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Agricultural Economics Research as Cattle and Beef Markets Ascended from Demise

Ted C. Schroeder

The cattle and beef industry suffered through major declines in consumer demand during the 1980s and 1990s. Economists were instrumental in identifying the decline, but traditional times series meat demand models became less useful as heterogeneous consumer preferences evolved. New research methodologies were adopted that guided industry market innovations that resulted in numerous beef product offerings. Going forward, information will be of utmost importance to industry innovation and growth including use of artificial intelligence, real-time surveillance of consumer demand, necessary market information, and risk management. Economists will be integral in designing and assessing the viability of these developments.

Key words: future directions

Introduction

Agricultural economists have been heavily involved in cattle and beef economic analysis during one of the most transformational periods the industry has experienced. Over the last few decades, major industry challenges required the adoption of new research methods and data to better understand the nature of changes occurring. The journey began with a substantial decline in consumer demand for beef that, although it was obviously happening, became increasingly difficult to explain using existing demand models and data. In response, industry stakeholders adopted new production and marketing systems to accommodate more discerning consumers. Evaluating these changes as an industry was shifting from a commodity market toward differentiated products created a host of challenges and opportunities for economists as we attempted to contribute to facilitating the transition. Economists played immensely important roles in conducting research to inform stakeholders, supply chain participants, and policy makers as the industry evolved in response to changing markets.

Major market developments included dramatic shifts in consumer demand, remarkable transformations in cattle markets and beef production, and sizable technological innovation. As we look toward the future, an even greater speed of change is in store for the industry. Well-trained agricultural economists capable of providing sound research-based guidance will be highly valuable. This article summarizes major contributions of agricultural economists in providing research and information to help guide the complex cattle and beef industry through a highly dynamic market environment and highlights substantive future developments where our talents will be needed.

Consumer Demand

Time-Series Structural Change and Specification

Starting around 1980, US consumer beef demand began an almost 20-year downward spiral (Purcell, 1998a), bottoming out at about half the 1980 base year by 1998 (Schroeder and Tonsor, 2011).

Schroeder is a university distinguished professor of agricultural economics, Kansas State University. tcs@ksu.edu

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Moreover, beef demand declined successively every year from 1980 to 1998 (Schroeder and Tonsor, 2011). While being part of broader major shifts occurring in food consumption (Barkema, Drabenstott, and Welch, 1991), economic impacts of the sustained decline in consumer beef demand were apparent. For example, net cash returns for cow–calf producers averaged −$5/cow, with 10 of 18 (56%) years between 1982 and 1998 being negative (US Department of Agriculture, 2011, 2025b).[1] In contrast, as consumer demand for beef stabilized and increased during the next 26 years (1999–2024), net returns averaged $83/cow and were negative only 5 times out of 26 (19%) years (US Department of Agriculture, 2025a).

The pass-through effects to cow–calf producers of changes in consumer beef demand have been rigorously quantified. Marsh (2003) built a multisector supply and demand model of the beef and cattle sector estimating how changes in the retail beef demand index impacted derived demand for feeder and fed cattle. He concluded that from 1976 to 1999, retail beef demand decline reduced cattle producer revenue by $13.3 billion (61%). McKendree et al. (2020) extended Marsh's (2003) work and added beef export demand to their model, concluding that a 1% increase in domestic retail beef demand increased feeder cattle price by 2.48% and a 1% increase in beef export demand increased feeder cattle price by 0.08%. Quantifying impacts of changes in retail beef demand on producer prices was instrumental in helping the industry understand the importance of consumer demand on producer prosperity.

In the midst of the major beef demand decline, agricultural economists and others made considerable investments to determine factors contributing to observed trends. Among the early work, Purcell (1998b, p. 1) noted, "I am increasingly convinced that a failure to understand demand is getting in the way of progressive efforts to halt the 20-year slide in market share for beef." As the beef demand demise transpired, numerous studies built a case for structural change occurring in meat demand sequentially advancing demand modeling methodology, data, and econometric tests (e.g., Chavas, 1983; Eales and Unnevehr, 1988; Moschini and Meilke, 1989; Choi and Sosin, 1990; McGuirk et al., 1995; Holt and Balagtas, 2009). In general, a consensus was that economically important and statistically significant structural change occurred in meat demand, though variation existed on timing and nature of adjustments. Somewhat in contrast, Chalfant and Alston (1988) made a case that model specification errors contributed to findings of structural change in red meat demand. This paper was perhaps the beginning of several other thoughts about whether previously concluded structural change was a result of consumer preference shifts or modeling and data challenges.

