EFFECTIVE AND EFFICIENT CATTLE AND BEEF MARKET ALIGNMENT:

PRICE AND VALUE DISCOVERY, DIVERGENT INCENTIVES, RISK MANAGEMENT,

AND FUTURE PROSPECTS

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EXECUTIVE SUMMARY

Background

The fed cattle and beef industry has experienced immense structural change over the past couple of decades and the velocity of change has accelerated in recent years. Evolving consumer demand for beef production assurances and product credence attributes; increasing demand for higher quality products; advancing beef processor product development and value-adding; growing product differentiation and branding; and expanding food service and export market demand have all contributed to structural change.

Recently, dramatic short-term market disruptions occurred. The Tyson Holcomb, KS beef packing plant fire in August 2019 followed by major supply chain disruptions and packing plant operational capacity constraints associated with Covid-19 in 2020 and the June 2021 JBS cyber-attack disrupted markets. These disturbances have raised concerns by market participants and policy makers about industry structure, performance, and resiliency.

The culmination of so many structural changes and market disruptions occurring rapidly and in sizeable proportions has contributed to notable market volatility. Furthermore, changes in how cattle producers, beef packers, and further downstream participants coordinate cattle production, beef processing, and product marketing to align with customer demands is reframing traditional ways of doing business. Longer-term marketing agreements and formula trade, third-party certifications, and increased alignment among vertical market participants is a clear trend in the industry.

The purpose of this study is to increase understanding of why value discovery in fed cattle and beef markets has changed so markedly over the past 20 years and provide vision for where these markets are headed in the future. The intent is to better enable industry stakeholders to align production, marketing, and supply chain coordination strategies; design enhanced market information reporting systems; promote competitive and well-informed trade; better manage risk; and inform policy and regulatory deliberations. The recent market disruptions and associated industry reactions temporarily distracted the long-term pathway of the industry and brought heightened attention to trade-offs in the current industry structure, but they have not changed clear longer-term trends.

Approach

This study addresses six specific objectives:

1. Reviewing changes in national and regional fed cattle procurement practices
2. Summarizing economic determinants driving how fed cattle are marketed and associated implications
3. Documenting how changes in fed cattle marketing methods have influenced beef quality to address changing customer demand
4. Synthesizing why evolving cattle and beef market coordinating mechanisms are undergoing structural evolution
5. Documenting how beef sales methods are impacting cattle procurement changes

6. Discussing changing market information needs to facilitate efficient fed cattle markets

To accomplish these objectives, we review and summarize published literature documenting the nature of and factors motivating changes in the ways the industry is marketing fed cattle and associated market impacts. We also present, interpret, and summarize the current state of market changes as reflected in USDA and industry data. Finally, we conduct new economic modeling to better understand how various changes in the industry are impacting cattle and beef quality.

Results

Expanding beef demand opportunities spurred substantial changes in beef supply chain coordination including dramatic changes in the ways fed cattle are being purchased and valued through marketing agreements and value-based pricing systems. Packers and feeders have forged marketing agreements because they address supply chain coordination challenges more effectively than negotiated cash fed cattle trade. Furthermore, several other agricultural industries have experienced similar shifts toward more marketing agreements, contract, and related vertical supply chain coordinating mechanisms. Incentives to adopt marketing agreements are multi-faceted, interconnected, and emanated, in part, to better meet evolving customer demands.

A stylized summary of cattle feeder and beef packer incentives and implications associated with various ways fed cattle are purchased is provided in Tables 1 and 2. We compare *Live* and *Dressed Negotiated* (i.e., cash negotiated trade); *Forward Contract*; *Negotiated Grid*; and *Formula* fed cattle purchases separated into two alternative valuation methods of *Marketing Agreement Non-Grid* and *Marketing Agreement Grid*. The color coding used in the tables (red, yellow, and green shading refer to relative effectiveness of each marketing method in addressing each consideration) is based on a synthesis of past research, numerous informal discussions with industry participants, and our assessment.

Cattle Feeders

For cattle feeders, the various fed cattle pricing and valuation methods offer highly varied incentives that differ across marketing methods (Table 1). To facilitate interpretation, we grouped the various individual impacts of each marketing method (individual rows in Table 1) into 1) Cattle Pricing and Value Signals; 2) Marketing Cost, Flexibility, & Risk Management; 3) Market Information; and 4) Supply Chain Coordination.

Cattle Pricing and Value Signals

Grid pricing is the main way value signals associated with quality, yield, and various differentiated branded programs are sent to cattle feeders. As such, the most effective cattle marketing methods to ensure price differentials reflect quality is through use of grids. Negotiated grids and Marketing Agreements with grids are the most effective of the marketing methods used in the industry to directly link value with quality, production assurances, and product credence attributes. Further, grid information sent back to cattle feeders enables them to better manage feeder cattle procurement, feeding protocols, certification and assurance

programs, and cattle harvest timing. Customized information feedback has created even greater value opportunities for cattle feeders to enter into marketing agreements. Incentivized by value-based pricing signals, Choice and higher quality grade cattle have increased markedly from around 55% of fed cattle graded in the early 2000s to more than 80% in 2020-2021. Our modeling reveals that a 10 percentage point increase in formula and grid fed cattle purchases corresponds to a 6 percentage point increase in the share of Choice quality grade beef (holding Prime constant).

Marketing Cost, Flexibility, & Risk Management

Reduced costs and market access are among the most prominent reasons cattle feeders enter into marketing agreements. Though marketing agreements reduce week-to-week marketing and price discovery costs and ensure market access, they also reduce flexibility for the cattle feeder and packer. Negotiated cash trade enables producers to readily reject cattle purchase offers. If leverage, defined here simply as the volume of fed cattle demanded by packers relative to harvest-ready fed cattle supply, swings in their favor, feeders can utilize that leverage to pursue more desirable terms of trade on the spot market. When leverage is unfavorable for the cattle feeder, spot marketers tend to have greater challenges negotiating desirable outcomes. Cattle feeders who prefer greater independence, have comparative advantages for negotiating individual transactions, and value increased ability to accept or reject prevailing offers are more inclined to negotiate weekly trade on the spot market. Opportunities to take advantage of short-term leverage swings are largely non-existent in marketing agreements.

Noted differences in market structures have led to regional divergences of producer opinions regarding marketing agreements. For example, cattle producers in the Iowa-Minnesota and Nebraska regions, where on average smaller operations are common, tend to use more cash negotiated fed cattle trade. In contrast, larger feeding operations in Colorado, Kansas, and Texas tend to favor marketing agreements. As a result, opinions relative to impacts of fed cattle purchasing methods on market efficiency diverge regionally and by operation size.

Market Information

Cash negotiated trade is reported by USDA AMS during the week a price is agreed upon. In contrast, formula trade price information is reported the week cattle are delivered to the packer and formula prices are often based on reported negotiated prices from one-to-two weeks earlier. As such, some industry participants are concerned formula trade does not contribute much new information to price discovery. Furthermore, because of how broadly the formula price category is defined and reported by USDA (i.e., it encompasses all trade that is not categorized into one of the other three reported categories), formula market information currently being reported is not highly informative. Concerns are compounded because formula trade, which represents 60% to70% of national slaughter, often relies on reported negotiated prices as a base price.

Supply Chain Coordination

Enhanced vertical supply chain coordination among cattle producers, processors, and other participants is probably the most important benefit that has resulted from marketing agreements. Better buyer-supplier communication enhances value signals, reduces costs, improves scheduling, facilitates ability to resolve problems, and better enables downstream alliances. These outcomes are all beef supply chain benefits associated with marketing agreements that directly benefit producers and ultimately beef consumers.

Table 1. Relative Ability of Alternative Fed Cattle Marketing Methods to Address Cattle Feeder Considerations.

	Cattle Feeder Considerations	Live Negotiated	Dressed Negotiated	Forward Contract	Negotiated Grid	Marketing Agreement Non-Grid	Marketing Agreement Grid
Cattle Pricing & Value Signals	Quality Premiums/Discounts						
	Yield Grade Premiums/Discounts						
	Dressed Weight Payment						
	Access to Carcass Performance						
	Branded / Certification Premiums						
Marketing Cost, Flexibility, & Risk Management	Price Discovery Cost						
	Secure Market Access						
	Price Risk Management						
	Delivery Timing						
	Leverage to Negotiate Weekly						
	Flexibility to Accept/Reject Offers						
Market Information	Contributes to Cash Price Discovery						
Supply Chain Coordination	Establishes Relationship / Resolve Issues						
	Enabling Downstream Alliances						

Not Effective **Moderately Effective** **Very Effective**

Packer/Customer Incentives and Tradeoffs

Table 2 summarizes a similar color-coded matrix to that of Table 1 but is focused on beef packer/customer considerations regarding fed cattle marketing agreements. Similar to the previous discussion, we focus on relative rankings of the various fed cattle purchase methods for beef packers. Since the noted attributes also often influence packers and other downstream beef customers, we refer somewhat more generally to fed cattle and beef customer impacts.

Meeting Beef Customer Demands

A host of factors influence beef packer ability to meet downstream customer demands. Many of these refer to specific product and service differentiation including Certifications, product Branding, Quality Assurances, Process Assurances, and Traceability. Having a known supply of cattle and established relationships with suppliers enables better quality control and production process assurances.

Having assured sources of fed cattle through marketing agreements also facilitates animal traceability and consistent product volumes so the packer is a reliable supplier to downstream customers with product-specific demands. Predictable supply is essential for product branding whether at retail or food service. Supply chain management incentives related to certification and branding provide incentives to use marketing agreements. We estimate net value added to beef sales associated with higher quality grade beef (more beef grading higher than Select) was approximately $700 million in 2019.

Firm Operations

Marketing agreements reduce the cost of regularly searching for and bidding on cattle. The agreements provide consistent, predictable slaughter quantities in a business where operating plants at capacity provides substantial per-unit cost savings. One tradeoff for packers that use marketing agreements is reduced flexibility. If a packer wishes to increase slaughter volume significantly relative to existing marketing agreements, their main option is to use the negotiated cash market for sourcing. If, on the other hand, they wish to reduce slaughter volume, adhering to existing agreements may not allow desired adjustments. As such, packers give up flexibility in cattle procurement when they enter into marketing agreements. Packers are increasingly selling a greater percentage of beef products through forward contracts beyond 21-day delivery. To manage supply and margin risk for these forward sales packers have increased incentives to form upstream purchase agreements with cattle suppliers to temporally match better with beef sales commitments.

Table 2. Relative Ability of Fed Cattle Marketing Methods Facilitate Meeting Beef Customer Preferences.

	Beef Packer Considerations	Live Negotiated	Dressed Negotiated	Forward Contract	Negotiated Grid	Marketing Agreement Non-Grid	Marketing Agreement Grid
Meeting Beef Customer Demands	Certifications						
	Branding						
	Quality Assurances						
	Process Assurances						
	Traceability						
	Assured Sourcing						
	Facilitates Vertical Alliances						
Firm Operations	Operating Efficiency						
	Risk Management						
	Flexibility						

Not Effective **Moderately Effective** **Very Effective**

Beef Customers and Consumers

The benefits arising from marketing agreements ultimately result in higher quality and more desired products to consumers. Furthermore, beef customers and consumers are demanding increased production and product assurances which can be more effectively and efficiently supplied through vertical marketing agreements between producers and beef packers. Consumers are demanding more food-service and branded products with greater product quality consistency and assurances which even further motivate vertical marketing agreements in the cattle and beef supply chain. Internationally, beef export markets require information on cattle production practices most readily documented and assured through marketing agreements between producers and packers.

Cattle and Beef Market Information

A surge in formula purchases of cattle as well as a proliferation of differentiated beef products being sold by packers has challenged cattle and beef market information and price reporting. Thinning negotiated cash market trade represents less volume than previously, though in fed cattle, cash negotiated trade has been relatively stable at around 20-25% for about the past decade. Formula purchased fed cattle represent highly varied cattle quality and specifications resulting in USDA reported price ranges that are typically so wide (averaging over 30%) they are not useful for interpreting the published information. On the beef sales side, over time packers have increased branded, differentiated, value-added beef production. Beef price reporting by USDA is challenged to reflect prices of these further processed and differentiated beef products.

Implications and Recommendations

- Short-run market disruptions associated with black-swan types of events have raised concerns about whether cattle and beef markets are working effectively and efficiently. We recommend policy deliberations work to prevent or reduce the adverse impacts of such events. However, we advise careful separation of how these events adversely affected market participants from other longer-term industry trends that have been driven by evolving economic incentives and will continue to advance in the future. Confusing and mixing consequences of short-run market disruptions relative to impacts of longer-run industry advancements and structural changes will likely lead to costly unintended consequences of policy actions.

