” where he stated “the food supply chain is breaking” (Tyson, 2020). Not surprisingly, this simultaneously elicited national attention and outrage by many inside and outside the agriculture industry. The corresponding media storm likely intensified panic buying of staple food items and rushes to procure local foods (Westervelt, 2020), not to mention contributing to already heightened anxiety levels. Recently, consumer advocacy groups have alleged that major meat packers fueled fears of shortages during the pandemic to boost demand and prices for meat products (Dorning, 2021). Many months after the initial shocks to supply chains the meat industry remains under scrutiny by consumer groups and regulators. This scrutiny illustrates continued public relations, and potentially legal, challenges resulting from the potential for public concern regardless of supply chain

* Corresponding author.

E-mail address: nwidmar@purdue.edu (N.O. Widmar).

<https://doi.org/10.1016/j.meatsci.2022.108812>

Received 20 October 2021; Received in revised form 6 March 2022; Accepted 28 March 2022

Available online 3 April 2022

0309-1740/© 2022 Elsevier Ltd. All rights reserved.

performance.

Social media is credited with significantly changing the mental, emotional, and overall human cognition surrounding the COVID-19 pandemic. ‘Doomscrolling’ (mostly negative) news during the COVID-19 era on online media platforms is known to fuel anxiety (Garcia-Navarro, 2020); that behavior combined with the growth in streaming and screen time during stay-at-home orders (Burch, 2020) creates the potential for societal anxiety at record levels. The use of online and social media in studying and evaluating the response to natural disasters including hurricanes (Freberg, Saling, Vidoloff, & Eosco, 2013; Kryvasheyeu et al., 2016; Liu, Lai, & Xu, 2018; Martin, Li, & Cutter, 2017; Sadri, Hasan, Ukkusuri, & Cebrian, 2018; Widmar, Rash, Bir, Bir, & Jung, 2021), fires (Kibanov, Stumme, Amin, & Lee, 2017), flooding (Moore & Obradovich, 2020) and earthquakes (Avvenuti, Cresci, La Polla, Meletti, & Tesconi, 2017; Earle, 2010; Mendoza, Poblete, & Valderrama, 2019) is well established in the literature. Real-time mapping of disasters using online media data can facilitate timely response and augment other data sources (Middleton, Middleton, & Modafferi, 2014). Since major viral outbreaks happen with less frequency, social media studies are less numerous. Studying the use of social media in both the U. S. and Nigeria during the Ebola outbreak, Odlum and Yoon (2015) encouraged the use of social media for public-specific and literacy-appropriate messaging to control outbreaks.

Prominent mass media coverage of the challenges faced by the meat supply chain during the COVID-19 pandemic are hypothesized to have influenced public perception of meat markets. This analysis uses online media listening and analytics, including natural language processing and net sentiment analysis, fundamentally the degree of positivity or negativity associated with the topic, to derive insight into the U.S. public’s relative attention (quantitatively) and sentiment (qualitatively and quantitatively) surrounding the U.S. meat markets during 2019 and 2020.

The total volume of online media/search results, comprised of online media on these topics, is presented over time, enabling the documentation of ‘the anatomy of COVID-19 in U.S. meat markets’ in online media space.

To further examine what happened to meat markets during this time, public perception, in the form of U.S. online media about meat markets, is also directly compared/contrasted to actual meat production, cold stocks of meat and poultry products, and overall availability of meat in the U.S.. Fundamentally, this analysis seeks to determine if the online media reflects reality in the U.S. meat markets; does perception reflect reality? Or, did online and social media volume and sentiment (perception) reflect an over or under reaction relative to the actual national meat production and availability situation (reality). Gaining understanding of this unique disaster in terms of online media versus reality may inform future disaster responses and aid in shaping communication with the public about food during times of stress.

2. Methods

The supply-side reality of the U.S. meat market situation, in terms of production and overall availability of meat products in U.S. markets is summarized using weekly production data in 2019 and 2020. The public’s overall perception of the state of those markets in both 2019 and 2020 were quantified and summarized using online and social media searches and analytics.

2.1. U.S. meat production and stocks

Total meat production was calculated as the sum of beef, pork, chicken and turkey production for federally inspected and commercially slaughtered livestock and poultry. Weekly beef and pork production data were obtained from the [USDA National Agricultural Statistics Service \(NASS\) \(2021\)](#). Weekly chicken and turkey production data were obtained from the poultry slaughter reports released weekly by

[USDA Agricultural Marketing Service \(AMS\) \(2021a, 2021b\)](#). Since weekly chicken and turkey data is not available from USDA NASS, poultry slaughter numbers were converted from per head basis to total production by multiplying the total number of slaughtered animals by average weight and dressing percentage. Monthly meat stocks, measured/presented as millions of pounds of pork, chicken, and beef in cold storage were obtained from [USDA National Agricultural Statistics Service \(NASS\) \(2021\)](#).

2.2. Online media data collection and analytics

Penetration of online media into people’s daily lives, particularly among younger people, allows access to a unique data set documenting people’s collective ‘stream of consciousness’. There are both negative and positive aspects of online and social media data collection and analytics. The negative aspect of social media listening is that the analyst is finding only those posts, conversations, or media that occurred naturally or in response to a non-research study affiliated stimulus. The positive aspects of social media listening, when done with the intention of understanding public perceptions or the public viewpoints on a topic of societal or public interest, is that the search results occurred sporadically or naturally and not in response to researcher stimuli. Online media exists in the form of comments, posts, reviews, responses to ongoing conversations, etc. (Widmar, Bir, Clifford, & Slipchenko, 2020). Whilst precise questioning and experimental design are the cornerstones of social science research based on surveys/questionnaires and focus groups, the lack of design is perhaps the appeal behind analyzing online and social media data. Natural language processing to discern sentiment (positive versus negative) collectively and among sub-searches of online content allows documentation of perceptions about a topic or point of interest without researchers participating in or instigating the conversation/topic.

Increasing interest in online and social media search and analytics platforms have been documented in recent years, but a large variety of web and database search tools are available depending on the research topic and question. Some databases and search tools are tailored, such as for searching legal documents or court cases, whereas others are news focused or broader. LexisNexis provides Universities and government agencies with business and news sources and associated searching capabilities (LexisNexis, 2018); Tonsor & Olynk, 2011 used LexisNexis to study whether animal welfare related media may be related to U.S. meat demand. Other researchers may employ alternative algorithms or online listening platforms to collection specific types or formats of online data. Social listening tools have been developed to aid in search, surveillance, and analytics and are perhaps most commonly used in marketing where lists such as “top 20 social media listening tools for 2020” present pros and cons of various platforms (Influencer Marketing Hub, 2020). This analysis employed the Netbase platform, which offers search and analysis capabilities for online media, including blogs, forums, consumer reviews, Twitter, Instagram, News and other media (Netbase, 2018a). Netbase ranks among the top social listening platforms, and has been used for research purposes as well as quantifying interest and sentiment for product development (Carr et al., 2015).