Left largely unanswered by the structural change in demand research was understanding, quantifying, and ranking major reasons contributing to beef demand's demise and associated structural change. What was increasingly apparent was that traditional demand determinants of prices and income were inadequate in explaining consumer beef demand evolution. Furthermore, estimated elasticities were "particularly sensitive to the specification of demand, chosen estimation method, and publication characteristics" (Gallet, 2010, p. 270). Beef demand model misspecification was problematic in several ways, including—among the more egregious—omitted relevant variables. However, this is not a critique of noted studies, as one cannot measure or quantify what one cannot observe. And there was much occurring that was not directly observable or well measured.

The innovative work of Brown and Schrader (1990) on the impact of cholesterol information on shell egg consumption introduced using a proxy variable to measure unobservable evolving consumer concerns or perceptions about a food product. The authors constructed a time-series index of medical journal articles to serve as a proxy for information consumers were exposed to about potential links between heart disease and cholesterol consumption. The information index (net of articles supporting and not supporting the link) was used as an egg demand determinant. The article index was a statistically significant and economically important egg demand driver.

[1] Net cash returns is defined here as the value of production less cash expenses.

Whether Brown and Schrader (1990) were *the* originators of introducing otherwise unobservable consumer perception changes in demand estimation over time through information indexes, I do not know. Regardless, following publication of their article, employing information indexes as potential demand shifters in time-series meat demand studies proliferated. The use of proxies such as numbers of articles and information index counts for unobservable information in demand estimation was an attempt to reduce omitted relevant variable problems and assess how factors other than traditional price and income were shaping consumer demand.

Potential proxies for demand shifters—such as advertising expenditures (Brooker, Eastwood, and Gray, 1994; Brester and Schroeder, 1995); food safety recalls (Marsh, Schroeder, and Mintert, 2004; Piggott and Marsh, 2004); health and nutritional information indexes (Kinnucan et al., 1997; Tonsor, Mintert, and Schroeder, 2010); and animal welfare information indexes (Tonsor and Olynk, 2011)—were assessed in time-series beef demand models. These proxies have generally had statistically significant but often modest at best economic impacts on consumer beef demand in time-series models.

Despite general agreement that identified omitted relevant variables belong in time-series demand models, included proxy variables have not markedly improved our ability to explain the evolution of aggregate consumer beef demand. Perhaps the proxies were inadequate at capturing what they were intended to measure, or consumers may be so heterogeneous that evolving information is weighted disparately across individuals and over time and we have not accurately calibrated the functional form or lag structure of information flows and impacts. Regardless, economists have been challenged to adequately explain changing consumer demand for beef using traditional time-series data. To address the challenge, cross-sectional demand studies became prominent.

Cross Sectional

An explosion in research occurred using surveys and experimental economics methods to try to better understand complex consumer food preferences especially for novel product attributes. That is, instead of using aggregate time-series data and information indexes and other proxy variables, surveys and experiments enable researchers to solicit preference rankings for product attributes directly from consumers. This literature has rapidly become way too large to adequately summarize in this article. The myriad of beef product attributes explored in this arena includes those summarized in Table 1 (adapted from Gao, 2007; Schroeder and Tonsor, 2011; Schroeder et al., 2024). Only one product attribute (own-price) among the more than 50 listed in Table 1 directly includes a traditional time-series modeling demand metric. Amid so many product attributes potentially influencing consumer purchase decisions, traditional time-series demand modeling is challenged to measure the impacts of these evolving attributes.

The two most common methodologies employed to solicit consumer preferences for various meat product attributes include best–worst scaling (see Finn and Louviere, 1992) and choice experiments (see Green and Srinivasan, 1990; Green, Krieger, and Wind, 2001). What have we learned? Way too much to summarize here. But we will discuss a few noteworthy points.

First, we have learned consumers possess widely varied beef preferences and individual consumers rank preferences such as those presented in Table 1 quite differently (Lister et al., 2017; Ardebili and Rickertsen, 2023). Such heterogeneous consumer preferences were unrecognizable in traditional aggregate time-series demand modeling. A few prevalent beef preferences among heterogeneous consumers have nonetheless been relatively consistent. Prevalent consumer beef preferences include foremost product freshness, food safety, price or value, flavor, and nutrition, followed by animal welfare and hormone and antibiotic use (e.g., Tonsor, 2023; Schroeder et al., 2024). However, variance of preferred product attributes across consumers is stark.