- Vertical supply chain relationships among cattle producers, beef packers, and beef customers have evolved and resulted in a long list of strong economic benefits which have increased over time. As such, any policy that might limit the ability of producers and packers to participate in such arrangements would be detrimental to the US cattle and beef industry as well as beef consumers as it would increase costs, reduce incentives to produce high quality beef, and increase risk. Any restrictions to these agreements would take the industry backwards rather than forward.

- Market information needs have changed. Livestock Mandatory Reporting is playing an essential role in providing important information to enhance market efficiency.

However, significant enhancements to data collection and market reporting are recommended. Improving and modernizing ways to provide more detailed and useful market information, especially about formula trade fed cattle and differentiated beef product sales, should be prioritized.

- We recommend formal research to evaluate the feasibility of using methods similar to those currently used by other federal agencies such as the Bureau of Labor Statistics in compiling the CPI in summarizing and reporting information for cattle and beef markets. In particular, we recommend exploring use of more advanced statistical methods for summarizing and reporting market information than current heavy reliance on weighted averages. However, to do this most effectively, more detailed data ideally will need to be collected under Livestock Mandatory Reporting. Through such efforts more clarity on price premiums and discounts associated with particular quality and product differentiating attributes can be made apparent and more light can be shed on the distribution of prices for cattle and beef. The result would be more useful market information facilitating more efficient and effective farm and wholesale markets.

CHAPTER 1: FED CATTLE PURCHASE METHODS

Objective 1

Review and assess prevalence and historic shifts for i) negotiated, ii) formula, iii) negotiated grid, and iv) forward markets for live and dressed steers and heifers at the national and regional levels. Highlight regional differences in marketing methods over time.

Cattle Marketing Methods

Integral to understanding what these major trends imply about market performance and associated supply chain impacts are the definitions of what types of fed cattle transaction types are included in each category by the United States Department of Agriculture (USDA) Agricultural Marketing Service (AMS) (USDA AMS 2020b):

1. *Cash negotiated* trade represents cattle purchased by the packer where the price is negotiated with the seller and cattle scheduled to be delivered to the plant within 30 days.

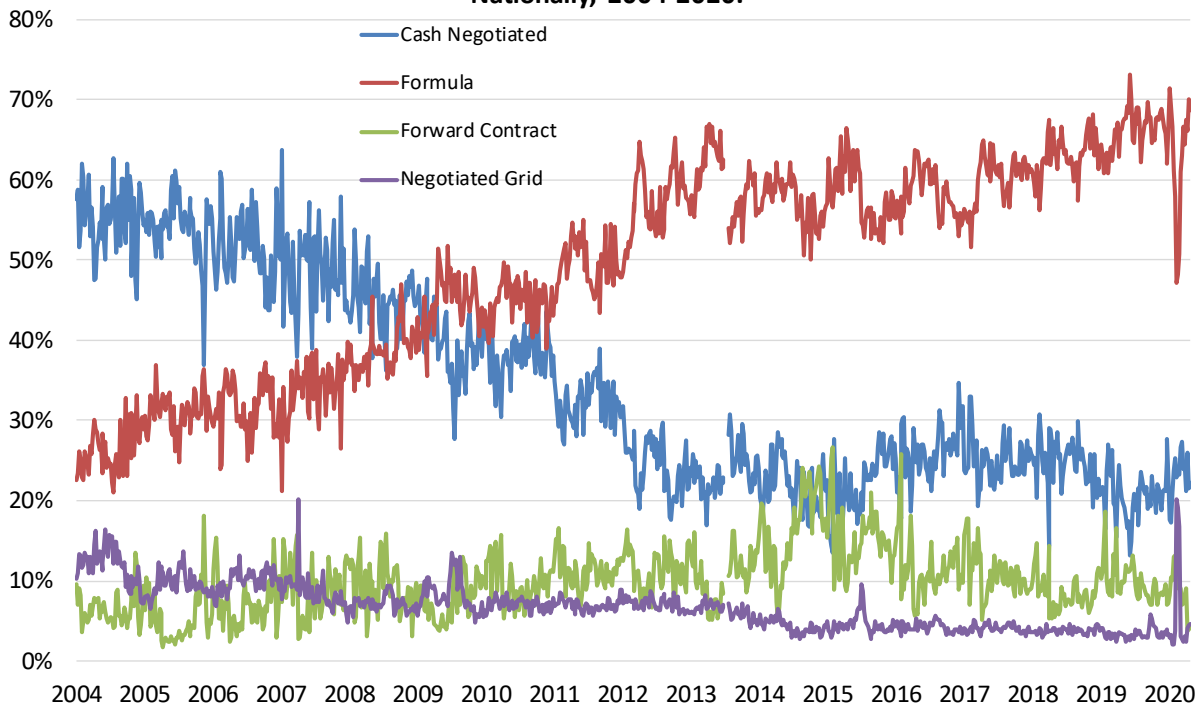
2. *Forward contract* trade is an agreement for the purchase of cattle in advance of slaughter where the base price is established referencing the CME Live Cattle Futures contract.

3. *Negotiated grid* purchases involve negotiating the base price between the packer and cattle feeder at time of the agreement with delivery expected within 14 days. The final net price is determined after slaughter and carcass grading by adjusting the negotiated base price by grid premiums or discounts based on carcass attributes.

4. *Formula* trade represents cattle committed for slaughter by any means other than cash negotiated, forward contract, or negotiated grid.

Fed cattle marketing methods have undergone a major transformation over the past 15 years, as illustrated in Figure 1.1. In the early 2000s cash negotiated trade represented about 55% of typical weekly national fed cattle volume. Negotiated grid and forward contract trade represented roughly 10% each with the remaining 30% being formula trade. Around 2007 formula trade started to increase relative share of fed cattle marketing to where by 2020 about 60-70% of fed cattle were formula purchases. Cash negotiated trade declined to about 20-25% by 2012 and has remained at roughly that level, increasing to over 30% at times, for the last decade. Negotiated grid and forward contracts combined represent the remaining 15% of trade volume.

Figure 1.1. Percentage of Weekly Live Cattle Marketed by Transaction Types Nationally, 2004-2020.



Data Source: USDA AMS as archived by LMIC
Numbers are all live and dressed sales of steers, heifers, other fed cattle, cows and bullsreported in a given week for each tranaction type.

The broad changes in the ways fed cattle are marketed have been widely documented and discussed. The marked decline in negotiated fed cattle trade during the early 2000s has generated considerable interest from stakeholders, analysts, and policy makers. With negotiated purchases hovering around 20-25% of purchases across the major cattle feeding regions and being much less in some regions (as discussed below), concerns have been voiced about potential thinness of the negotiated market. Peel et al. (2020) provided an in-depth discussion regarding the nature of concerns being raised. Concerns with overly thin markets include they can lead to poorly informed trade; more volatile prices across transactions; individual transactions having unjust influence on reported prices; enable market manipulation; reduce trust in reported prices; and generally reduce overall market efficiency.

Concerns about fed cattle market thinness and its impact on price discovery are certainly not a new topic. Tomek (1980) tested market thinness in the Denver terminal market some 40 years ago. More recently, Tomek's framework has been applied to determining 'how thin is too thin?' at national and regional levels (Koontz 2013). Statistical analysis shows that the number of negotiated cattle needed to achieve pricing accuracy thresholds varies across region (Brookover 2020; Koontz 2013). This regional variation is important to document and understand when evaluating the US live cattle sector. USDA AMS currently reports fed cattle prices for five separate regions of Colorado, Iowa-Minnesota, Kansas, Nebraska, and Texas-Oklahoma-New

Mexico market areas. Prices in the negotiated markets for these regions vary statistically across regions especially in the months of September, October, and November (Informa Economics 2016). Due to notable differences in feedlot and packer market structures across these regions, the relative mixtures of the various fed cattle marketing methods also vary considerably. As a result, some areas have greater concerns surrounding thin negotiated fed cattle trade because it represents a small portion of transactions week-to-week. Schroeder, Schulz, and Tonsor (2019) discussed this issue in detail arguing that more geographic aggregation may be needed for USDA to report negotiated fed cattle prices consistently. However, they also cautioned that with divergence in prices across market areas at times caused by variation in local supply and demand conditions, aggregating transactions across too broad of regions masks important fundamental market information.

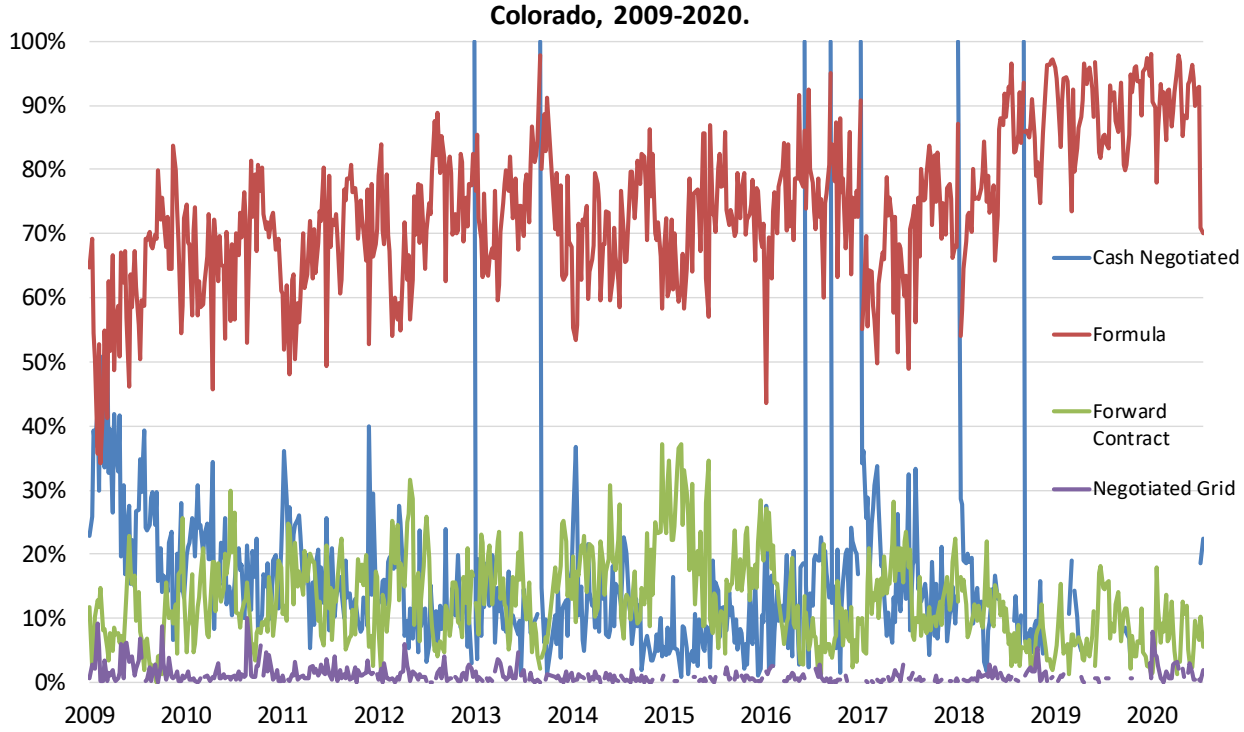
Due to the regional diversity, we document the issue of how various purchasing mixtures and prices vary by region. This is important to understand for at least two reasons. First, it illustrates marketing behavior and market prices vary considerably at times across regions. Second, any potential industry or policy reactions to thinning markets will impact each region differently.

Cattle finishing occurs in many states but the majority is done in the five major reporting regions of Colorado, Iowa-Minnesota, Kansas, Nebraska and Texas-Oklahoma-New Mexico. For example, the July 2020 National Agricultural Statistics Service *Cattle on Feed* report showed that, of all cattle on feed in feedlots of at least 1,000 head, about 84% were in these five regions. We explore how marketing methods for fed cattle have changed across each of the five major regions next.

Colorado

Colorado's data are somewhat unique due to a mix of market and reporting factors (Figure 1.2). There are many weeks where prices are not reported due to USDA AMS confidentiality reporting guidelines. Even though negotiated trades are typically about 25% of all trades, there are weeks where only negotiated sales were reported. There are also many weeks in 2018, 2019, and 2020 where no negotiated trades were reported. These data issues cause some extreme observations, but the major trend of formula sales dominating the market is evident. Colorado was regularly experiencing formula shares of 70% by 2010 when about half the five-area trade was attributed to formula sales. Likewise, cash negotiated share was regularly below 20% from 2011 forward. Colorado shifted toward formula sales earlier than other regions.

Figure 1.2. Percentage of Weekly Live Cattle Marketed by Transaction Types in Colorado, 2009-2020.