The Netbase social and online media listening platform was used to study the volume and net sentiment of online and social media related to U.S. meat markets and availability in calendar years 2019 and 2020. The two-year period of study offers sufficient time for understanding of seasonality in volume and/or sentiment of online media, as well as enabling an in-depth look at the unprecedented market disruptions of COVID-19, which took place beginning in March 2020 in the U.S. markets. Due to the nature of social and online media data, in which posts may be removed or reinstated, it is imperative to report to the dates on which data was formally collected and datasets were finalized. Data was downloaded and summarized between March 8th and March 15th, 2021.

Although searches in multiple languages and across multiple

regions/countries of the world are technologically possible, local language interpretation, such as slang, shorthand, and cultural context, are acknowledged challenges of such broad geographic ‘text as data’ collection efforts. The geography for all searches employed in this analysis was limited to the United States (including U.S. Minor Outlying Islands) and exclusively posts in English were searched.

Primary search terms parameterized a search which attempted to quantify online and social media, including news media, social media posts, blogs and other online chatter, and verbiage generally related to meat and U.S. meat markets. Fifty-three primary meat search terms were identified using USDA Agricultural Marketing Service (AMS) retail reports for beef, pork, chicken and turkey (USDA Agricultural Marketing Service (AMS), 2021a, 2021b). Researchers combined common terms and incorporated common hashtags to reference inputs to meat production lines, such as cattle and feedlot, and reference to meat cases and counters, to develop the eventual list of 53 primary search terms as follows: beef, Beef, #beef, Cattle, cattle, #cattle, chicken, #chicken, chickens, #chickens, lamb, #lamb, #lambs, feedlot, pig, #pigs, hog, #hog, hogs, #hogs, pork, #pork, meat, #meat, turkey, #turkey, turkeys, #turkeys, poultry, #poultry, ribeye, steak, #steak, tenderloin, filet mignon, sirloin, london broil, brisket, Ground Round, Ground Chuck, Ground Sirloin, Ground Beef, Pork Loin, Pork Chops, Pork Chop, Spareribs, Ham, Bacon, Sausage, Chicken Wings, meat counter, meat case.

Researchers employ both inclusionary and exclusionary search terms, refined in a process called search tuning, to tailor searches to the specific subject matter intended. There are many colloquial phrases, sports teams, and online games for example, that mention animals or meat products that were not the intended topic of study. Researchers developed a total of 250 exclusionary terms (Appendix A), including terms such as sacrificial lamb, you’re a sheep, beefed up, Farmville, and Peppa Pig, among others. Simultaneously, 121 exclusionary domains were identified (Appendix A), including boardgamegeek.com, teaxshuntingforum.com, tractorybynet.com, and a variety of others determined by researchers to be contributing media unrelated to the subject matter intended. A total of 135 authors were also excluded during tuning processing (Appendix A).

An additional search filter developed to search for mentions of COVID-19 in the 2020 calendar year, within the findings of the primary meat search described, was developed. To develop these COVID-19 search terms preliminary data were collected weekly, on Sundays, for the previous Sunday through Saturday starting after the first cases appeared on December 31st 2019 (Taylor, Boulos and Almond, 2020) for the first 15 weeks of the pandemic. Terms included in the search were COVID, #COVID, COVID-19, #COVID-19, coronavirus, #coronavirus, SARS-CoV-2, and #SARS-CoV-2 (CDC, 2020; Gharib, 2020). Researchers employed these weekly searches to tailor the eventual 16 inclusionary COVID-19 search terms employed as follows: COVID, COVID-19, #COVID, #COVID-19, coronavirus, #coronavirus, SARS-CoV-2, #SARS-CoV-2, COVID_19, #COVID_19, Covid19, #Covid19, COVID19, #COVID19, Covid_19, #Covid_19.

Sentiment, ascertained using Netbase’s Natural Language Processing capabilities, of individual posts was determined (Netbase, 2018b). Researchers analyzed initial search results and the key words driving sentiment associated with online media search results, both negative and positive to ascertain contextual correctness within the subject matter context. Approximately 10% of posts were spot checked by researchers to ensure sentiment assignment accuracy. Posts were read and assigned either a negative, positive, or neutral sentiment by the researcher, and their assignment was checked against the Netbase algorithm’s assignment. Adjustments can be made by re-assigning words to be either positive, negative, or neutral as needed. For this analysis, no reassignment was necessary. Net sentiment is the result of the total percent of positive posts less the percent of negative posts, resulting in a net sentiment which is necessarily bounded between –100% and +100%. A third category of posts, neutral posts, is not used in the

calculation of net sentiment but is included in other search metrics, such as top words. Sentiment is a key contribution to this analysis which allows researchers to link real-world events, such as market disruptions caused by COVID-19 in March 2020, to corresponding online chatter.

The general meat search was conducted for calendar years 2019 and 2020. Total posts, mentions, authors, and net sentiment were collected weekly for the time period studied. Posts are the number of documents containing mention of the topics (Netbase, 2020). Mentions are individual sentences within a post that mention primary terms, in this case the meat related terms (Netbase, 2020). The number of posts will never be greater than the number of mentions, as each post will contain at least one, if not multiple mentions. For example, in a single post someone may say “The ground chuck at store A was sold out. However, we found some ground chuck at store B.” This post would count as one post, but contains two mentions of meat, one which would be classified as negative, and the other positive.

On Twitter, retweets are a process where a person can, for all intents and purposes, quote another person’s post. Additional text may or may not be added. During analysis, retweets can be removed to reduce the amplification of the opinion if they are not providing additional information. Or, retweets can be kept to capture the influence of a broader issue (Gasco, Clavel, Asensio, & de Arcas, 2019). This analysis is on the general perceptions, from the online public, about meat markets, availability, and use in the US. Therefore, we wanted to be able to identify spikes in the overall number of posts and mentions, so we retained re-tweets in our analysis. In terms of sentiment analysis, the original tweet, and any additional text that was added to a quoted or “retweeted” tweet, was analyzed separately.

Top terms mentioned, domains, and sources summarizing search findings were summarized for 2019 and for 2020 independently, to facilitate comparisons. A source provides a general idea of where a post appeared, for example on a news site. A more detailed example of where the post appeared, for example cnn.com, is a domain.