Beef quality including flavor, tenderness, and juiciness has received particular attention during the 1980–1990s beef demand decline. Beef quality concerns were a central issue identified by both

Table 1. Beef Product and Process Attributes Potentially Influencing Consumer Purchases

Assurance	Marketing	Physical Product	Food Safety
Sustainable	Price / Value	Fresh/frozen	USDA inspected
Animal welfare	Trust	Meat cut/thickness	Freshness/best if used by
Origin	Brand	Trim level	Food safety recall
Locally grown	Store	Marbling/quality grade	Additives
Support small farms	Shelf presentation	Ease of preparation	Foreign material
Traceable	In-store assistance	Package size	Allergens
Natural	Product selection	Processed	Smell
Organic	Packaging	Color/purge	
Biotechnology	Labeling	Smell	
Environmental	Featuring		
Low carbon	News media	**Experience**	**Nutrition & Health**
Growth hormones	Social media	Flavor	Calories
Antibiotic free	Delivery options	Juiciness	Fat level/fat type
Breed	Loyalty programs	Tenderness	Carbohydrates
Age and source			Sodium
			Nutrient levels

*Notes:*Sources: Data from Gao (2007), Schroeder and Tonsor (2011), and Schroeder et al. (2024).

meat scientists and economists (Smith et al., 1992, 1995; Schroeder et al., 1998). Considerable work by the US Meat Animal Research Center focused on ways to improve beef tenderness (Koohmaraie et al., 1996; Shackelford, Wheeler, and Koohmaraie, 1999). Early emphasis was on measuring meat tenderness with mechanical shear force.

Lusk et al. (2001) used Becker–Degroot–Marschak (BDM) auctions with consumers while they were shopping in grocery stores in a novel study to measure willingness-to-pay for guaranteed tender steaks. Consumers taste-tested tender and tough rib-eye beef steaks. When the two steaks were not labeled relative to tenderness, 72% preferred the tender steak. When the two steaks were labeled for tenderness, 90% preferred the tender steak. Consumers were willing to pay economically important premiums for guaranteed tender steak products, with 51% willing to pay on average $1.84/lb more (retail Choice rib-eye steaks were selling for about $7/lb at the time of the study) for the guaranteed tender rib-eye steak when labeled as such. Feuz et al. (2004) followed up on this work using an experimental auction and found similar results. Platter et al. (2005) used a sealed bid Vickery-type auction to assess consumer willingness-to-pay for steak tenderness further confirming previous work. The beef tenderness issue is no longer as major a concern as it was 20 years ago because of genetic and feeding management adjustments the industry made. This body of research contributed to driving industry changes.

Second, from survey work we have learned while the list of possible food labels attempting to attract as many heterogenous consumers as possible is enticing, information overload can reduce label effectiveness and value of specific label claims (e.g., Drugova, Curtis, and Akhundjanov, 2020), but redundant labeling can still be of value to consumers (e.g., Ufer, Ortega, and Wolf, 2022). Furthermore, mandated labeling that is not demanded by, or beneficial to, consumers can increase costs without offsetting benefits. This was evident in mandated country-of-origin-labeling (COOL) of ground and muscle retail beef products, which took effect in March 2009 (Jurenas and Greene, 2013). Several studies illustrated the costs and welfare gains and losses associated with mandated COOL, including two key articles published in the same issue of *JARE* in 2004 (Brester, Marsh, and Atwood, 2004; Lusk and Anderson, 2004) and a later article also published in *JARE* finding no impact on consumer demand for beef associated with COOL (Taylor and Tonsor, 2013). Due to costs without sufficient offsetting benefits, and because COOL was found to violate US WTO obligations, the federal COOL mandate was ultimately repealed in 2015 (Greene, 2016). Economic impacts together with the WTO ruling were instrumental in the repeal of COOL.

Third, we have learned some label information (e.g., origin, local, organic, natural) acts as cues for other attributes consumers may perceive to be present (Umberger et al., 2003; Gao and Schroeder, 2009). Label information cues may be perceived by consumers as related to product freshness, quality, supporting social issues, or others. The issue of food product labeling continues to be a highly debated topic with opposing views across numerous labeling topics. Economists have much to provide in this dialogue.

An important related issue in ranking consumer food preferences is balancing stated preferences with how desired outcomes might be achieved. A stated preference is of limited value if we do not also understand how consumers perceive the way a desired product attribute can be realized. Several studies have explored this issue in various ways and a couple of excellent examples are noted here. Lusk and Parker (2009) measured consumer preferences for different fat levels and fat types in ground beef. Consumers were willing to pay more for lower levels of saturated and higher levels of healthy fat. The authors then completed a best–worst scaling analysis of how consumers would prefer to modify fat in ground beef. Preferences strongly favored what might be considered natural approaches like grass feeding and sorting and were strongly against using animal cloning to modify ground beef fat type or amount.

Colson, Huffman, and Rousu (2011) assessed consumer acceptability of enhanced nutrient content of food products attained through various genetic modification methods. The authors concluded that consumers were willing to pay for food products with enhanced nutrient content, but the way in which nutrients in food were enhanced mattered. Consumers were willing to pay more for nutrient enhancements generated through intragenic as opposed to transgenic modification.