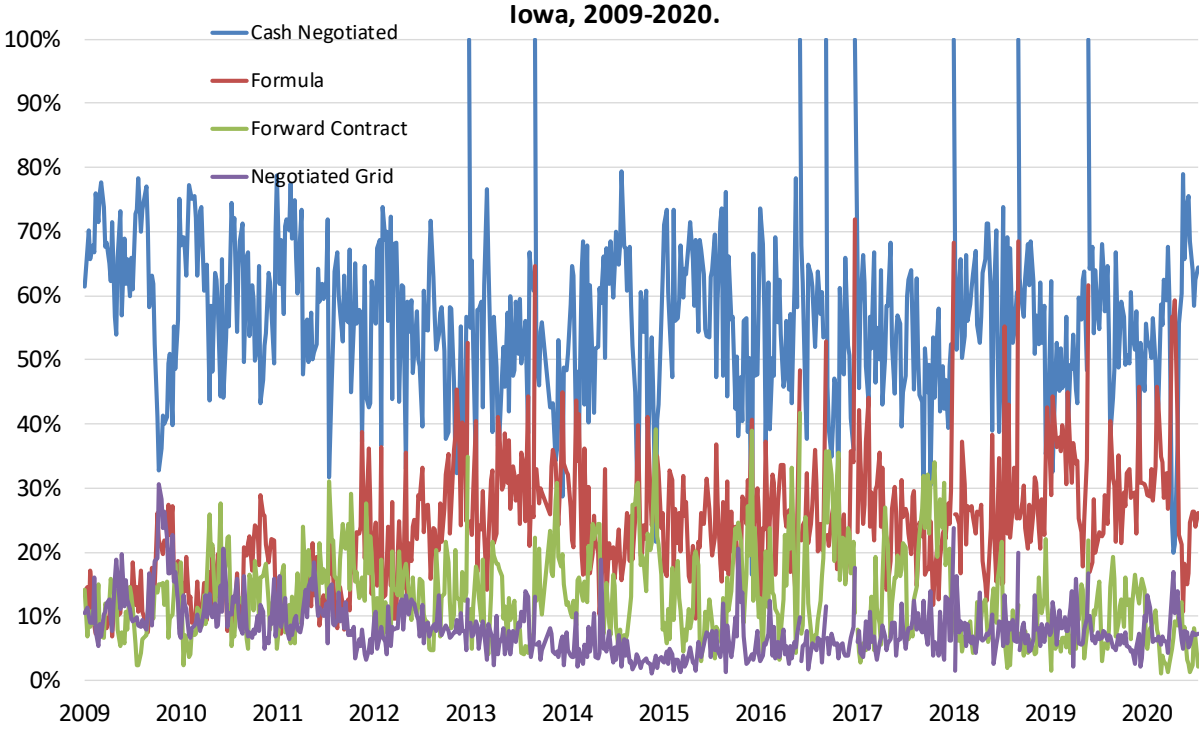


Data Source: USDA AMS Livestock Manadatory Reporting Data Mart
Numbers are all live and dressed head reported in a given week for each tranaction type
Negotiated Grid was not tracked prior to mid-2008.

Iowa (IA-MN-MO)[2]

Iowa-Minnesota (Figure 1.3) is the only market among the five major reporting regions where negotiated sales have regularly represented more than half the weekly transactions over the past decade. The trend over time of percentage of transactions represented by formula sales has also been flatter than other regions. Share of formula sales in Iowa-Minnesota increased steadily from 2009 to 2013. Since 2013, with the exception of a few weeks, the share has stayed in the range of 20% to 40%.

Figure 1.3. Percentage of Weekly Live Cattle Marketed by Transaction Types in Iowa, 2009-2020.



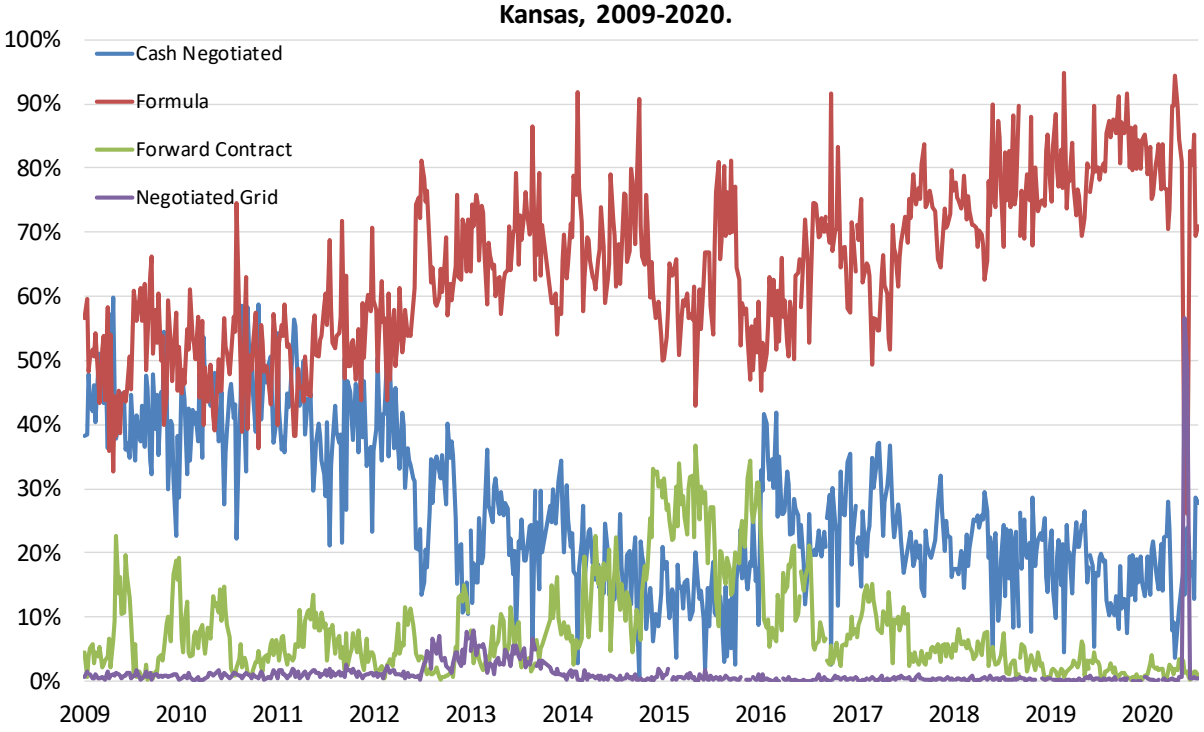
Data Source: USDA AMS Livestock Manadatory Reporting Data Mart
Numbers are all live and dressed head reported in a given week for each tranaction type
Negotiated Grid was not tracked prior to mid-2008.

[2] Iowa-Minnesota is defined as an LMR reporting region. However, this regional chart is based on USDA AMS report LM_CT167, which groups Iowa, Minnesota, and Missouri together. The Missouri numbers are not substantial.

Kansas

The trends for Kansas (Figure 1.4) are similar to national trends. Since 2012, the shift toward formula pricing and away from negotiation has been steady. The week-to-week variation in marketing methods is less in Kansas than other regions, making it easier to identify trends on the chart.

Figure 1.4. Percentage of Weekly Live Cattle Marketed by Transaction Types in Kansas, 2009-2020.

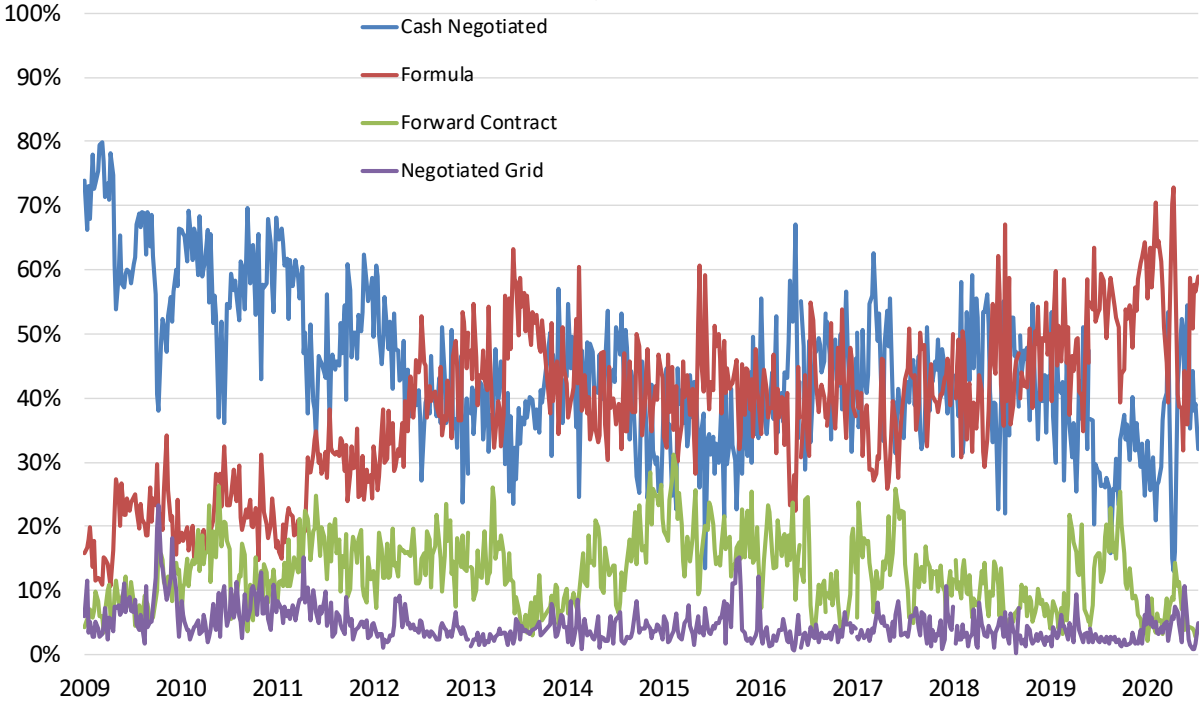


Data Source: USDA AMS Livestock Manadatory Reporting Data Mart
Numbers are all live and dressed head reported in a given week for each tranaction type.
Negotiated Grid was not tracked prior to mid-2008.

Nebraska

Nebraska (Figure 1.5) has been one of the most robust negotiated cash markets of the five regions. Between 2011 and 2019, cash negotiated sales generally made up about 40% of all Nebraska fed cattle marketings. The trend away from negotiation and toward formula largely stopped between 2012 and 2019. In 2019, there was another relative move toward formula sales but that trend largely reversed in 2020. It remains to be seen when and if Nebraska sales evolve toward formula sales other regions have experienced.

Figure 1.5. Percentage of Weekly Live Cattle Marketed by Transaction Types in Nebraska, 2009-2020.

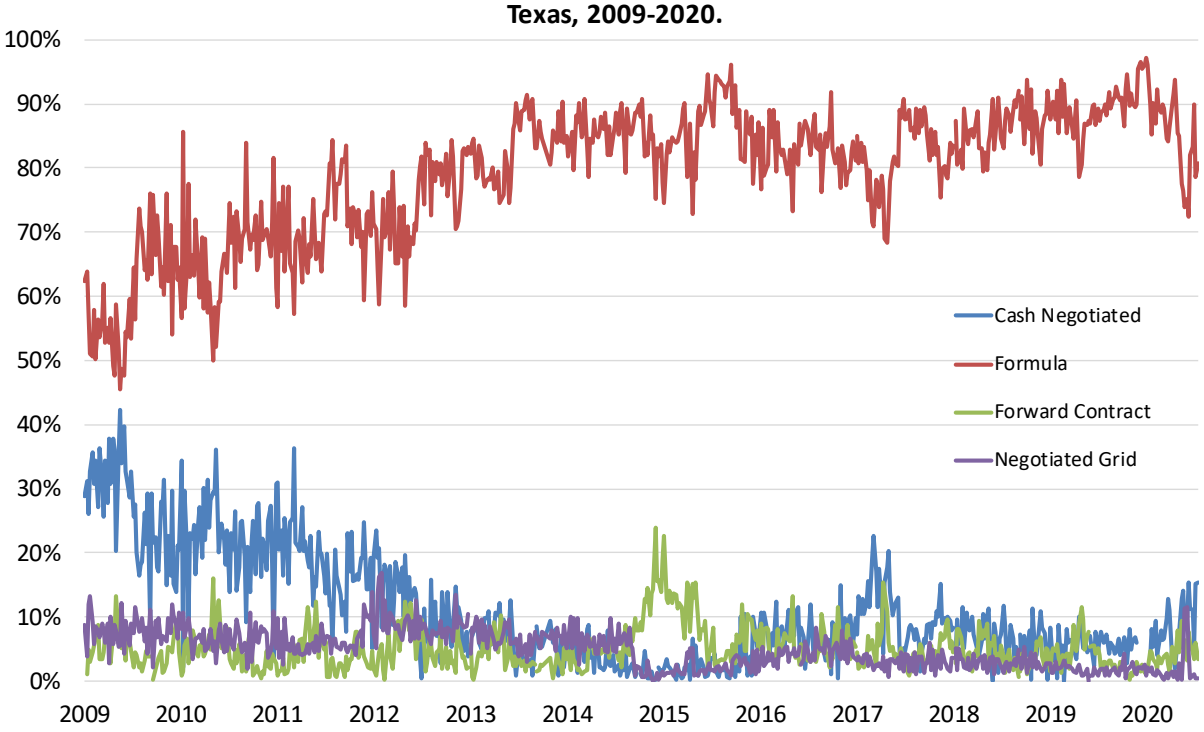


Data Source: USDA AMS Livestock Manadatory Reporting Data Mart
Numbers are all live and dressed head reported in a given week for each tranaction type
Negotiated Grid was not tracked prior to mid-2008.