3. Results and discussion

U.S. meat production in April and May 2020 was 1.5 billion lbs., or 10%, less than the same two-month period in 2019 (USDA National Agricultural Statistics Service (NASS), 2021). Meat supply in the U.S. received a lot of attention early on during the pandemic due to meat packing plant closures and shutdowns which reduced the meat production in the U.S. for a short period of time (Balagtas & Cooper, 2021; Hobbs, 2021). On the public-facing side, there were periods of time when shoppers moved rapidly and heavily into shopping for at home food preparation and consumption (Balagtas & Cooper, 2021; Hobbs, 2021). Given the news media attention placed on the meat supply chain, including the full-page ad claiming the system was ‘breaking’ (Tyson, 2020), one may posit that there was a massive amount of concern in the U.S. public about meat supply chains. However, the reality was that there was relatively small volumes of chatter or public conversation devoted to meat supply during the COVID pandemic in 2020 (Fig. 1). Furthermore, investigation into the meat supply, including production and stocks in cold storage, reveal that the meat supply chain was responsive, and that while production decreased measurably, there was not a shortage in the U.S. meat market.

Fig. 1 labels four key time periods during which notable spikes in total mentions in the online searches conducted about meat can be seen. The Thanksgiving holiday yields significant comments about the turkey served for the holiday meal, driving total mentions observably higher both years studied. In August 2019 there was the “chicken sandwich wars”; Popeye’s launched a fried chicken sandwich on August 12th 2019 which sparked notable debate regarding the best fast food chicken sandwich (Cobe, 2021) and fueled a short-lived but massive spike in total mentions captured in the search conducted.

The COVID-19 initial period of adjustment and attention surrounding U.S. meat production and supply in the Spring of 2020 does show a

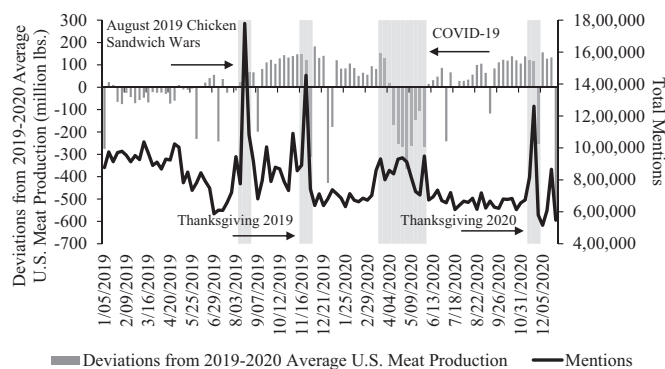


Fig. 1. Weekly deviations from 2019 to 2020 average in U.S. total meat production and the online media mentions about meat during 2019 and 2020.

visually detectable rise in total mentions about meat generally. However, the rise was not of the same scale as some of the other notable and visually detectable events during the study time period. Viewed another way, COVID-19 specific mentions comprised a very small portion of total meat mentions during 2020 (Fig. 2). Notably the share of meat mentions related to COVID-19 did peak during the time period during which production decreases occurred (Fig. 1).

The notable decrease in meat production in April and May 2020 did not yield a shortage in the U.S. marketplace due to the ample stocks of meat in cold storage which were drawn down during this time period of decreased production. Fig. 3 depicts the drawdown of meat in cold storage during the April and May 2020 time period. During the month of April meat in U.S. cold storage declined by 282 million lbs., representing 42% of the drop in April 2020 meat production relative to the 2019–2020 average meat production (USDA National Agricultural Statistics Service (NASS), 2021).

May 2020 saw a notable drop in total meat production, relative to the 2019–2020 average meat production, coming in 1.1 billion lbs. below average. Unexpectedly, U.S. meat in cold storage increased during May 2020. This may reflect the complexities being faced in the meat market during this time period as stocks were attempted to be replenished alongside continuing strength of demand for supermarket and retail food channels. Notably, the study of total meat may obscure some of the intricacies of meat demand during this time period when consumers were adjusting to at-home cooking and consumption, leaving certain meat items popularized in restaurants, like beef tenderloins or chicken wings, in abundance while ground beef and other at-home cooking staples remained hard to find in some places (Balagtas & Cooper, 2021; Hobbs, 2021; Ortez, Thompson, & Widmar, 2021).

While notable decreases in meat production existed in April and May 2020, meat production had rebounded by the first week of June 2020 as

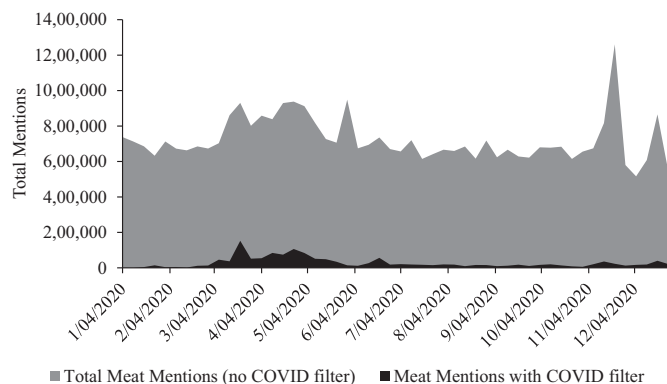


Fig. 2. Weekly COVID-19 specific mentions as share of total meat mentions in 2020.

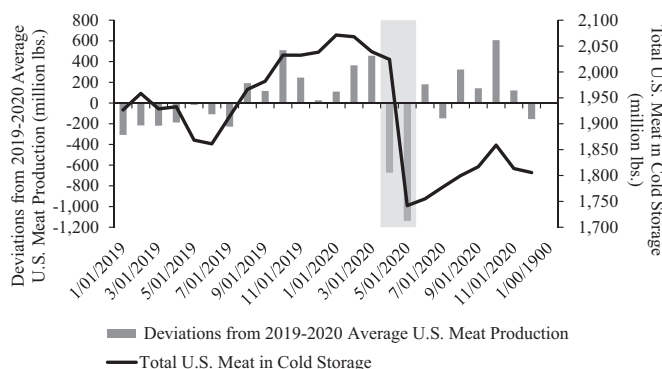


Fig. 3. Monthly deviations from 2019 to 2020 average U.S. meat production and U.S. stocks of meat in cold storage.

processing plants reopened during the month of May (Fu, 2020). Furthermore, and generally missing from many critiques of the U.S. meat supply chain, is the understanding that immediately after the hardest months of the pandemic in the meat production system, the U.S. still had 1.7 billion lbs. of meat in cold storage (USDA National Agricultural Statistics Service (NASS), 2021). Thus, production indeed fell measurably in the Spring of 2020, but there was not a shortage of meat in the U.S. supply chain or food system. It is important to note that although there was not a meat shortage, there were shortages of some specific products. For example, few retail grocery stores have butchers, meaning that beef products come to the store pre-rendered (Peel, 2021). This limited the grocery stores' ability to adjust to increased beef demand caused by a shift from food service to retail (Peel, 2021). Additional issues such as differences in the make-up of ground beef between retail and food service, resulted in specific bottlenecks that cold storage could not overcome for specific products (Peel, 2021). However, meat, although perhaps not exactly the specific product the consumer wanted, was still readily available. Appendix B displays the total meat in cold storage for individual meat products.