There is considerable value in not only ranking consumer preferences but also in understanding how consumers react to the way a stated preference is accomplished. Economists are well-suited to measure such tradeoffs and we should do more of this as we explore preference rankings. Such information can both guide industry decisions and inform policy.

Finally, product attributes affecting consumer purchases listed in Table 1 continue to change over time as beef products and production methods are modified, consumer nutritional and health emphases evolve, demographics change, consumer real income grows, social media proliferates, and new information is discovered. Thus, there will continue to be a large body of research devoted to studying new food innovations as well as consumer perceptions and preferences for a wide range of product attributes. The pace of change, as discussed later, raises the value of collecting real-time information.

Supply Chain

As consumer preferences changed and economists became better at understanding nontraditional drivers of beef demand, the cattle and beef industry followed suit and launched a journey that transformed the entire beef supply chain. The crux of the change was reframing the supply chain from a commodity market to differentiated product markets. The 20-year consumer beef demand decline made it painfully clear that the industry was not producing what consumers wanted; by the late 1990s, economists were routinely demonstrating that factors beyond traditional demand determinants were important drivers. By the early 2000s, advancements in survey methods to better understand consumer preferences helped build the road map for necessary supply chain transformation to revamp beef demand.

One of the first necessary steps was to redesign the supply chain especially at the cattle feeder–beef packer interface, where fed cattle were being valued at essentially the same price despite large value differences present across individual animals in a transaction. Notable effort in the 1990s by Wayne Purcell at the Research Institute on Livestock Pricing focused on this issue (Purcell, 1997). Getting efficient price signals sent from beef packers to producers required overhauling how fed cattle were being marketed and valued, and a sizable body of research built the case (Schroeder et al., 1997). Emphasis was placed on moving away from cash negotiated pricing to grid valuation

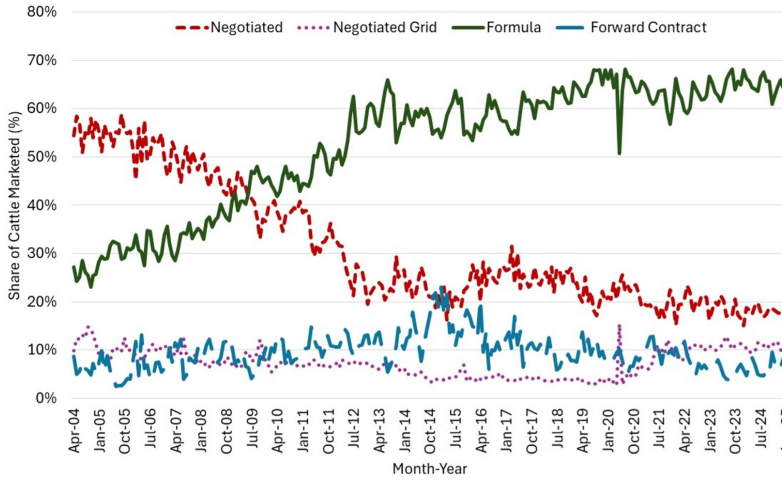

Figure 1. Monthly Shares of Cattle Marketed Using Alternative Methods, April 2004–April 2025

Source: LMIC using data from USDA.

of fed cattle with grid premiums and discounts designed to mirror value of cattle to packers and downstream customers (Schroeder and Graff, 2000).

The results of this effort were immense. Figure 1 illustrates changes in how cattle have been sold to packers over approximately the last 20 years. Most notably, negotiated cash trade went from representing about 55% of slaughter cattle marketings in 2004–2005 to about 20% since 2021. In contrast, formula plus negotiated grid trade increased from representing around 35% in 2004 to approximately 75% of cattle since 2022.

Cash negotiated transactions are cattle purchased by the packer in direct negotiation with the seller to be delivered to the plant within 30 days. Under cash negotiated trade, live cattle all bring the same price in a sale lot and prices across transactions at a point in time are generally similar (Schroeder, Coffey, and Tonsor, 2023). With negotiated grids the base price is negotiated and net price is determined by adjusting the base for carcass premiums and discounts following slaughter. Formula trade represents cattle committed for slaughter by any means other than negotiated, negotiated grid, or forward contract generally with a base price that is established via formula and net price typically adjusted for quality after slaughter (US Department of Agriculture, 2020). Grid pricing results in potentially large variation in prices paid for cattle within a pen as well as across transactions (Schroeder, Coffey, and Tonsor, 2023).

The impact of moving the fed cattle industry toward value-based pricing of fed cattle was astonishing. Fed cattle quality grade improved immensely following this transition. Liu et al. (2009) provided econometric evidence of how marketing agreements corresponded with improved beef quality over time. Recent work by Schroeder, Coffey, and Tonsor (2021) and extended and updated by Doumit (2025) confirmed this result. The essence of this work concluded that increased prevalence of valuing fed cattle using grids that provide premiums for high quality and discounts for low quality cattle has been strongly associated with the marked increase in quality of beef produced over time.