Texas

The Texas market has long been the extreme case of relying on formula sales. Since 2013, the share of weekly trades which were formula based has regularly been above 80%. There are some deviations. Conditions in the 2015 and 2020 time periods discussed in the Kansas section are also visible in the Texas data but on a relatively smaller scale.

Figure 1.6. Percentage of Weekly Live Cattle Marketed by Transaction Types in Texas, 2009-2020.



Data Source: USDA AMS Livestock Manadatory Reporting Data Mart
Numbers are all live and dressed head reported in a given week for each tranaction type
Negotiated Grid was not tracked prior to mid-2008.

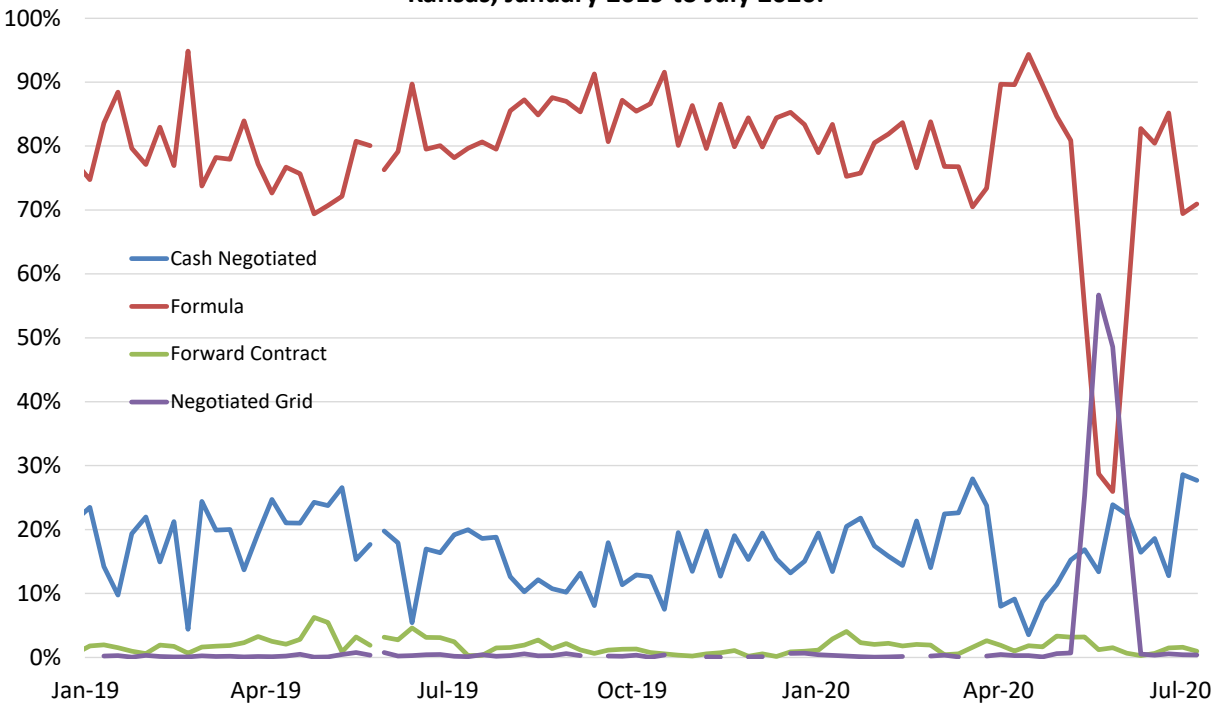
Deviations from Normal

In late 2014 and early 2015, a noticeable portion of marketings shifted from formula to forward contract, with forward contract marketings accounting for about 25% of transactions at the national level for several weeks (Figure 1.1). This time period corresponds to a historic peak in live cattle prices. As prices started to decline, it is reasonable that many feeders had expectations of price decreases and sought to forward price based on historically high prices. The increase in forward contract sales during the same period differed across regions. A shift was particularly evident in Texas-Oklahoma-New Mexico region (Figure 1.6).

Another stark deviation occurred in May and June 2020. That is, the sudden and short-lived prominence of negotiated grid transactions. The shift was most pronounced, but not limited to,

Kansas. The following chart (Figure 1.7) includes only 2019 and 2020 data to emphasize the magnitude of this shift.

Figure 1.7. Percentage of Weekly Live Cattle Marketed by Transaction Types in Kansas, January 2019 to July 2020.



Data Source: USDA AMS Livestock Manadatory Reporting Data Mart
Numbers are all live and dressed head reported in a given week for each tranaction type.

From 2009, when negotiated grid sales were first reported as a distinct category, to May 2020 the maximum reported head marketed by negotiated grid sales in a week was 6,942 and largest weekly percentage of marketings by negotiated grid was 8%. Table 1.1 shows negotiated grid sales during four weeks of May and June 2020. Negotiated grid marketings were several-fold greater, both in levels and as percentage of all marketings, than any previous week.

Table 1.1. Kansas Negotiated Grid Marketings, Selected Weeks from May to June 2020.

LMR Report Date	Head Marketed as Negotiated Grid	Negotiated Grid Marketings as a % of all KS Marketings
May 18, 2020	18,721	25%
May 25, 2020	49,006	57%
June 1, 2020	44,565	49%
June 8, 2020	22,826	23%

The context around this change was the packing plant closures brought on by Covid-19 disruptions causing large swings in live cattle and beef prices (Lusk, Tonsor, and Schulz 2020).

Major packing plant closures suddenly decreased demand for cattle, as there was insufficient operational capacity to harvest market-ready cattle. The environment was tense and changing week-to-week. Cattle feeders and packers had to proceed with knowledge of current constrained packing plant operational capacity and expectations of when capacity might begin to return to more normal levels. The reporting week of May 18 was a turning point in this situation as live cattle sales in Kansas began to increase and packing plant constraints, though still severe, started to ease. As a result, formula sales decreased by thousands of head and negotiated grid sales increased. Though it is impossible to know the exact reasoning behind the actions of sellers and buyers, a likely cause was the inability of formula selling to keep pace with the rapidly changing live cattle supply and demand fundamentals. Formula sales often use a base price derived from negotiated sales of the past one or two weeks. To that base is added premiums and discounts based on carcass performance. Expected demand for live cattle increased greatly from one week to the next as packing plants began to go back online at reduced levels. In this case, the one or two-week lagged negotiated price was not representative of expected demand conditions associated with plants opening. Therefore, cattle feeders who wanted the benefit of receiving compensation for carcass performance but did not want to use lagged negotiated prices as a base, turned to negotiated grid sales. This allowed the carcass performance premiums and base price to better reflect current conditions.

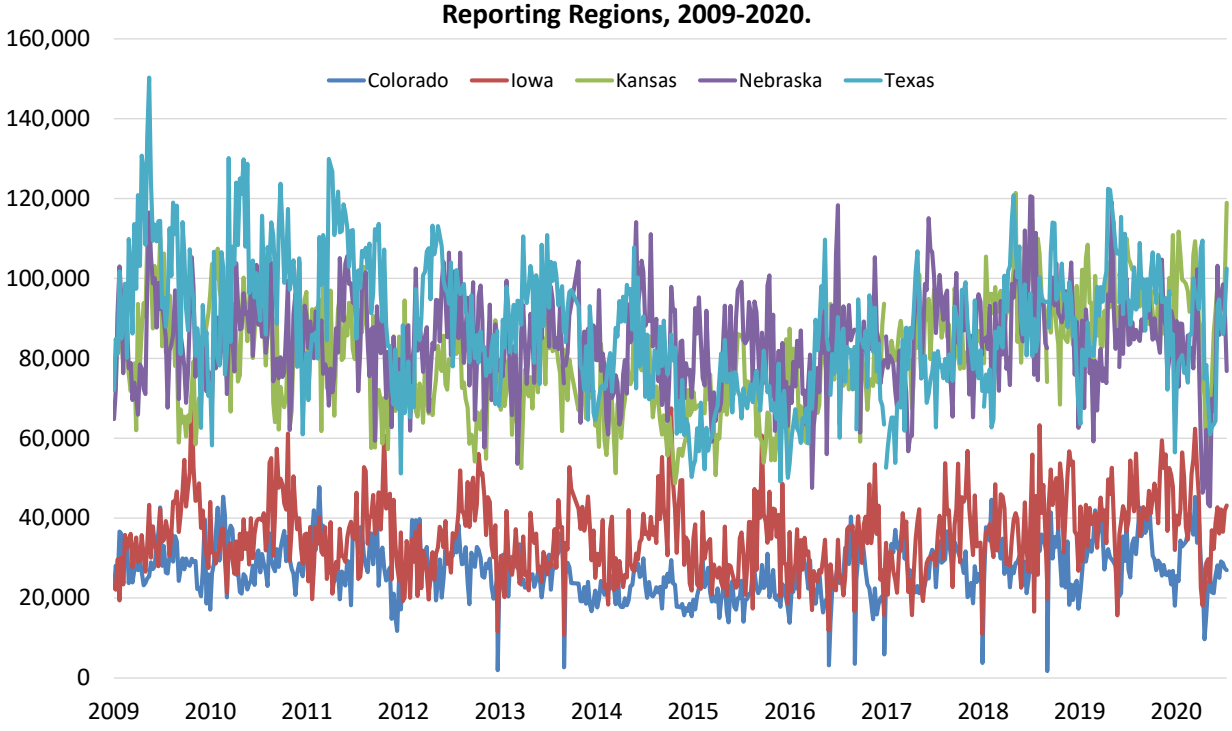
Important to realize from this event is there are potentially subtle changes that can occur in fed cattle trade that can rapidly shift cattle between negotiated grid and formula trade categories as reported by USDA. For example, if the base price in the formula trade was sporadic, as it was during these major disruptions in some areas, the packer and feeder may have simply "negotiated" an alternative base each week for what would otherwise have been formula trade. That is, by simply shifting the base price from that stipulated in a marketing agreement to using for example the mid-point of reported trades and both packer and feeder negotiating on the substitute base for that week, the transaction easily shifted from formula to negotiated grid. The packing plant disruption of Covid-19 was an historic event. Flexibility or marketing alternatives allowed cattle feeders to divert cattle from formula sales to negotiated grid sales.

Regional Differences

Within Transaction Types

As each region exhibits different preferences regarding transaction types, that means transaction methods are influenced differently by the regions (Figure 1.8). On average, the Texas region sells the most fed cattle across all transaction methods and Colorado sells the fewest. However, there are commonly weeks where either Kansas or Nebraska report the largest number.

Figure 1.8. All Weekly Live Cattle Reported Marketings in the Five Major Reporting Regions, 2009-2020.