The average net sentiment in the general meat search was 32 (Fig. 4). Broken down by year, the average net sentiment was 33 in 2019, with a standard deviation of 9, and 31 in 2020, with a standard deviation of 11. The overall net sentiment about meat in U.S. online indeed fell during the acute COVID-19 impact period of April and May 2020, but remained positive (24) on a -100 to +100 scale. While the net sentiment of search results in the general meat search did deviate over time, there were very few structural changes in meat sentiment seen. There is a notable drop in the net sentiment in the last week of May 2020. However, further investigation reveals news coverage about chickens killed in a fire in Pennsylvania (Stauffer, 2020) and a number of other non-COVID-19 related occurrences were the primary influences of this shift in sentiment.

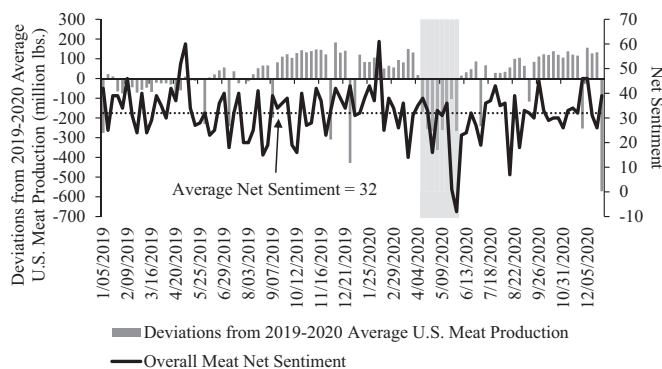


Fig. 4. Weekly deviations from 2019 to 2020 U.S. meat production and net sentiment of meat online media searches in 2019–2020.

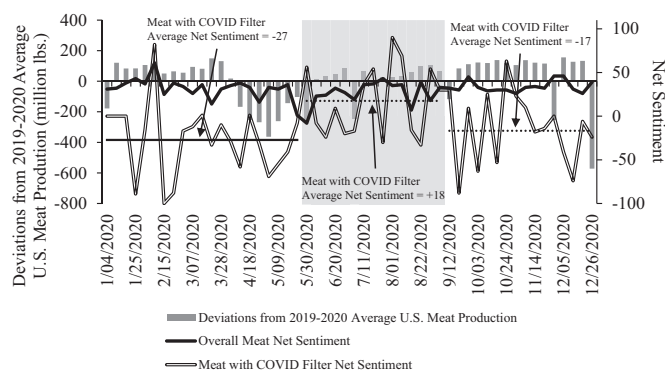


Fig. 5. Weekly overall meat search results and COVID-19 subsearch results net sentiments with meat production deviations from 2019 to 2020 average.

Fig. 5 depicts the net sentiment of the COVID-19 specific search within the general meat search, essentially yielding the sentiment of meat-related posts that mention or refer to COVID-19. The net sentiment, for COVID-19 within the meat search broke down into three distinct phases or time periods. The January through May 2020 time period was characterized by early discussions of COVID-19 in China and then was followed by the COVID-19 first wave in the U.S. Early in 2020 comparisons of COVID-19 to other viral outbreaks, such as “swine flu” (Rettner, 2020; Scott, 2020), and hypotheses about possible animal origins of the COVID-19 virus dominated discussions. Simultaneously debate about other close proximities between animals and humans in which a novel virus such as COVID-19 may make the leap to humans (Taylor, Boulos and Almond, 2020) made headlines. Then, the mid-March 2020 shutdowns in the U.S. saw closures of schools and restaurants drive rapid and large-scale supply chain adjustments as U.S. residents demanded large volumes of staple food items through retail channels (Hobbs, 2021). Meat processing plants were plagued with COVID-19 outbreaks among workers (Saitone, Schaefer, & Scheitrum, 2021; Taylor, Boulos and Almond, 2020) and faced significant adjustments with closures that sent reverberations across the nation as livestock systems faced challenges with systems ‘backing up’ as processing facilities closed or slowed (Balagtas & Cooper, 2021; Hobbs, 2021; Marchant-Forde & Boyle, 2020; McCarthy & Danley, 2020). Taken together, the average net sentiment for the meat search with the COVID-19 filter was -27 for the January – May 2020 time period.

The second distinct time period in Fig. 5 is the Summer of 2020, during which the average net sentiment of the meat search with the COVID-19 filter applied rose substantially to $+18$. This time period saw plants reopening, meat production returning to pre-pandemic levels, rebuilding of U.S. cold stocks of meat, and improvements in meat processing plant worker health reports as testing became more widely available and guidelines were put in place to try to protect worker health and safety (Fu, 2020). The third and final phase of September through December of 2020, saw the COVID-19 filtered meat search average net sentiment fall to -17 . A variety of factors contributed to this fall in net sentiment including the fall of 2020 being dominated in many online and social media channels by the upcoming 2020 election alongside the significant worsening of the COVID-19 pandemic in the U.S. Social media mentions often include multiple topics or themes in a single post, and negativity surrounding adjustments in holiday meals (often meat) choices and worsening pandemic factors and/or election-related factors, including meat plant or supply chain challenges, occurred.

4. Conclusions and implications

Perception of the general public, and that of the media generated in

2020, regarding the U.S. meat supply chain functionality and performance versus reality of U.S. total meat production is worthy of investigation. Given the increased speed of person-to-person communication through social and interactive online media and ability of online media to shape and amplify conversations, the use of online and social media to discern perception of the U.S. meat industry is fitting and timely. Furthermore, the ability of the U.S. meat industry to recognize and respond to public concern may be necessary to respond transparently about product availability during disasters in the future.

The increase in total search mentions associated with COVID-19 was the smallest of the identified peaks in mentions throughout the 2019–2020 time period studied. The volume of mentions of COVID-19 in reference to the meat supply were timely in matching the timing of production volume being depressed due to plant closures, slowdowns, and COVID-19 challenges. Timing between the online media mentions and real-world happening aligns, although we cannot disentangle whether plant closures or production availability caused these increases or if they were or due to other mentions like safety among meat plant workers or related discussions. Simultaneous occurrences were seen but causality cannot be established.