Figure 2 illustrates the increase in percentage of fed steers and heifers grading Choice or higher over the April 2004–April 2025 period, corresponding with the same time frame as Figure 1. In 2004, about 55% of fed steers and heifers graded Choice and Prime. This increased steadily until 2021, where it has since hovered around 80%–85%, with variation being mostly seasonal. Popular press estimates indicate that fed cattle quality grade improvements have generated considerable added revenue for producers from around $38/head (Schroeder, 2024) to as much as $160/head for specialized genetics (Speer, 2025). For an industry with a relatively slow biological reproduction

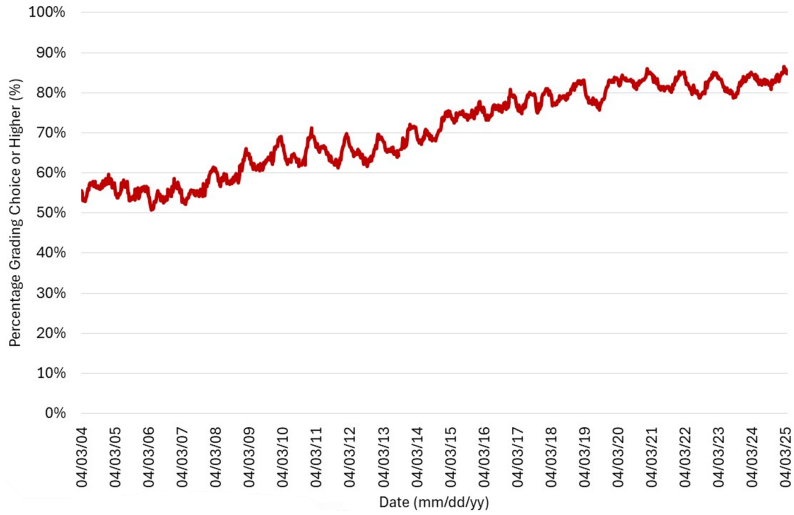

Figure 2. Weekly Percentage of Steers and Heifers Quality Grading Choice Plus Prime, April 2004–April 2025

Source: Calculated using data from LMIC reported by USDA.

cycle, a breeding herd whose genetics take years to appreciably change, and considerable asset fixity present at every stage of the supply chain, the rate of change in quality of beef produced revealed in Figure 2 is remarkable.

The supply chain realignment also certainly involved more than beef quality. Many of the product attributes presented in Table 1 require specific cattle production practices or certifications to ensure since many are credence attributes. Producers will only adopt such practices if added costs result in greater premiums when cattle are marketed. As such, associated alliances or agreements with beef processors to pay premiums for certifications and specific product or production attributes has also spurred greater formula pricing of fed cattle. Essential to getting market signals to producers is paying explicitly for desired animal and beef traits. Such market signals, however, must be available to producers to enable them to respond and make production and marketing adjustments. The issue of how to provide accessible, timely, and trusted market information to the beef supply chain has been another major evolution to which economists have heavily contributed.

Market Information

In April 2001, the Livestock Mandatory Reporting Act (LMR) went into effect, replacing a more than 50-year-old voluntary price reporting system. LMR required qualifying beef packers to report fed cattle purchase and boxed beef sales information twice daily to the USDA Agricultural Marketing Service. This act was motivated by concerns about market transparency, especially relative to changing cattle marketing methods illustrated in Figure 1, as formula trade was not reported to USDA prior to LMR (Ward, 2006). In fact, information like that contained in Figure 1, and much more, was not even available prior to LMR enactment. LMR was, and to some extent still is, controversial, as questions remain on the need for and impacts of LMR (Koontz and Ward, 2011).

Economists have been instrumental in development and assessment of LMR and have heavily leveraged associated market information provided through LMR (Ward, 2006). While Wachenheim and DeVuyst (2001) and Njoroge (2003) suggested LMR could result in greater collusion among packers, Azzam (2003) made a compelling case that LMR may foster more competitive conduct among packers. Boyer and Brorsen (2013) used agent-based auction models to demonstrate that cattle feeders benefit from LMR because it increases cattle buyer competition. Though these studies (excluding Boyer and Brorsen, 2013) were completed early after enactment of LMR, I am not aware

of empirical tests on the now more than 20 years of LMR data reporting of model predictions from these three previous conceptual studies.