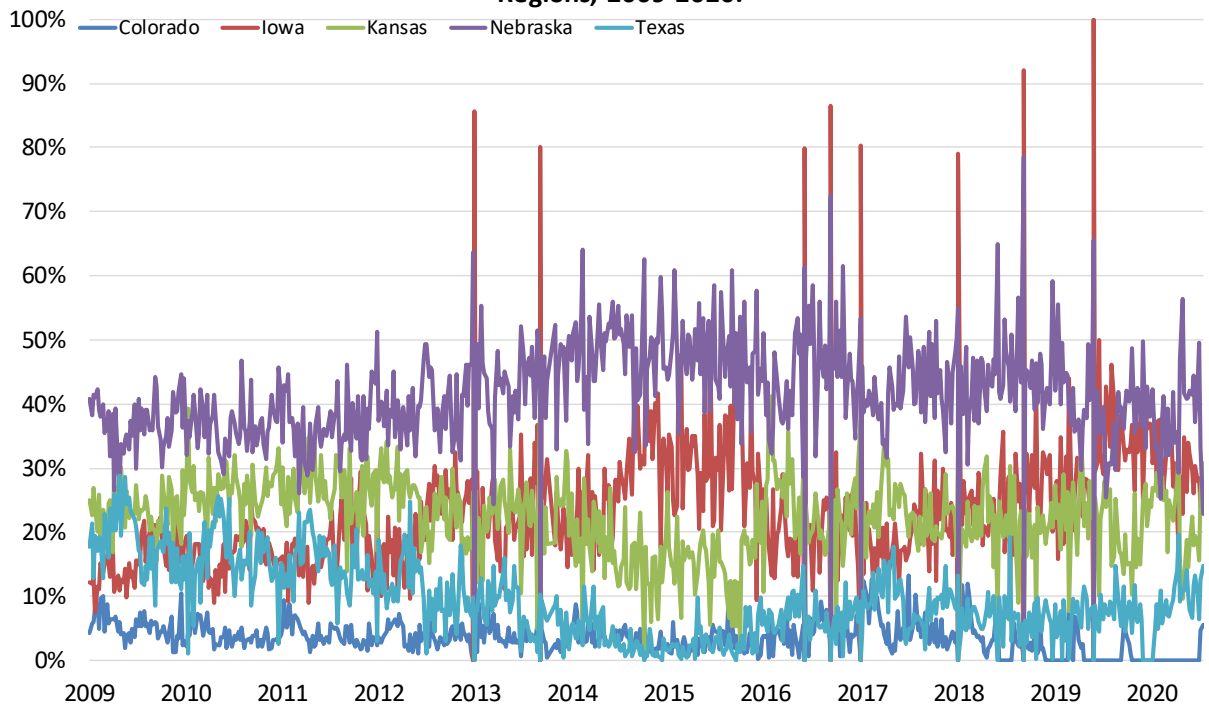


Data Source: USDA AMS Livestock Manadatory Reporting Data Mart
Numbers are all live and dressed head reported in a given week for each tranaction type.

Negotiated Sales

Nebraska has established a reputation as perhaps the most robust regional cash negotiated market. The percentage of cattle sold via negotiation in Nebraska has remained steady for many years (Figure 1.9). Nebraska also represents the largest shares of negotiated cash sales of any region. Anecdotally, the negotiated Nebraska price is heavily utilized as a base price for formula pricing in other regions. Texas and Colorado have the lowest share of the negotiated market. Kansas and Iowa and in the middle, with Iowa cattle counting for an increasing share over the past few years. As the live cattle market is analyzed the diversity of regional contributions is key to understand. As one example, Texas cattle generally represent more of the five-area live cattle market than any other region but Nebraska clearly dominates the negotiated market, sometimes comprising half the negotiated sales.

Figure 1.9. Share of the Negotiated Cash Market of theFive Major Reporting Regions, 2009-2020.

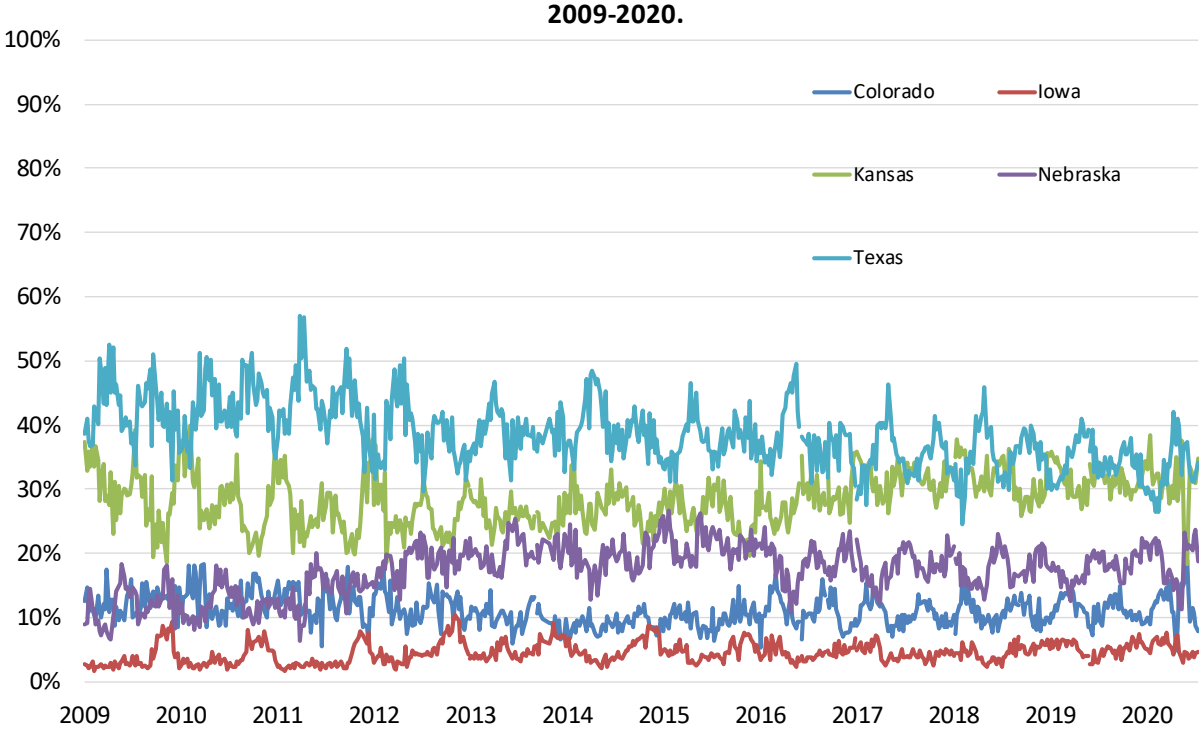


Data Source: USDA AMS Livestock Manadatory Reporting Data Mart
Numbers are all live and dressed head reported in a given week for each tranaction type.
Negotiated Grid was not tracked prior to mid-2008.

Formula Sales

The contributions of each major region to all formula sales is quite different than to negotiated sales (Figure 1.10). In the case of formula marketings, Texas has clearly been the major region. However, this is changing as Kansas formula cattle have begun to increase in relative magnitude over the past five years. Formula sales in the Iowa region are historically the lowest percentage of the five regions. There is no evidence this trend is changing.

Figure 1.10. Share of the Formula Market of the Five Major Reporting Regions, 2009-2020.



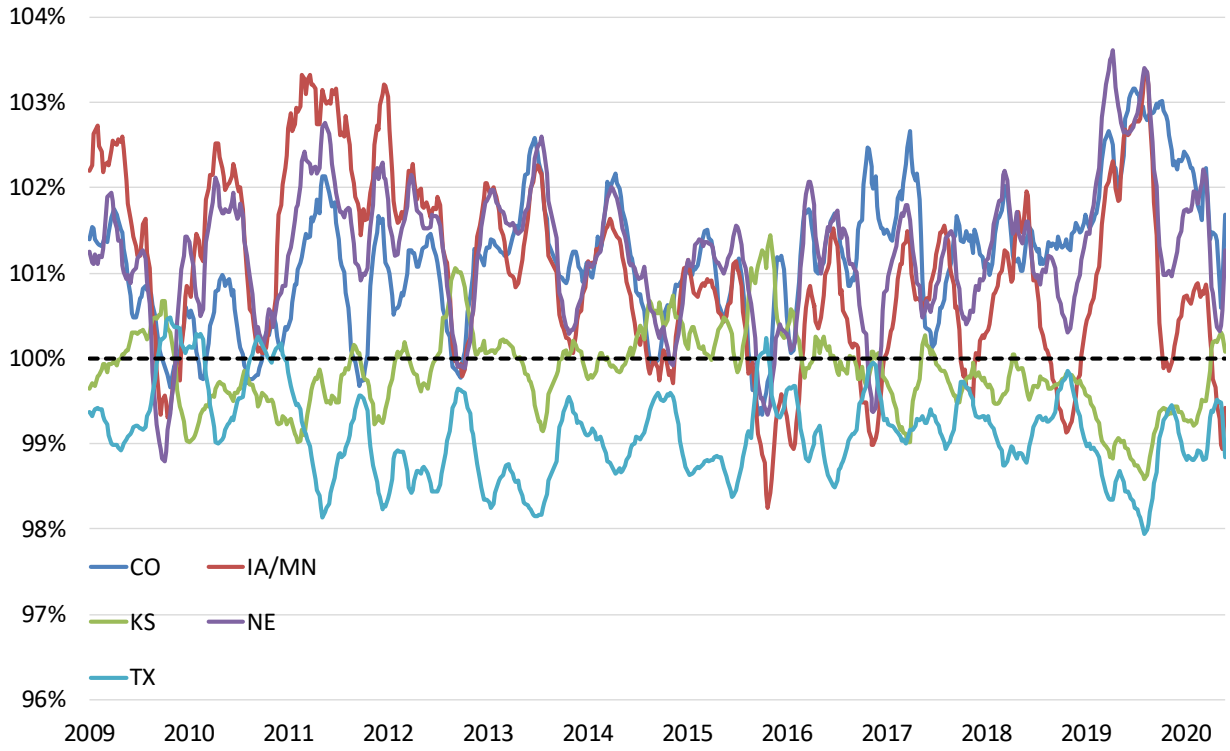
Data Source: USDA AMS Livestock Manadatory Reporting Data Mart
Numbers are all reported live and dressed formula sales in a given week for each region.
Negotiated Grid was not tracked prior to mid-2008.

The implications of the regional variation are complex but important to consider. Due to climate and other factors, live cattle in Texas differ from those fed farther north. There is the current reality that Texas cattle represent a large portion of all fed cattle and all formula sales but represent a relatively tiny fraction of negotiated trade. On the other Nebraska fed cattle sales are contributing more than any other region to negotiated trade, which in turn, establishes the base for formula trade. This mismatch in contributions across the transaction types is concerning to many in the industry.

Formula Net Sale Prices Across Regions

Reported net formula sale prices differ noticeably across regions with some persisting patterns. Each region's weekly formula price as a percentage of the average five-area price is illustrated in Figure 1.11. An eight-week moving average of prices is shown to reduce the week-to-week noise present in the data and make the chart easier to read.

Figure 1.11. Regional Dressed Formula Prices as a % of Five-Area Dressed Formula Price (8-week Moving Average), 2009-2020.



Texas net formula prices are generally the lowest of the regions, though formula sales represent almost all Texas sales and Texas is the major region, in terms of formula sales. On the other hand, there are relatively few Iowa cattle sold via formula but average formula prices are comparable to other regions. . As this chart is based on per hundredweight (cwt) prices, this is not completely unexpected. All else equal, cattle in the northern regions of Iowa, Nebraska, and Colorado have higher quality grades than those in Texas.[3] Cattle from these regions are rewarded accordingly in formula sales. The price movements in Texas formula cattle are often opposite of those in the northern regions.

[3] Cattle in Texas have the advantage of generally having a higher dressing percentage than those in the northern regions. Dressing percentage is the weight of a carcass as percent of live weight. This means that comparing per animal prices would likely show outcomes to be more similar across regions.