Total public interest, measured as the percent of total online media mentions of COVID-19 relative to the total mentions of meat overall, was relatively small. Yet, a number of high-ranking meat industry leaders, along with major journalistic outlets and some academic or industry groups, warned of ‘impending doom’ in the meat industry which never materialized. In today’s high-speed information networks, the potential for sparking mass panic, especially during times of distress, is worrying. Reflection on the perception – broadly speaking – versus reality, measured in actual pounds of production and the performance of the supply chain in delivering product to the U.S. marketplace is important to prevent unnecessary concern and potential panic in the future. Furthermore, directed investment in building resiliency for future strains faced in the supply chain requires accurate understanding of the strain sustained, rather than over (or under) reactions fueled by speculation.

Despite the ongoing conversations about the pandemic revealing vulnerability in the meat supply chain, a direct comparison between perception and reality reveals that total meat production in the U.S. showed resiliency and efficient recovery after the April and May 2020 declines due to COVID-19—in this case, perception did reflect reality. Therefore, calls to create redundancies in the meat supply chain through disaggregation or local, direct-to-consumer marketing channels, while intuitively appealing, are not a panacea and lack rationale (Hobbs, 2021; Lusk et al., 2020; Ma & Lusk, 2021). Much has been written about the complex tradeoffs between a supply chain that is efficient and produces affordable food for consumers during “normal” times and one that is redundant, flexible, and resilient to “abnormal” shocks (Hobbs, 2021; Lusk et al., 2020). Therefore, proposals aimed at addressing the structure of the meat supply chain in the name of the pandemic need to be carefully vetted and held up against both the reality of what happened and the perception created through online media.

Declarations of Competing Interest

None.

Acknowledgement

This work was supported partially by the USDA National Institute of Food and Agriculture, Hatch project IN00044133 “Changing Preferences for Meat Proteins by US Residents.”

Appendix A

A.1. Exclude terms

@Blacknmild, @YouTube, pig out, @sheep-in-clouds, Peppa pig, peppa pig, pump milk, hogging the, Egg Town, cattle call, hog tied, GO CHICKENS, go chickens, go bulls, ranch village, farmville, #Farmville, #farmville, Farmville, chicken-radio, chicken radio, LA rams, LA Rams, playing chicken, hen party, I bet ewe, sheeple, The Silence of the Lambs, silence of the lambs, Silence of the Lambs, starting beef, bush hog, too chicken, play cicken, cash cow, cash-cow, eggs in one basket, wolf in sheeps clothing, wolf in sheep's clothing, Gaston, Shaun the Sheep, shaun the sheep, hog wild, wild boar, wild boar, guinea pigs, you are a pig, you are a sheep, you are sheep, you are pigs, beef them up, beef you up, beef him up, wolf in sheep's clothing, fucking pig, Normal Lamb, Norman Lamb, Mia Farrow, Mr. Lamb, Ms. Farrow, Holy Cow, holy cow, beefed up, Bay of Pigs, bay of pigs, kicken' chicken, kickin' chicken, commie sheep, smart sheep, tell the other sheep, Dirty Pig, dirty pig, you are a chicken, you're a chicken, stuffed animal, bloated pig, lipstick on a pig, spring chicken, name is cow, wild hog, Wild Hog, lamb of god, lamb of God, electric sheep, #lambogod, dishonor on my cow, chicken shit, sacrificial lamb, Sacrificial lamb, squeal like a pig, Samhain/Samain, Cow Tools, golden calf, ate like a pig, PUG AND PIG, being a chicken, Jumbo Eye pencil, milkmakeup, lambs of dalamud, Im a goat, I'm a goat, I am a goat, I am a sheep, I'm a sheep, you're a sheep, chicken nugget animation, pig-boy, anime, chicken fucking, chicken fucker, chicken fuckers, boobs, y'all beef, FUCK YOUR SHEEP, hog-arm, calve socks, counting sheep, counting the sheep, counting the lambs, #countingsheep, Counting your chickens before they hatch, counting your chickens before they hatch, Calf Muscle, calf muscle, calf skin, cow audio, Cow Audio, #cowaudio, #nikecowok, spirit animal, #spiritanimal, Wally Lamb, chicken suit, #chickensuit, chickensuit, chicken costume, chicken limo, tax beef, a sick pig, pigs like you, POTUS pig, World of Warcraft, #WoW, #WorldofWarcraft, MMO, #MMO, MMORPG, #MMORPG, Minecraft, XP Farm, XP Farming, mob farm, mob farming, xp farm, NFL, Xavier Rhodes, Cornerback, Conor Lamb, Big Baller Brand, LavVar Ball, @MrBudSmith, serial rapists, LaVar, Johnny Walker, henparty, #henparty, hair pi, hair pie, #hairpi, #hairpie, vagina, [thefriendegg.com](https://www.thefriendegg.com), @the_fried_egg, rape, #rape, #the_fried_egg, racist, segregation, segregationists, Fusionistas, #BoycottSOTU, rasgulla, rasagulla, Micah, @SketchBallzz, Spongebob, e-doctor, #Spongebob, Corinthians, Overlord, @biowindycyhawk1, Nassar, Larry Nassar, #LarryNassar, #Nassar, Genesis, @Judylynnpresto3, Vamousse, nude, moon, octopus, donor, Kinder, kinder, Avatars, #kinder, Pokemon, #Pokemon, Pokemon Go, #PokemonGo, #Pokemongo, Pokemon GO, #PokemonGO, Poké Stop, #PokéStop, Pokémon, #Pokémon, Poke Stop, #Pokestop, chicken pox, Radio Free Europe, Trump, Kurds, Russia, Erdogan, Syria, U.S. troops, Mount Olive, Turkey Brooke Park, pork to be added to the bill, gang shit, now I got beef, Greenland Shark, have beef wit me, no serious beef, PS5, Greece, Madrid, midfielder, soundtrack, going HAM, old town road, Geoffrey Bacon, Nintendo, #GeorgeFloydProtests, GeorgeFloyd, George Floyd, parliament, Turkey earthquake.