Several studies have demonstrated increased market efficiency following LMR enactment. Pendell and Schroeder (2006) concluded cash negotiated fed cattle prices were more strongly spatially integrated following LMR consistent with Azzam's (2003) argument that information pooling could occur. Fausti et al. (2010) determined after implementation of LMR grid premium and discount variation increased suggesting a notable increase in price transparency. Chung, Rushin, and Surathkal (2018) found vertical beef market prices exhibited increased speed-of-price-transmission following LMR enactment, suggesting stronger vertical market alignment. Mathews et al. (2015) concluded cash-futures price convergence improved and particularly that cash price played a more important role in price discovery following LMR enactment.

Parcell, Tonsor, and Schroeder (2016) conducted a baseline review of LMR and identified emerging future challenges facing the information content of LMR. They concluded that major structural shifts were occurring in livestock and meat markets, challenging LMR to keep pace with pertinent information reporting. Many changes discussed earlier in this article surrounding changing consumer demand and cattle and beef industry responses through increased vertical coordination, product differentiation, marketing agreements, formula pricing, and reduced daily negotiated trade require new ways to collect and report market information.

The USDA Agricultural Marketing Service in 2023 launched the Cattle Contracts Library (CCL) to increase information about pricing signals present in formula fed cattle trade, the dominant way in which cattle are marketed (Figure 1). Prior to CCL, little was publicly reported about what factors contributed to a wide range in net prices cattle feeders received when selling cattle using formula or grid pricing (Schroeder, Coffey, and Tonsor, 2023). The weekly CCL summary report (US Department of Agriculture, 2025a) provides information about premiums and discounts paid to producers under formula marketing agreements. Price adjustments include those for quality grades, yield grades, carcass weight, management programs, brand initiatives, and "other," which includes specifications such as beta-agonist free, foreign born, and beef/dairy cross (Tonsor, Schroeder, and Coffey, 2023). While such reporting efforts provide more information about factors influencing producer price differentials than previously available, more is needed both in fed cattle (Schroeder, Coffey, and Tonsor, 2023) and boxed beef (Coffey, Schroeder, and Tonsor, 2023) markets to increase transparency and provide clearer market signals (especially for the most prevalent factors in Table 1) throughout the supply chain. Economists need to be involved in design and testing more comprehensive market information reporting efforts.

Producer Response

Cattle producers' responses to market signals and new opportunities to add value to fed cattle have been remarkable. Economic analyses have been instrumental in understanding and assessing the viability of adopting new production methods, technology, and information to inform producers of profitably of such opportunities.

Economic analysis of value-based pricing for cattle feedlots was instrumental in identifying both potential revenue enhancement for higher quality cattle as well the need to manage risks associated with steep yield grade and heavy-weight carcass discounts (Schroeder and Graff, 2000). Determining optimal market timing and marketing method has long been a focus of feedlot managers as several tradeoffs occur as fed cattle are fed longer.[2] Lusk et al. (2003) concluded that using ultrasound technology prior to placement on feed to predict subcutaneous fat and rib-eye area and marbling could enhance cattle feeder producer revenue by $5–$33 per head depending on how cattle were

[2] As cattle are fed to heavier weights, cost of gain increases as heavier-weight cattle require more energy for maintenance; dressing percentage increases as more weight is proportionally added to the carcass relative to live animal; marbling and quality grade tend to improve; yield grade worsens; and heavy-weight carcass incidence increases. See Horton et al. (2025) for a comprehensive analysis of these tradeoffs.

sold. Koontz et al. (2008) demonstrated that the value of sorting pens of fed cattle into alternative marketing groups using ultrasound technology provided returns of $15 to $25 per head to producers above and beyond the returns noted by Lusk et al. (2003) for selecting marketing method. Such technology holds promise for enhancing both producer decision-making as well as beef quality and consistency, but costs remain high.

Another important area of assessment for improving cattle quality has been that of genetic markers and DNA. This information could change cattle feeding management in several ways, including cattle placement weight, days on feed, implant usage, beta agonist usage, feed rations, and fed cattle marketing methods. Economic analysis has demonstrated mixed values of testing and utilizing animal DNA for enhancing cattle feeding profitability. Weaber and Lusk (2010) showed that using DNA marker tests for genetic selection could produce important economic benefits ($7.6 billion over 20 years) through initially breeding-bull selection and later heifer retention for meat tenderness markers. Even with this "proof of concept" (Weaber and Lusk, 2010, p. 1468), questions remain about costs of testing, free-riders, and how such information might be incorporated into the marketplace to provide adoption incentives.

A series of articles (DeVuyst et al., 2007; Lusk, 2007; Lambert, 2008) analyzed economic opportunities for use of leptin genotyping in selecting days on feed and estimating carcass value using pricing grids for fed cattle. The general conclusion was that leptin gene information has important economic value for cattle feeders if used for guiding cattle feeding duration and marketing method management. Revenue enhancement opportunities in the rough range of $20 to more than $60 per head have been found. However, the costs of testing make the net return of such testing no better than a breakeven proposition (DeVuyst et al., 2007).