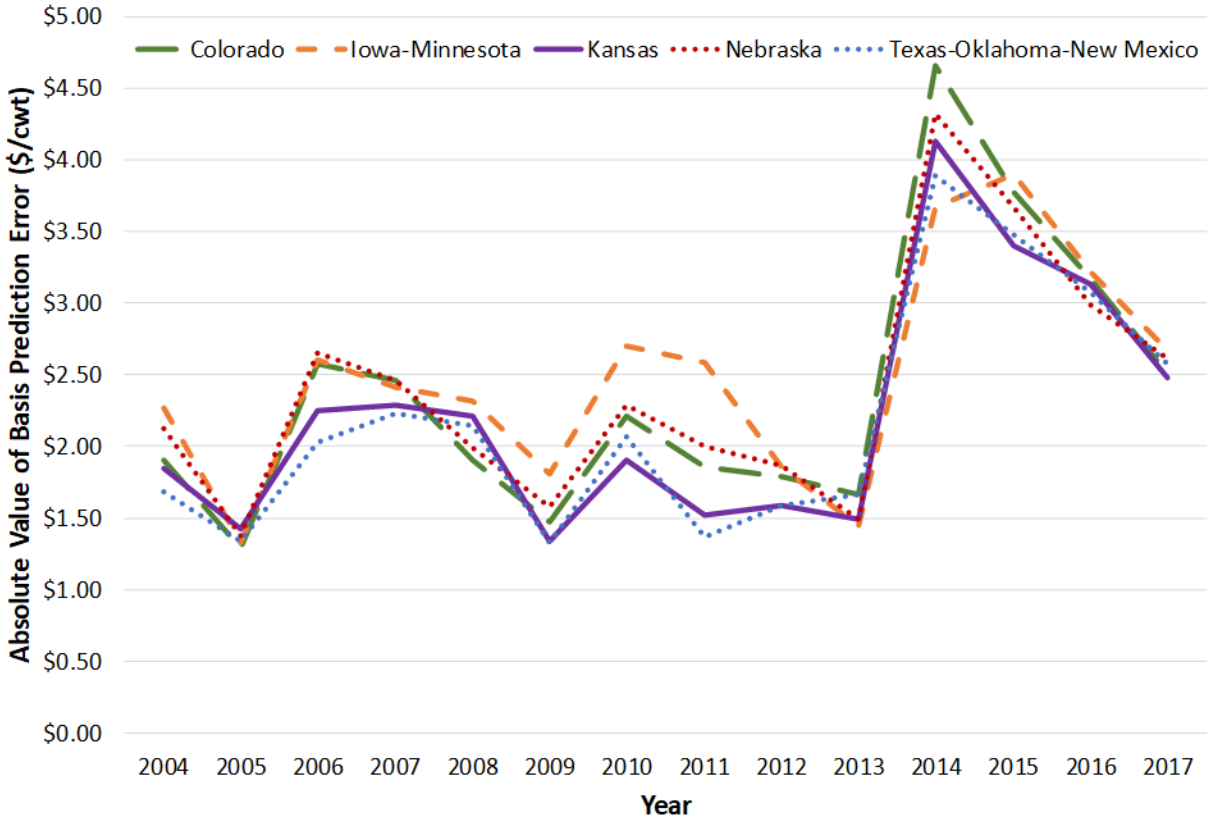
Relative to Live Cattle Futures

The CME Live Cattle Futures Contract is used by those wishing to hedge the sale or purchase of live cattle. A specific contract price should represent the synthesis of opinions across hedgers and speculators about expected supply and demand conditions for fed cattle. Basis is the difference between a local cash price and futures price. Past research has shown that basis can vary substantially across regions. This has risk management implications that, though important, are beyond the scope of this study. However, we briefly outline regional basis differences as an illustration of the regional variation in US fed cattle markets.

Schroeder, Tonsor, and Coffey (2018) compared basis prediction errors across regions (Figure 1.12). The ability to predict basis was often more difficult (i.e., greater prediction error) in Iowa-Minnesota and Nebraska than in Kansas and Texas. The issue here is not that regional basis differs. That is to be expected, given that each region is being compared to the same futures contract and, as discussed, the cattle in each region differ. The important point is that predictability of basis differs. Although more rigorous research is needed, this suggests supply and demand factors in each region vary enough to create a divergence in the way regional prices move relative to each other and to futures prices.

Coffey, Tonsor, and Schroeder (2018) also examined regional basis prediction errors in the five major reporting regions. They confirmed regional differences. For example, Iowa-Minnesota and Nebraska prediction errors were related to the total number of cattle marketed in a week but that was not true for the other regions. Iowa-Minnesota prediction errors were more sensitive to the steer/corn price ratio (a proxy for marginal benefit of adding more pounds to live cattle) and transportation cost than other regions. The authors hypothesized these differences were due to the prevalence of relatively cheaper corn in Iowa and relatively longer distances from Iowa feed yards to packing plants, respectively. The relevant point for this study is that differing basis values point to substantial differences across regional markets.

Figure 1.12. Annual Average Absolute Value of Nearby Basis Prediction Error in Five Major Markets, 2004-2017. (Copied from Schroeder, Tonsor, and Coffey 2018)



Source: Calculated from data obtained from USDA AMS and Livestock Marketing Information Center

Regional Market Differences

The observed differences in fed cattle marketing methods employed across regions demonstrates the substantial diversity across these regions. The differences show that incentives vary across regions. This underscores that policy decisions must not treat all five major fed cattle marketing regions (or other regions) as homogenous. The practices in each region have developed over time as a response to local opportunities and challenges. There are strong economic, production, and logistical reasons trade looks different across regions. Further, the regional markets are, perhaps more than ever, deeply interconnected through formula sales that use a five-area average or specific regional price as base prices. Any policy that impacts a single region will certainly have spillover effects in others.

CHAPTER 2: MOTIVES FOR MARKETING AGREEMENTS

Objective 2

Review and summarize economic determinants and estimate value differences of the current ways fed cattle are valued including costs, incentives, quality control, and risk management. Special emphasis will be placed on better understanding stark differences in these methods across cattle feeding regions and structures to assess implications by different stakeholders with varied compositions (e.g., large commercial feed yards vs. smaller farmer-feeder operations).

Motivations for Alternative Marketing Arrangements

Several studies have identified and assessed factors motivating various ways fed cattle are sold by producers to packers. In this section we discuss studies identifying and assessing motivations for use of alternative marketing arrangements (AMAs) and grid pricing.

Past Research

RTI 2007

One noteworthy study completed on factors motivating use of various fed cattle and beef marketing practices including AMAs is the *GIPSA Livestock and Meat Marketing Study* conducted by RTI International and published in 2007.[4] The RTI research team conducted surveys with producers, packers, processors, wholesalers, exporters, retailers, and food service operators across cattle, hog, and lamb industries. We focus our review summary on cattle producer and beef packer results.

Cattle producer survey results were based on 293 respondents to a stratified survey sample of operations that included cow-calf, backgrounder, and feedlot segments. Of 293 total respondents, 62 considered their operation a feedlot, though 93 indicated they sold fed cattle in the past year. A couple of significant drawbacks for purposes of our study is the RTI 2007 did not separate survey results for feedlots from other producers (cow-calf and backgrounding). Furthermore, based on the survey results, it is apparent the survey had a relatively small number (less than 25) of commercial feedlots represented in responses. This is a concern for our purposes because by far the largest volume of fed cattle marketed to packers are from commercial feedlots. However, the RTI authors separated most producer results by operation size ("small" with less than $25 million in annual sales and "large" having $25 million or more). In all likelihood, large operations were predominantly feedlots given annual sales volume and small operations were a mixture of mostly cow-calf, backgrounders, and small feedlots.

Beef packer survey results were based on surveying the 60 largest beef packers and 240 remaining small packers. The total responses received included 30 of the large and 34 small beef packers.

[4] The complete volume of reports associated with the GIPSA Livestock and Meat Marketing Study are available at: https://www.gipsa.usda.gov/psp/publication/live_meat_market.aspx

The methods used to sell cattle by producer survey respondents are summarized in Table 2.1. Small operations were most likely dominated by cow-calf producers or backgrounders and 84% used public auctions to sell cattle while only 6% used formula pricing. In contrast, 74% of large operations used negotiated and 57% used formula pricing methods. An important implication of the divergence in use of formula pricing by varied operation sizes and likely sector represented is that smaller operations (and cow-calf) tend not to use formula pricing arrangements and, as such, may not fully understand them from lack of experience with such pricing methods or they may not perceive a formula pricing arrangement is useful for their operation. This could contribute to divergence of opinions observed by cow-calf producers or smaller feedlot operations about formula pricing relative to larger commercial feedlots.

Table 2.1. Cattle Producer Reponses to "What types of pricing methods were used by your operation for selling calves and cattle during the past year?"

Pricing Method	Percentage of small operations (N= 270)	Percentage of large operations (N=23)
1. Individually negotiated pricing	**31.7**	**73.9**
2. Public auction	**83.6**	**34.8**
3. Formula pricing	5.7	**56.5**
4. Custom fed / backgrounded, not marketed by your operation	5.7	17.4
5. Internal transfer	0.2	13.0
6. Custom slaughtered for your operation	5.4	4.3
7. Sealed bid	0.5	0.0
8. Other	0.0	0.0

Notes: Small operations were those with less than $25 million annual sales and Large operations had at least $25 million. Columns sum to more than 100%, as respondents used multiple methods.
Source: RTI (2007), Volume 2, p. 6-44.

Cattle producers were surveyed regarding the three most important reasons they used only cash or spot markets for selling calves and cattle. Results were not reported separately by operation size categories because of confidentiality. The most important reasons cited for using only cash markets were (Table 2.2) the independence and flexibility they offered (54%); the perception sell prices were higher than alternatives (41%); and they enhanced producer ability to benefit from favorable market conditions (38%). Roughly 25% cited that the cash market did not require entering into contracts, allows them to more quickly adjust to market changes, and reduces selling costs. Generalized, the dominant reasons producers used the cash market centered around increased flexibility, ability to respond more quickly to market conditions, and independence.

Table 2.2 Cattle Producer Reponses to "What are the three most important reasons why your operation only uses the cash or spot market for selling calves and cattle?"

Reason	Percentage of operations (N=293)
1. Allows for independence, complete control, and flexibility of own business	**54.1**
2. Can sell calves and cattle at higher prices	**40.9**
3. Enhances ability to benefit from favorable market conditions	**37.5**
4. Does not require managing complex and costly contracts	**24.8**
5. Allows for adjusting operations quickly in response to changes in market conditions	**23.1**
6. Reduces costs of activities for selling calves and cattle	**22.8**
7. Does not require identifying and recruiting long-term contracting partners	19.9
8. Allows for sale of higher quality calves and cattle	16.3
9. Reduces risk exposure	11.8
10. Facilitates or increases market access	11.6
11. Reduces price variability for calves and cattle	8.4
12. Can easily sell small number of animals (write in)	4.2
13. Reduces potential liability and litigation concerns	4.0
14. Convenience (write in)	3.0
15. Eliminates possible negative public perceptions about use of contracts	2.8
16. Other	1.2
17. No other choice (write-in)	0.8
18. Increases supply chain information	0.8

Source: RTI (2007), Volume 2, pp. 6-50, 6-51.

Beef packers were also asked why they use only cash markets for purchasing fed cattle in the RTI study. However, few (if any) of the 60 largest packers would have used only the cash market for fed cattle purchases thus, the packer survey findings for this question are not useful for our purposes as very few packers were represented and they were likely dominated by small plants.

Cattle producers were also queried regarding their motivations for use of AMAs. Results are reported in Table 2.3. The most common reasons among small and large operations were selling higher quality animals; selling for higher prices; reducing risk exposure; and securing a buyer. Divergence was apparent where small operations also indicated use of AMAs reduced price variability, whereas no large operations indicated this was the case. Many more large operations, 43%, indicated increasing market access was a major motivator compared to only 19% of small operations. Market access has likely become a greater concern with recent events such as the Holcomb beef packing plant fire in 2019 and Covid-19 disruptions in 2020 (USDA, AMS 2020). About 29% of large operations also indicated AMAs improve week-to-week production management.

Table 2.3. Cattle Producer Reponses to "What are the three most important reasons why your operation uses alternative sales methods for selling calves and cattle?"

Reason	Percentage of small operations (N=270)	Percentage of large operations (N=23)
1. Allows for sale of higher quality calves and cattle	**52.3**	21.4
2. Can sell calves and cattle at higher prices	**38.1**	**57.1**
3. Reduces risk exposure	**34.3**	**34.5**
4. Reduces price variability for calves and cattle	**34.6**	0.0
5. Secures a buyer for calves and cattle	**26.3**	**35.7**
6. Provides detailed carcass data	20.4	14.3
7. Facilitates or increases market access	19.1	**42.9**
8. Reduces costs of activities for selling calves and cattle	12.9	7.1
9. Increases flexibility in responding to consumer demand	10.2	0.0
10. Improves week-to-week production management	9.0	**28.6**
11. Enhances access to credit	8.5	0.0
12. Reduces potential liability and litigation concerns	8.5	0.0
13. Allows for product branding in retail sales	4.5	14.3
14. Increases supply chain information	4.4	7.1
15. Other	0.0	14.3
16. Allows for product traceability	0.0	7.1
17. Allows for food safety and biosecurity assurances	0.0	7.1

Notes: Small operations were those with less than $25 million annual sales and Large operations had at least $25 million.
Source: RTI (2007), Volume 2, p. 6-51.

The RTI study also surveyed hog and lamb producers regarding reasons they used AMAs. The most common responses for hog producers were because they reduced risk (76% of respondents), they reduced price variability (44%), they secured a buyer (39%), they reduced costs for selling (23%), and producers could sell hogs for higher prices (21%). Lamb producer common responses were selling lambs at higher prices (67%), securing a buyer (46%), and reducing risk exposure (41%).