A.2. Exclude domains

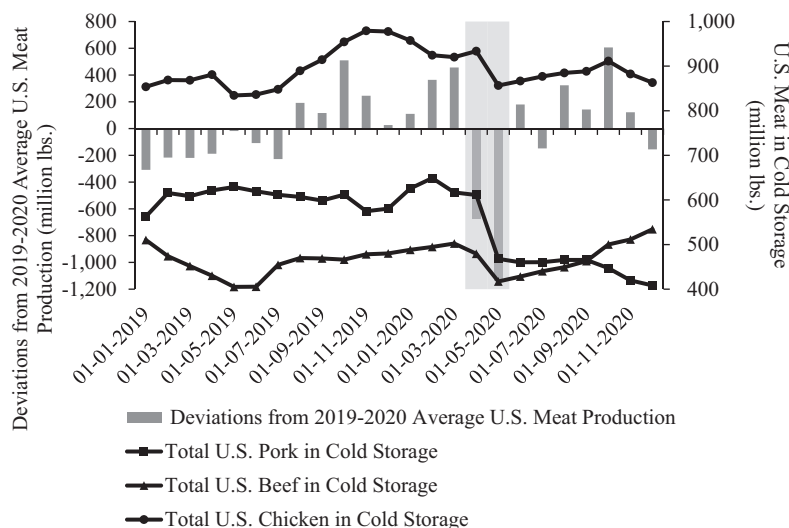
[Boards.4chan.org](https://boards.4chan.org), [breitbart.com](https://www.breitbart.com), steamcommunity.com, forums.hardwarezone.com.sg, hogville.net, forums.digitalspy.com, bigfooty.com, hotcopper.com.au, uk.answers.yahoo.com, au.answers.yahoo.com, tigerdroppings.com, forums.spacebattles.com, forums.penny-arcade.com, gamefaqs.com, ign.com, nz.answers.yahoo.com, boardgamegeek.com, thefarmingforum.co.uk, forum.supercell.com, dailymail.co.uk, topix.com, worldstarhiphop.com, boards.ie, thehill.com, medium.com, nairaland.com, neogaf.com, [texas hunting forum.com](https://texas Hunting forum.com), article.wn.com, daily caller.com, fark.com, forums.sherdog.com, infowars.com, stuff.co.nz, trueviralnews.com, play.google.com, thestudentroom.co.uk, forum.lowyat.net, theland.com.au, pastebin.com, defence.pk, s13.ziffboards.com, 24hourcampfire.com, mediaite.com, investorshub.adfn.com, vanguardngr.com, tmz.com, mmo-champion.com, forum.nationstates.net, lipstickalley.com, pjmedia.com, timesofindia.indiatimes.com, expedia.de, patheos.com, forums.sufficientvelocity.com, boards.straightdope.com, indianexpress.com, hindustantimes.com, tractorbynet.com, stackoverflow.com, farmonline.com.au, queenslandcountrylife.com.au, avclub.com, thaivisa.com, blogs.rediff.com, imdb.com, corvetteforum.com, bulbapedia.bulbagarden.net, ca.answers.yahoo.com, briefreport.co.uk, thehindu.com, forums.server.twoplus.com, forum.mtbr.com, forum.gon.com, telegraph.co.uk, news.com.au, cheatsheet.com, rawstory.com, forums.leagueunlimited.com, expedia.com.hk, tripadvisor.in, rollercoaster.ie, prnewswire.com, firstpost.com, heraldscotland.com, thedibb.co.uk, townhall.com, agriland.ie, weeklytimesnow.com.au, uberpeople.net, shroomery.org, diabetes.co.uk, dailytelegraph.com.au, expedia.com, gardenhousebrighton.co.uk, chadmoyer.blogspot.com, mariowiki.com, northqueenslandregister.com.au, smh.com.au, whaleoil.co.nz, explore.org, actuarialoutpost.com, weaselzippers.us, 8ch.net, forums.delphiforums.com, sltrib.com, deccanherald.com, mirror.co.uk, trapperman.com, imdb2.freeforums.net, forums.realm.com, wcrpforums.com, bitcointalk.org, eelv.djamilasonzogni.eu, standard.co.uk, inquisitr.com, answers.yahoo.com, ar15.com, e-cigarette-forum.com, us.battle.net, houzz.com

A.3. Exclude authors

india-today-news-yahoopartner:tumblr.com, TeaHerbMilkSoap:twitter.com, JohnsonAliveInter:johnsonaliveinter.com, expedia.com:expedia.es, expedia.com:expedia.com, expedia.com:expedia.at, expedia.com:expedia.dk, expedia.com:expedia.fr, rebrn.com:rebrn.com, zanytimemachine-suit45:tumblr.com, adamssean533:tumblr.com, huacowsforlife:tumblr.com, chickenpipdx:twitter.com, voteforLaur13:twitter.com, yahoonews-uk:tumblr.com, carfanz1:twitter.com, TanteEstherBlog:twitter.com, noreply@blogger.com:biggrinall.org, artbyasch:twitter.com, yahoonews-sg:tumblr.com, RasMikaereEnochMcCart:groups.google.com, labdoghome:twitter.com, EastlakeHood:twitter.com, yahoostyle-sq:tumblr.com, H4RMONY-saved:twitter.com, MuluLewis:twitter.com, Javi5hH:twitter.com, bukbot:tumblr.com, cownmilkbot:twitter.com, ughcumminggg:tumblr.com, Shit-PosterBot:twitter.com, eggseveryword:twitter.com, GrandCanyonWx:twitter.com, robloxeggbot:twitter.com, beforeitsnews.com:beforeitsnews.com, dailymaildigest:tumblr.com, sportmetweets:twitter.com, NewsSportsND:twitter.com, AllAboutSocc3r:twitter.com, Redneckbot:twitter.com, Anonymous:answers.yahoo.com, SportsRoadhouse:twitter.com, timesofindia.indiatimes.com:timesofindia.indiatimes.com, thepunkmummy:tumblr.com, beef-jerkynon-official:tumblr.com, ivie-green:tumblr.com, wildgreekgodbot:twitter.com, chickensoupbot:twitter.com, faridabadtutor:twitter.com, eggs-benedict-and-butter:tumblr.com, barntiques859:twitter.com, botburgers:twitter.com, gaylord69bot:twitter.com, RamsViews:twitter.com, Ratio-Christi:twitter.com, NewpetSuppliesN:twitter.com, DogsandCatsShop:twitter.com, petsazon:twitter.com, imilkmyprostate:twitter.com, cbs8:cbs8.com, BeefEnt:twitter.com, wn.com:article.wn.com, cbc:cbc.ca, chickenman:twitter.com, kidoctr:twitter.com, deltamoonsoap:twitter.com, glitterkitten-alix:tumblr.com, AmazonCustomer:amazon.com, VegasPokeMap:twitter.com, radommagichin:twitter.com, Smelly_Flowers:twitter.com, sirks:tumblr.com, dnaindia.com:dnaindia.com, tribuneindia.com:tribuneindia.com, Sheeple101:twitter.com, charlesmustafaa:tumblr.com, mark-perez948:tumblr.com, PolloPwner:twitter.com, circescmenagerie:tumblr.com, magicstrangestu:twitter.com, Root4HomeTeam:twitter.com, JunkyardBlonde:twitter.com, RTP1G:twitter.com, barebear2fuck:tumblr.com, rubberpigproject, oakcheese:tumblr.com, answers.com:answers.com,