More recently, advancements in tests for the leptin gene bundled with other genomic information have enabled assessing more feedlot cattle performance measures. Thompson (2018, p. 21) summarized seven such measures of "yield grade, marbling, average daily gain, hot-carcass weight, rib-eye area, tenderness, and days on feed" that can be evaluated. This additional information motivated studies by Thompson et al. (2014, 2016) to further assess the value of genetic testing in cattle feeding. However, even with advancements in genetic testing technology, economic viability of using genomic information to enhance cattle feeding management has remained elusive.

Results found with the use of ultrasound and genotyping information are important for quantifying the price point that such testing will need to attain to be viable. While this may be discouraging, recognizing the value potential provides a target for where the cost will make adoption worthwhile. We have nonetheless seen important potential for this technology. As gene testing becomes cheaper and richer in content, such information will be utilized more by feedlots. Baseline economic research completed to date will be an essential part of future adoption decisions. And cattle gene editing will open an even larger future economic assessment panorama.

Future Directions

Given the economic importance of the cattle and beef industry, economists will continue to have immense opportunities to bring our concepts and analysis to help shape the future of the industry. Innovations in technology, changes in production management, advances in marketing, evolving market information, market structure, and policy will drive our role.

Artificial Intelligence

Technology evolves to solve complex issues and improve efficiency. Artificial intelligence (AI) will rapidly change how cattle are raised, marketed, and processed as well as logistics and supply chain management. Individual animal management facilitated through new sensors and associated information technology including computer vision algorithms, machine learning, and deep learning will advance cattle production into precision farming (Guarnido-Lopez et al., 2024). AI in animal

production has been focused on a combination of disease detection and animal performance through individual identification, animal behavioral (e.g., feed and water intake, aggression, activity) monitoring, health (e.g., coughing, temperature, heart rate, breathing) detection, growth assessment, and environmental and animal welfare management (Bao and Xie, 2022; Fuentes et al., 2022; Michelena, Fontenla-Romero, and Luis Calvo-Rolle, 2025).

Animal sensors can more rapidly and accurately identify cattle health issues, facilitating more timely and effective treatment protocols (Michelena, Fontenla-Romero, and Luis Calvo-Rolle, 2025) while enhancing animal welfare and reducing use of unneeded medications. Further downstream, AI has been tested in packing plants for meat quality issues such as prediction of dark cutters based on preharvest information (Jaddoa et al., 2024) and beef yield prediction (Matthews et al., 2022). However, many notable challenges remain in AI development and adoption. The technology is still being developed and refined. Data collection, data quality, cost, and modeling complexity challenge advancement of AI in beef cattle production (Hossain et al., 2022). Little rigorous economic analysis has accompanied this rapidly developing arena. Our assessment is needed as adoption will not occur without both scientific effectiveness and economic viability.

Evolving Consumer Demand

I have read numerous articles representing several disciplines (e.g., economics, animal science, engineering, veterinary medicine, data science) in the livestock and meat space that justify their study with growing world population, increasing global consumer affluence, and predicted large growth in meat demand. I have used similar arguments myself, so I believe the sequence has merit. However, as discussed in some detail in this article, consumers have changed by impactful ways well beyond numbers of mouths to feed and the amount of discretionary income consumers possess. As lifestyles continue to change, so will consumer expectations and demand for food. Understanding these changes and guiding industry adjustments will require innovation in how economists measure, explain, and predict consumer behavior. While traditional aggregate time-series demand modeling has provided knowledge about consumer demand, more contemporaneous demand analysis will be essential going forward. Scanner data demand analysis was an early phase of this transition and will continue to be useful, but consumer panels and diaries will have more impact going forward.

Several initiatives collecting more detailed consumer information have been around for a while and are regularly updated including broad consumer surveys and diaries such as the USDA-ERS National Household Food Acquisition and Purchase Survey (US Department of Agriculture, 2025c) and Bureau of Labor Statistics Consumer Expenditures Surveys (US Bureau of Labor Statistics, n.d.). These restricted-use data sources provide considerable opportunities for economic analysis for those willing to invest time in learning the details of the data systems and establishing data system access. Such data, while incredibly rich in detail, also have challenges and limitations, and both sources remain relatively unexploited.

Regular (e.g., monthly) survey initiatives focused on evolving consumer perceptions are also gaining increased value as time series of these cross-sectional datasets grow including the Consumer Food Insights at Purdue University (Purdue University Center for Food Demand Analysis and Sustainability (CFDAS), 2025) launched in 2022 and the Monthly Meat Demand Monitor (Meat Demand Monitor Dashboard) at Kansas State University, which has data going back to 2020. Such efforts to collect near real-time consumer information provide immense value especially as time series of these on-going surveys become available to understand the dynamic nature of consumer perceptions, knowledge, and demand influencers. These types of data will continue to be valuable information for academic research well into the future. The challenge will be to keep the commitment and resource support to maintain these rich information sources.