Beef packers in the RTI study were surveyed regarding the three most important motivations for their use of AMAs in both fed cattle purchases and beef product sales. Approximately 78% of small beef packing plants indicated they used only the cash market to purchase fed cattle, whereas only 10% of large beef packing plants purchased cattle only in the cash market. In contrast, large plants purchased 33% of their cattle using AMAs (this is much larger in recent years as documented elsewhere in this report) while 18% of purchases by small packers used AMAs. Of the 64 packers that responded to the survey, 34 used formula pricing, which is dominated by large plants in the survey. The most important reasons beef packers use AMAs for cattle purchases were improving supply chain management (58%) and securing higher

quality cattle (54%) (Table 2.4). At roughly 40% each were allowing for product branding, enabling market access, and improving efficiency. The use of AMAs to facilitate branding will be increasingly important to the beef sector as the value of branded beef as a percent of all boxed beef increased from 7% in 2004 to 31% in 2019 (see Chapter 5). Absent AMAs, beef packers would likely struggle to consistently procure cattle meeting specifications needed to maintain branded products. Likewise, accessing foreign markets requires meeting specific standards (discussed in more detail later) and AMAs allow packers to consistently meet those standards. The value of beef exports doubled between 2010 and 2019 from $4 billion to $8 billion (Meat Export Federation). Exports are a vital component of demand for US beef and the importance of access to export markets is growing. For beef product sales, by far the most important was AMAs increased beef packer ability to meet consumer demands (72%) followed by reducing risk (48%), improving supply chain management (44%), and reducing price variance (44%). Generalizing results, beef packers used AMAs for both cattle purchases as well as beef sales to better manage product quality, improve supply chain management, and manage risk.

Table 2.4. Beef Packer Reponses to "What are the three most important reasons why your plant uses alternative purchase methods for purchasing fed cattle (sales methods for selling beef products)?"

Reason	Purchase fed cattle, percentage of packers (N=64)	Sale beef products, percentage of packers (N=64)
1. Improves week-to-week supply chain management	**57.7**	**43.9**
2. Secures higher quality fed cattle (sales of higher quality beef)	**53.8**	12.1
3. Allows for product branding in retail sales	**46.2**	0.0
4. Allows for market access	**42.3**	8.0
5. Improves efficiency of operations due to animal uniformity	**42.3**	NA
6. Reduces costs of activities for buying fed cattle (selling beef)	**34.6**	0.0
7. Increases flexibility in responding to consumer demand	19.2	**72.0**
8. Allows for product traceability	3.8	0.0
9. Can purchase fed cattle at lower prices (sell beef for higher prices)	0.0	12.1
10. Reduces risk exposure	0.0	**47.9**
11. Reduces price variability for fed cattle (beef products)	0.0	**43.9**
12. Increase supply chain information	0.0	0.0
13. Allows for food safety and biosecurity assurances	0.0	0.0
14. Reduces potential liability and litigation concerns	0.0	0.0
15. Enhances access to credit	0.0	0.0
16. Secures a buyer for beef products	NA	**24.0**
17. Other	0.0	12.1

Source: RTI (2007), Volume 2, pp. 7-24, 7-32.

A question often raised is the source of base prices used in formula pricing agreements. The RTI packer survey revealed for grid priced formula traded cattle, the most popular base price sources were CME cattle futures (56%), plant averages (50%), USDA dressed quote (44%), and USDA live quote (44%) (Table 2.5). For formula cattle without a grid, CME cattle futures (32%) and USDA dressed prices (29%) were most common responses. Though not explicitly stated in the study, based on response tallies, we estimate about 29 plants answered the "with a grid" and approximately 20 answered the "without a grid" segments. We expect some of the same plants answered both segments.

Table 2.5. Beef Packer Response to "For fed cattle purchased by your plant during the past year using formula pricing, what was the base price of the formula?"

	Percentage of respondents (N=64)	
Base Price Source	with a grid	without a grid
1. CME cattle futures	**56.2**	**32.0**
2. Individual or multiple plant average price	**50.0**	12.5
3. USDA dressed or carcass quote	**43.8**	**28.6**
4. USDA live quote	**40.6**	19.6
5. Private subscription price	34.3	12.4
6. USDA boxed beef price	25.1	8.9
7. Individual or multiple plant average cost of production	18.7	14.3
8. Retail price	15.6	19.6
9. Other market price	0.0	10.8

Source RTI (2007), Volume 2. p. 7-19.

Schroeder et al. 2002

In 2002, Schroeder et al. conducted a mail out survey of cattle feeders located in the states of Iowa, Kansas, Nebraska, and Texas using cattle producer association mailing lists. Overall, 1501 surveys were mailed with 316 responding.

Included in the survey was having respondents score their perceptions of motives for forming marketing agreements with packers for fed cattle and for selling fed cattle using grid pricing. Table 2.6 reports the ranked respondent scores for 187 cattle feeders who had marketing agreements in place and for 236 respondents who had used grids at the time of the survey. The major motives to form marketing agreements and grid pricing were obtaining quality grade and yield grade premiums and enabling access to carcass data. For marketing agreements guaranteeing a buyer for cattle and reducing marketing costs were also important. Being able to sell cattle for a higher base price was also important for grid users.

Table 2.6. Cattle Feeder Respondent Motives to Form Supply Contracts/Marketing Agreements with Packers (for those who had agreements in place) and Motivation for Grids (for those who used Grids).

Motive to Form Agreement / Grid Price	Motives to form agreements, those with agreements in place, N=187 Average response (1=strongly disagree to 9=strongly agree)	Motives to grid price, those who use grids, N=236 Average response (1=strongly disagree to 9=strongly agree)
Able to obtain quality/yield grade premiums	**6.5**	**7.4**
Enables access to detailed carcass data	**6.1**	**6.8**
Guarantees a buyer for cattle	**5.9**	5.0
Reduces marketing time and costs	**5.6**	4.9
Able to sell cattle at a higher base price	5.3	**6.1**
Reduces price risk and/or basis risk	5.1	3.9
Facilitates financing arrangements with lenders	4.6	4.1
Pressured by packers	4.0	3.8
Increases Competition Among Packers	N/A	4.2

Source: Schroeder et al., 2002.

Schroeder et al. also asked cattle feeders several questions regarding perceptions about pricing and structural concerns in the fed cattle and beef industry (Table 2.7). Of the questions posed, the one most strongly agreed to was that cash market bids by packers were lower when packers have cattle contracted with a score of 7.7 (9=strongly agree). Next highest ranked was a preference for formula prices in grids to be tied to downstream markets such as boxed beef or retail sectors. Reduced trading in the cash market was feared to be harmful to the beef industry. There was generally less agreement that packers should be broken into several smaller companies or that packers should not be permitted to contract or form marketing agreements with retail and food service entities.

Table 2.7. Cattle Feeder Perceptions of Pricing and Structural Issues Associated with Fed Cattle Markets.

Survey Statement	Average response (1=strongly disagree to 9=strongly agree) (N=307)
Cash market bids by packers are lower when packers have cattle contracted	**7.7**
Formula base prices in grids should be tied to boxed beef or retail markets	**7.2**
Reduced trading in the cash market would be harmful to the beef industry	**6.8**
Packers should not be permitted to own and feed cattle	**6.6**
Negotiated base prices in grids are preferred to formula prices	**6.3**
More producer-owned packers would benefit the beef industry	**6.2**
The largest retail grocers should be broken into several smaller companies	5.0
The largest packers should be broken into several smaller companies	4.9
Packers should not be permitted to contract or form marketing agreements with feeders and cattle owners	4.8
Packers should not be permitted to contract or form marketing agreements with retail and food service customers	4.2

Source: Schroeder et al., 2002.

Impacts of Purchase Methods on Packer Financials

RTI 2007 – Packer Financials

As part of the RTI 2007 study, monthly financial data were collected from beef packing plants over the October 2002-March 2005 period. The data were collected from 21 plants owned by four beef packing companies representing more than 80% of federally inspected steer and heifer slaughter. We highlight results germane to our particular study:

Volume-weighted average financial measures for the packing plants were:

- Average Total Cost $138.61 per head [range $120 to $164]
  (excluding cost of cattle)
- Average Gross Margin $140.73 per head [range $23 to $212]
  (beef and by-product sales revenue minus cattle purchase cost)
- Profit -$2.40 per head [range -$137 to $73]

Volume-weighted cattle purchase shares were:

- Forward contracts 4.2%
- Marketing Agreements 29.5%
- Packer owned results suppressed for confidentiality (less than 5%)
- Direct trade (i.e., cash negotiated) or auction barns ~60%

A regression model explaining plant cattle volume slaughtered revealed forward contract and packer owned cattle were strong substitutes for cash market cattle purchases. However,

packers apparently viewed cash cattle as less substitutable for marketing agreement cattle than forward contract cattle. A 1% decline in marketing agreement volume resulted a 0.83% increase in cash cattle purchases whereas, a 1% decline in either forward contract or packer owned cattle resulted in a 0.99% increase in cash cattle purchases. The implication is that any policy limiting marketing agreement purchases would likely result in packers operating plants at lower overall cattle volumes, at least in the short term.

Monthly volumes of cattle procured by plants through the cash market were almost twice (1.74 times) as variable as AMA volumes. In review of recent LMR weekly packer cattle purchase methods, over the 2016 – November 2020 time frame negotiated cash market (cash negotiated plus negotiated grid) purchase volume was about 1.45 times more variable than AMA (formula plus forward contract) purchases based on comparing coefficients of variation. During just January – November 2020, overall beef packer cattle purchase volumes for both cash negotiated and AMAs increase considerably with challenged operating capacity due to Covid-19 (Tonsor and Schulz 2020), with cash negotiated volume varying 1.17 times more than AMAs based on comparisons of coefficients of variation. Overall, these volume variations suggest AMAs tend to have greater stability over time than cash negotiated purchases, which is consistent with AMAs improving packer efficiency and supply chain management.

Large plants had higher per-unit costs when operating at low volumes than small plants operating at capacity. The obvious conclusion is large plants must operate near capacity to reduce costs and be profitable. However, large plants generally have a $1 to $3 per head lower cost than smaller plants when both were at capacity illustrating clear economies of scale. Costs increased rapidly when volumes declined below capacity for both large and small plants. “The magnitude of scale economies is substantial and clearly a main factor in the decision-making process of meat packing firms” (RTI 2007, p 3-17).

Though, for some plants, use of AMAs reduced costs, in other plants their use was associated with higher costs and overall the cost impact was small. The study found general cattle market conditions were the primary determinants of gross margins and plant profitability. Slaughter volume next most important factor. Impacts of AMAs were mixed but on average a 1% increase in AMA purchase volume increased gross margin $0.31 and profit $0.49 per head. Through simulations, the study concluded use of AMAs had direct cost savings on about $1.22 per head, reduced costs due to reduced variability in cattle volumes of $1.70 per head and cost reductions due to increased slaughter volume of $3.56 per head. Thus, the total packing plant savings associated with AMAs was about $6.50 per head.

Supply Chain Coordination

The cattle producer – beef packer relationship has often been described as confrontational. It is debatable as to how prevalent these confrontational relationships are but they are not ubiquitous. Given their reliance on each other, an adversarial relationship between feeder and packer is not conducive to coordinating the supply chain, quickly resolving conflicts that might arise, or working together to solve problems. The importance of establishing strong buyer-supplier relationships (SBSR) relationships has been clearly established in the supply chain

literature (Board 2011; Kannan and Tan 2006). Recent literature has focused even further on advantages of multiple vertical layers of supply chain relationships, such as cow/calf-backgrounder-feeder-packer (e.g., Kataike et al. 2019). Established marketing agreements where both the supplier and buyer mutually benefit from the agreement creates strong business relationships that facilitate a collaborative approach. This directly improves several dimensions of the supply chain, which is further discussed in the next section addressing impacts of cattle purchasing methods on packers/customers.

When a catastrophic event occurs, such as the Holcomb plant fire in August of 2019, those with established relationships were able to more effectively work together to mitigate the negative impacts. Because of the strong and lasting business relationship both the feeder and the packer have an incentive to work together to adjust timing, scheduling, logistics, and other coordination issues to continue serving downstream customer needs.[5]

Vertical Supply Chain Relationships in other Industries

Relationships and agreements among vertical participants in supply chains have existed for a long time, but they have increased in overall importance over time. This study focuses on how the beef supply chain has rapidly adopted marketing agreements and formula pricing of fed cattle. This section provides a broader context by illustrating how marketing agreements are common among many other agricultural production sectors. We also identify reasons marketing agreements have become common in individual commodity markets. The overriding purpose is to demonstrate how trends experienced in the cattle and beef markets are not isolated and are mirrored in many other agricultural and food industries for similar reasons. While a much more extensive list of industry examples and industry-specific details could be provided, here we provide a concise summary. The following highlights five US agricultural industries illuminating trends documented throughout this report for cattle and beef markets are common in many agricultural commodities.