prnewswire-yahoopartner:tumblr.com, rjesse2728:tumblr.com, sfgate.com:sfgate.com, pig—boy:tumblr.com, RTfaggot:twitter.com, LisaSTL:mysteryshopforum.com, onenewspage.com:onenewspage.com, rt_pig:twitter.com, gregorybellgregorybellgregorybel:tumblr.com, FrasierHarry:twitter.com, chickensoundeffects:tumblr.com, AventureLilloise;0:ehftb.blogspot.com, CarlsbadSurfs:twitter.com, german-slave:tumblr.com, newsfeeds@nzherald.co.nz:nzherald.co.nz, starburstwarrior:tumblr.com, MushroomOmarigl:twitter.com, fleecejohnsoney:twitter.com, PoGoCV:twitter.com, MLSMafia:twitter.com, IncrediblePetSI:twitter.com, exposedfagsubboypisspig:tumblr.com, FinestLuxe:twitter.com, shrubbinatorbot:twitter.com, atlantajournalconstitution:tumblr.com, beatriceiasabell88:tumblr.com, kill-me-again-im-still-conscious:tumblr.com, RedBootChicken:twitter.com, TheLoveOfSheeps:twitter.com, RodrigoB727:twitter.com, PikachuTrainer_:twitter.com, ice_crystal:twitter.com, itzwikipedia:twitter.com, sae-you-sae-me, BmoreMysticPub:twitter.com, cheapo7:twitter.com, underdeskloser:twitter.com, MontienWine:blog.montienwine.com, MerryKicks:twitter.com, patcofone:twitter.com, EmmaGPaley:twitter.com, FoodSharer:twitter.com, redditOf:twitter.com, tinyantagonist:tumblr.com, ClickTrackProf:twitter.com, bobprah:twitter.com, CatchEmAll:twitter.com, Arrian.

Appendix B



Monthly deviations from 2019 to 2020 average U.S. meat production and U.S. stocks of meat in cold storage by type (beef, pork, and chicken).

References

Avvenuti, M., Cresci, S., La Polla, M. N., Meletti, C., & Tesconi, M. (2017). Nowcasting of earthquake consequences using big social data. *IEEE Internet Computing*, 21, 37–45.

Balagtas, J. V., & Cooper, J. (2021). The impact of COVID-19 on United States meat and livestock markets. *Choices*, 36(3), 1–10.

Bir, C., Peel, D., Halcomg, R., Raper, K., & Jones, J. J. (2021). The impact of COVID-19 on meat processing, and the renewed interest in local processing capabilities. *Western Economics Forum.*, 19(1), 9–20.

Burch, S. (2020). Streaming time almost doubles as viewers flock to Netflix, Hulu during pandemic. *The Wrap*. Available online <https://www.thewrap.com/streaming-time-almost-doubles-as-viewers-flock-to-netflix-hulu-during-pandemic-chart/> (accessed May 24, 2021).

Carr, J., Decreton, L., Qin, W., Rojas, B., Rossochacki, T., & Yang, Y. (2015). Social media in product development. *Food Quality and Preference*, 40(2015), 354–364.

CDC. (2020). *Coronavirus disease 2019 (COVID-19) situation*. CDC. Available online: <https://www.cdc.gov/coronavirus/2019-ncov/summary.html> (Accessed March 2, 2020).

Cobe, P. (2021). A brief history of the chicken sandwich wars. *Restaurant Business*. Available online <https://www.restaurantbusinessonline.com/food/brief-history-chicken-sandwich-wars> (accessed May 25, 2021).

Cowley, C. (2020). *COVID-19 disruptions in the U.S. meat supply chain*. Federal Reserve Bank of Kansas City. Available online <https://www.kansascityfed.org/agriculture/ag-outlooks/COVID-19-US-Meat-Supply-Chain/> (accessed May 24, 2021).

Dorning, M. (2021). Smithfield sued for profiting from Covid meat-shortage fears. *Bloomberg – Business*. Available online <https://www.bloomberg.com/news/articles/2021-06-21/smithfield-sued-for-profiting-from-covid-led-meat-shortage-fears?ref=q8selhDd>.

Earle, P. (2010). Earthquake twitter. *Nature Geoscience*, 3(4), 221–222.

Freberg, K., Saling, K., Vidoloff, K. G., & Eosco, G. (2013). Using value modeling to evaluate social media messages: The case of hurricane Irene. *Public Relations Review*, 39, 185–192.

Fu, J. (2020). Meat processing plants are reopening. Is it safe for workers to return? *The Counter*. Available online <https://thecounter.org/meat-processing-plant-covid-19-cdc-report-coronavirus/> (accessed May 25, 2021).

Garcia-Navarro, L. (2020). *Your ‘doomscrolling’ breeds anxiety*. NPR. Available online <https://www.npr.org/2020/07/19/892728595/your-doomscrolling-breeds-anxiety-heres-how-to-stop-the-cycle> (accessed May 24, 2021).

Gasco, L., Clavel, C., Asensio, C., & de Arcas, G. (2019). Beyond sound level monitoring: Exploitation of social media to gather citizens subjective response to noise. *Science of the Total Environment*, 658, 69–79.

Gharib, M. (2020). Must-Know vocab for COVID-19 from droplets to zoonotic. Available online <https://www.npr.org/sections/goatsandsoda/2020/01/28/800142530/must-know-vocab-for-wuhan-coronavirus-from-droplets-to-zoonotic>.

Hobbs, J. (2021). The COVID-19 pandemic and meat supply chains. *Meat Science*, 108459.

Kibanov, M., Stumme, G., Amin, I., & Lee, J. G. (2017). Mining social media to inform peatland fire and haze disaster management. *Social Network Analysis and Mining*, 7(1), 30.

Kryvasheyev, Y., Chen, H., Obradovich, N., Moro, E., Van Hentenryck, P., Fowler, J., & Cebrian, M. (2016). Rapid assessment of disaster damage using social media activity. *Science Advances*, 2(3), Article e1500779.

LexisNexis. (2018). Nexis. Available online <https://www.lexisnexis.com/en-us/product/s/nexis.page> (accessed May 24, 2021).

Liu, W., Lai, C., & Xu, W. (2018). Tweeting about emergency: A semantic network analysis of government organizations’ social media messaging during hurricane Harvey. *Public Relations Review*, 44(5), 807–819.

Lusk, J. L., Tonsor, G. T., & Schulz, L. L. (2020). Beef and pork marketing margins and price spreads during COVID-19. *Applied Economic Perspectives and Policy*, 43, 4–23.