Market Information

Fed cattle have transformed from a commodity being priced similarly to a differentiated product with value based on quality grade, yield grade, carcass weight, and increasingly other discernments including breed, production practices, traceability, age and source, and numerous other verified processes and certifications. Historically, USDA-AMS has been the gold standard for market information guiding producer production and marketing decisions. However, AMS market reporting is challenged to keep pace with substantial structural change in fed cattle and beef markets. Issues surrounding data collection, how to report data, how to maintain confidentiality of information, and thin trade are prevalent in both cattle and beef information reporting. Efforts by USDA to reduce gaps in information including introduction of the Cattle Contracts Library are commendable and bring more information to market participants. However, more is needed to understand factors affecting transaction value differentials, how data collection mechanisms need to evolve to capture relevant data, and how such information can be reported with confidentiality maintained. Even defining confidentiality is elusive.

Initial work illustrating the use of hedonic models to facilitate market reporting has illustrated potential value (Coffey, Schroeder, and Tonsor, 2023; Schroeder, Coffey, and Tonsor, 2023). However, the data currently being collected from packers to enable the use of hedonic models for market reporting of fed cattle especially, and to some extent boxed beef, are insufficient. More details regarding attributes affecting net prices need to be collected to report more reliable and informative price differentials. This specific case is more of an example, as similar arguments could be made for reporting of upstream feeder cattle prices and downstream retail prices, not to mention challenges associated with collecting and reporting meaningful food service prices. The point is, the entire space of what market information to collect, and what and how to report it, will continue to be a topic of major importance in providing market information to supply chain participants. Economists are uniquely suited to provide guidance in addressing these questions.

Risk Management

This might be a catch-all category, but with capital-at-play in agriculture, and livestock and meat general, at historically high levels, effectively managing market (and other) risk is crucial. While risk management is broad, the focus here is specific and relates especially to managing market risk beyond the commodity level. Well-established, workably efficient futures markets are readily accessible for livestock and feed. However, futures contracts and related government livestock revenue protection instruments largely focus on aggregate relatively short-run commodity market risk. They are not designed for managing other risks such as differentiated product value risk, cattle quality risk, market access risk, contractual risks, and others.

With the rapid change in especially how fed cattle are sold and valued, as illustrated in this article, traditional risk instruments may not be sufficient for managing market risk with traditional commodity risk instruments (Schroeder, Tonsor, and Coffey, 2019). For example, Alderson and Schroeder (2025) show that basis risk for fed cattle is nearly double traditional basis risk for cattle sold on a grid if one randomly selects the distribution of cattle attributes and grid premiums and discounts vary over time. This is just one example of how market risk differs when using traditional commodity futures markets changes with differentiated products. Economists will be front and center in continued work in design and testing of effective risk management instruments for differentiated agricultural products.

Conclusion

The US beef cattle industry experienced a major paradigm shift when after 20 years of declining consumer demand producers changed the way they produced and marketed cattle. Agricultural

economists were instrumental in guiding the industry in this transformation through our applied research. However, economists had to transition from traditional time-series demand analysis to ultimately more cross-sectional modeling to better understand how and why demand was changing. The next natural task was for economists to help design and assess innovative cattle valuation systems that sent strong incentives for producers to produce what consumers wanted. Valuation methods such as grid and formula pricing were the result, but market information was insufficient to provide clear market signals. Thus, an overhaul of public market information reporting occurred again, with agricultural economists involved in design and evaluation. Furthermore, cattle producers needed information to respond to new market signals and economists were instrumental in assessing tradeoffs as producers considered adopting new production and marketing strategies.

The cattle and beef industry will continue to rapidly evolve as technology such as artificial intelligence adds more data and information to decision-making at every level of the vertical supply chain. Economists are uniquely suited to help assess the mountain of information and messy data that will be generated. Someone will need to sort through and determine the most useful information.

Consumer demand will continue to evolve in ways that reflect changing values, lifestyles, and preferences of a highly heterogeneous society. The more that can be collected from consumer behavior, near real-time, and reported to the market, the better the industry will be able to respond. Though biological lags in cattle production are rigid and the supply chain is laden with firms having considerable asset fixity at nearly every level, players have demonstrated that they can adapt and adjust to new information and incentives at a pace faster than we expected they could or would. Opportunities for well-trained agricultural economists across a large span of expertise—including cattle production, technology, artificial intelligence , market information, supply chain management, risk management, consumer demand, and numerous other issues—will continue to be strong for the cattle and beef industry well into the future. It is time to train the next generation of students and scholars to help guide the industry through its many fascinating challenges.

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