Ma, M., & Lusk, J. L. (2021). Concentration and resiliency in the U.S. meat supply chains. Working paper. Available online <https://static1.squarespace.com/static/502c267524aca01df475f9ec/t/604a8fd90c5f442753fc6b2d/1615499225493/Ma%2BLusk+Concentration+resiliency+US+meat+supply+20210310.pdf> (accessed May 27, 2021).

Marchant-Forde, J. N., & Boyle, L. A. (2020). COVID-19 effects on livestock production: A one welfare issue. *Frontiers in Veterinary Science*, 7, Article 585787.

Martin, Y., Li, Z., & Cutter, S. L. (2017). Leveraging twitter to gauge evacuation compliance: Spatiotemporal analysis of hurricane Matthew. *PLoS One*, 12, Article e0181701.

- McCarthy, R., & Danley, S. (2020). COVID-19 meat plant closures. *Meat+Poultry*. Available online <https://www.meatpoultry.com/articles/22993-covid-19-meat-plant-map> (accessed May 25, 2021).
- Mendoza, M., Poblete, B., & Valderrama, I. (2019). Nowcasting earthquake damages with twitter. *EPJ Data Science*, 8(1), 3. <https://doi.org/10.1140/epjds/s13688-019-0181-0>
- Middleton, S. E., Middleton, L., & Modafferi, S. (2014). Real-time crisis mapping of natural disasters using social media. *IEEE Intelligent Systems*, 29(2), 9–17.
- Moore, F. C., & Obradovich, N. (2020). Using remarkability to define coastal flooding thresholds. *Nature Communications*, 11, 530. <https://doi.org/10.1038/s41467-019-13935-3>
- Netbase. (2018a). About netbase. Available online <https://www.netbase.com/about-netbase/> (accessed May 24, 2021).
- Netbase. (2018b). Natural language processing. Available online <https://www.netbase.com/natural-language-processing-nlp/> (accessed May 24, 2021).
- NetBase. (2020). Overview. Available from: https://NetBasequid.com/wp-content/uploads/NetBaseQuid_overview.pdf (Accessed on 14 December 2020).
- Odlum, M., & Yoon, S. (2015). What can we learn about the Ebola outbreak from tweets? *American Journal of Infection Control*, 43(6), 563–571.
- Ortiz, M., Thompson, N. M., & Widmar, N. J. O. (2021). Filet Mignon: It's What's for Dinner? COVID-19 Impacts on the Relative Wholesale Prices of Beef Cuts. *Choices: The Magazine of Food, Farm, and Resource Issues*, 37(1), 319826.
- Ozili, P., & Arun, T. (2020). Spillover of COVID-19: impact on the global economy. SSRN Working Paper. Available at SSRN <https://ssrn.com/abstract=3562570>.
- Peel, D. (2021). Beef supply chains and the impact of the COVID-19 pandemic in the United States. *Animal Frontiers*, 11, 33–38.
- Rettner, R. (2020). How does the new coronavirus compare with the flu? *Scientific American*. Available online <https://www.scientificamerican.com/article/how-does-the-new-coronavirus-compare-with-the-flu/> (accessed May 25, 2021).
- Sadri, A. M., Hasan, S., Ukusuri, S. V., & Cebrian, M. (2018). Crisis communication patterns in social media during hurricane Sandy. *Transportation Research Record*, 2672(1), 125–137.
- Saitone, T. L., Schaefer, A., & Scheitrum, D. P. (2021). COVID-19 morbidity and mortality in U.S. meatpacking counties. *Food Policy*, 101(102072).
- Scott, S. (2020). A decade before coronavirus, I covered the swine flu pandemic. Here's how it compares to COVID-19. *ABC News*. Available online <https://www.abc.net.au/news/2020-02-18/coronavirus-vs-swine-flu-medical-reporter-sophie-scott-analysis/11965922> (accessed May 25, 2021).
- Stauffer, H. (2020). 4-alarm Martic Township blaze killed 42,000 chickens; firefighters saved 2 attached buildings, chief says. *LNP Lancaster Online*. Available online http://lancasteronline.com/news/local/4-alarm-martic-township-blaze-killed-42-000-chickens-firefighters-saved-2-attached-buildings-chief/article_99265dc8-d1ac-11ea-b898-fffc6c89a909.html#:~:text=A%20four%20alarm%20fire%20killed,around%205%3A30%20p.m.%20Tuesday (accessed May 25, 2021).
- Taylor, C. A., Boulos, C., & Almond, D. (2020). Livestock plants and COVID-19 transmission. *Proceedings of the National Academy of Sciences*, 117, 31706–31715.
- Tonsor, G. T., & Olynk, N. J. (2011). Impacts of animal well-being and welfare media on meat demand. *Journal of Agricultural Economics*, 62(1), 59–72.
- Tyson, J. (2020). A delicate balance: Feeding the nation and keeping our employees healthy. *The Washington Post*. April 26th. Available online https://www.washingtonpost.com/context/tyson-ad/86b9290d-115b-4628-ad80-0e679dcd2669/?itid=ik_inline_manual_2 (accessed May 25, 2021).
- USDA Agricultural Marketing Service (AMS). (2021a). National weekly retail activity reports Accessed January 10, 2021 at <https://www.ams.usda.gov/market-news/retail>.
- USDA Agricultural Marketing Service (AMS). (2021b). Weekly poultry slaughtered under federal inspection (NW_PY017) Accessed January 10,2021 at <https://mymarketnews.ams.usda.gov/filerrepo/reports>.
- USDA National Agricultural Statistics Service (NASS). (2021). Quick stats Accessed January 10, 2021 at <https://quickstats.nass.usda.gov/>.
- Westervelt, E. (2020). As food supply chain breaks down, farm-to-door CSAs take off. NPR. Available online <https://www.npr.org/2020/05/10/852512047/as-food-supply-chain-breaks-down-farm-to-door-csas-take-off> (accessed May 24, 2021).
- Widmar, N. O., Bir, C., Clifford, M., & Slipchenko, N. (2020). Social media sentiment as an additional performance measure? Examples from iconic theme park destinations. *Journal of Retailing and Consumer Services*, 56, Article 102157.
- Widmar, N. O., Rash, K., Bir, C., Bir, B., & Jung, J. (2021). The anatomy of natural disasters on online media: Hurricanes and wildfires. *Natural Hazards*. <https://doi.org/10.1007/s11069-021-04975-4>
- Wiener-Bronner, D. (2020). Everything at the grocery store is getting more expensive. *CNN Business*. Available online <https://www.cnn.com/2020/08/05/business/grocery-prices-rising/index.html> (accessed May 24, 2021).
- Wolf, C. A., Novakovic, A. M., & Stephenson, M. W. (2021). COVID-19 and the U.S. dairy supply chain. *Choices*, 36(3), 1–8.