Malt Barley

A commonly cited vertical supply chain agreement in agricultural production is that of the malt barley industry. Barley variety (two-row and six-row) and quality varies and maltster contracts specify quality requirements. Maltsters enter into contracts with producers to secure desired production from specific regions often through acreage contracts. Many producers have produced barley for specific brewers for more than 30 years demonstrating the long-term nature of the relationship and associated loyalty of both parties to the contracts (Boland and Brester 2006). The contracts often use formula pricing with premiums based on Chicago Board of Trade Soft Red Winter Wheat futures prices (Adjemian et al. 2016) and some brewers do not participate at all in the open market for barley (Boland and Brester 2006). For barley growers, contracts provide market access, price premiums, quality incentives, and risk management opportunities. For maltsters, contracts provide malt barley volume, variety, and quality essential for their malt processing.

[5] These sentiments were shared with us in personal, confidential discussions with several industry participants.

Tobacco

A sizeable reduction in production and a major increase in contracting transformed the US tobacco industry. From 1996 to 2017 US tobacco production declined by 53% (USDA, NASS 1998; USDA NASS 2018) while the share of tobacco produced under marketing contracts grew from less than 1% to 90% (USDA, ERS 2018). The majority of the increase in contracting share took place over about a four-year period when one cigarette company, Phillip Morris, made public it intended to begin contracting tobacco following challenges in securing the desired quality of tobacco in the spot market. During this time period the US Federal Tobacco program and associated quota system was dissolved leading to reduced production and increasing consolidation among tobacco growers, making contracting more feasible and attractive to producers. The very rapid transition away from auction markets to contracts is summarized by Dimitri (2003, p 2):

> *"…prices or institutions might not have adapted in such a way to provide growers with incentives to increase the quality or alter the mix of quality they produced and marketed. As a result, tobacco manufacturers were probably not receiving the blend and quality they required to produce cigarettes and cigars."*

By offering higher prices for better quality tobacco under marketing contracts, tobacco companies provided growers price incentives to enter contracts. As such, tobacco producers quickly switched from using auction markets that generally paid similar prices regardless of quality, to marketing contracts offering greater premiums for quality attributes the producer could influence as well as larger discounts for off-quality (Dimitri 2003). Given the sizeable structural changes occurring in the US tobacco industry, net long-term impacts of contracting are a complex issue. However, stronger price incentives for higher quality tobacco production are apparent under modern contracts.

Peanuts

USDA indicates 72% of peanut production in 2019 (USDA, ERS 2021) was produced under a marketing contract (some would label the typical peanut contract a hybrid of marketing and production contracts). This was a significant increase relative to about 21% under contracts in 2001 (MacDonald et al. 2004). Peanut contracts were motivated by several things but perhaps most important was the elimination of historical marketing quota system long present in the industry. In a survey of producers in the 2004 ARMS, 62.5% indicated changes in the peanut program motivated them to use marketing contracts (MacDonald and Korb 2011). Contracts offer producers increased price certainty in a market with limited price information available as well as known market access (Dohlman and Livezey 2005).

Fruits

Just under 50% of fresh fruit in the US is contracted, with the vast majority of contracts being marketing contracts (USDA, ERS 2021). A survey conducted of California growers in 1999 found that 67% of fresh fruit contracts tied prices to downstream markets (Ligon 2001). Price risk is of utmost importance to fruit growers because fruit price volatility is relatively high, no futures market exists to offset the price risk, and perishability limits producer ability to alter sales

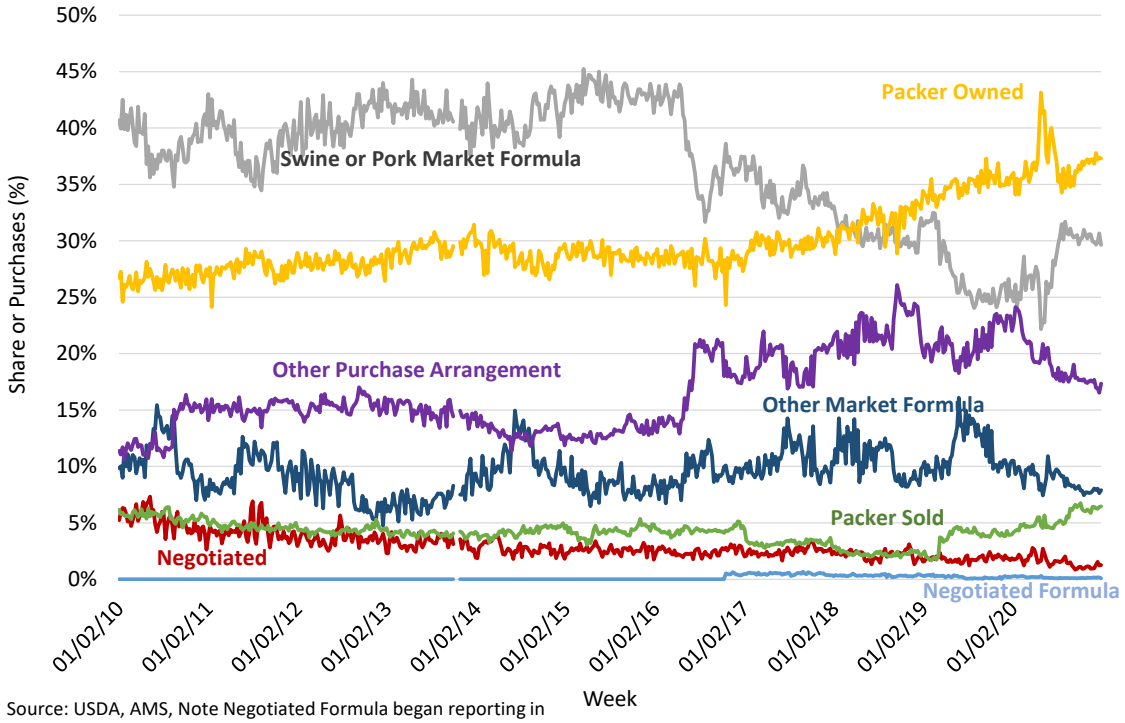
timing. Marketing contracts offer price risk management for producers. Better risk management enables the grower to invest in production practices and resources (e.g., labor, fertilizers, pesticides) that also enhances fruit quality. As such, the contracts result in higher quality produce as well as reduce price risk (Ligon 2001). Overall, supply chain management is a major reason handlers of fresh fruit desire to enter into contracts with growers. Perishability, challenges in transport and handling, and variation in quality all provide incentives for handlers to enter contracts with growers to better manage product sourcing.

Swine

The swine and pork industry shares many similar characteristics to the cattle and beef industry, so it is worth highlighting the role of various marketing arrangements used by hog producers with packers. The swine industry relies on more and different vertical coordination methods relative to the cattle industry. Figure 2.1 illustrates weekly shares of various barrow and gilt purchase methods over the 2010-2020 period based on LMR data.

A much larger share of barrows and gilts are packer-owned than cattle with roughly 35% of hogs slaughtered by the packers who own the hogs and roughly 5% of hogs are sold by a packer to another packer. The most common producer selling methods include Swine or Pork Market Formula which is around 30% of overall share (roughly 50% of producer sales if one excludes Packer Owned and Packer Sold). Swine or Pork Market Formula trade are hogs priced using a formula with the base price derived from negotiated hog and/or wholesale pork cutout values. The second most common producer selling method is the Other Purchase Arrangement which is any purchase that does not fit into one of the other four producer selling methods. Other Arrangement represents around 17% of recent overall slaughter (or roughly 28% of producer sold hogs). Cash negotiated only represents about 1% of total barrow or gilt slaughter (or 1.6% of producer sold hogs).

Figure 2.1. Livestock Mandatory Swine Purchase Methods, Weekly 2010-2020.



Source: USDA, AMS, Note Negotiated Formula began reporting in October 2016, prior to that it was included in other Formula categories

Motivations for hog producer and packer purchase methods being used were surveyed in the RTI (2007) study. The most common motives for producers to use alternative marketing arrangements for selling hogs were 1) reduces risk exposure (76%), 2) reduces hog selling price variability (44%), and 3) secures a buyer (39%). For pork packers the main motives for alternative purchase arrangements were 1) improving week-to-week supply management (62%), 2) secures higher quality market hogs (60%), and 3) allows market access (40%).

Summary

The purpose of this section was to illustrate how vertical supply arrangements between agricultural producers and handlers and packers have evolved over time and identify major motivations for observed changes in selected sectors. The trends toward increased use of market agreements and contracts across many agricultural commodities is striking. While some commodities have long had marketing agreements in place (e.g., malt barley and swine) others have seen dramatic increases in recent years (e.g., tobacco and peanuts). Motives (across producers and handlers/packers) are similar, though vary in relative importance across commodities. Common motives are apparent and generally include:

1. Improving supply chain management of often perishable products
2. Reducing price risk
3. Securing market access
4. Securing price premiums for product quality
5. Sending stronger price/value signals vertically in the supply chain

The implications of these motives are that marketing agreements may enhance producer ability to manage risk and often offer opportunity to capture higher net prices for output. Producers are thus incentivized to invest more inputs into producing higher quality output. Processors and handlers secure products to enhance supply chain management which results in reduced handling costs and higher quality end-products. Ultimately, consumers benefit by having higher quality, fresher, and lower-cost food products that better match their demands as a result of improved supply chain management associated with marketing agreements.

CHAPTER 3: IMPACT OF MARKETING AGREEMENTS ON BEEF QUALITY

Objective 3

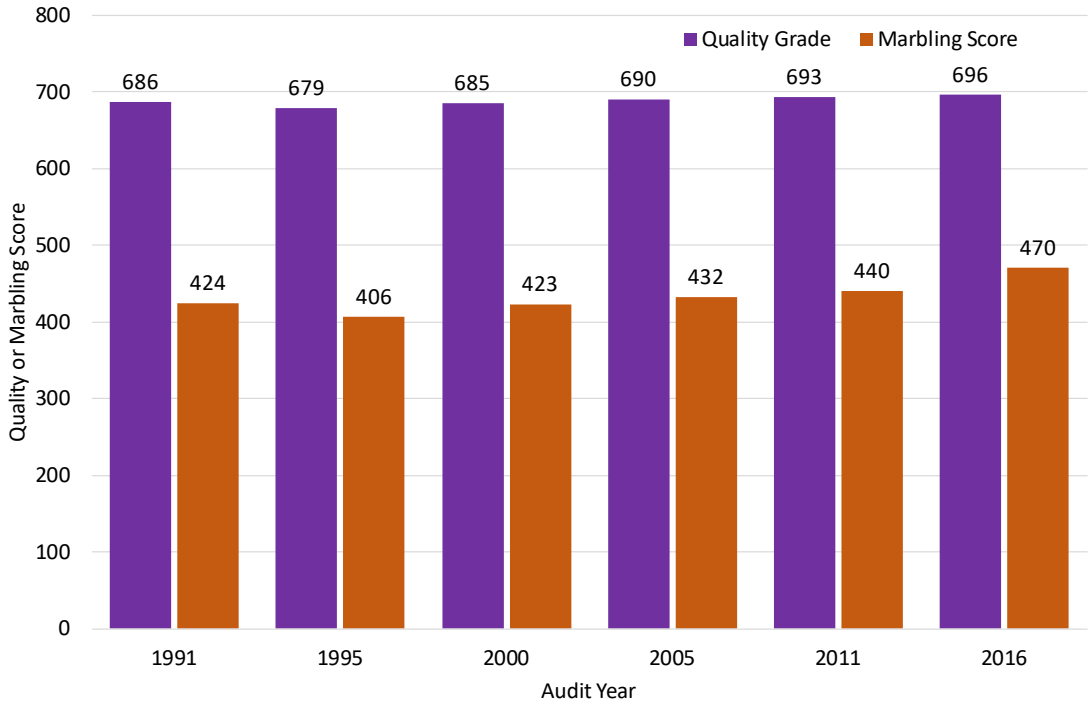
Determine whether evolving fed cattle marketing agreements and formula trade have contributed to improving cattle and beef quality and associated impacts on consumer products and consumer demand.

Improving Beef Quality

How changing fed steer and heifer quality has been associated with changing fed cattle market value signals can be observed through changes over time in beef quality. A couple of alternative sources for assessing changes in beef quality over time are the *National Beef Quality Audit* and USDA steer and heifer quality grading reports.

The *National Beef Quality Audit*, funded by the Beef Checkoff, has been conducted in five-year intervals by teams of academic meat scientists from several institutions. The first audit was completed in 1991 with subsequent audits conducted in 1995, 2000, 2005, 2011, and 2016. Included in the audits are sampling 10% of each lot from a day's production at major beef packing plants. For example, in the most recently completed 2016 audit, 30 plants were included in the quality audit representing 9,106 beef carcasses (Boykin et al. 2016). Figure 3.1 illustrates the average quality grade and marbling score from the quality audits. From 1991-1995 quality grade and marbling both declined, however, every audit since then has experienced increasing quality grade and associated marbling scores. From 1995 to 2016 average quality grade increased by 17 points (2.5%) and marbling score by 64 points (15.8%).

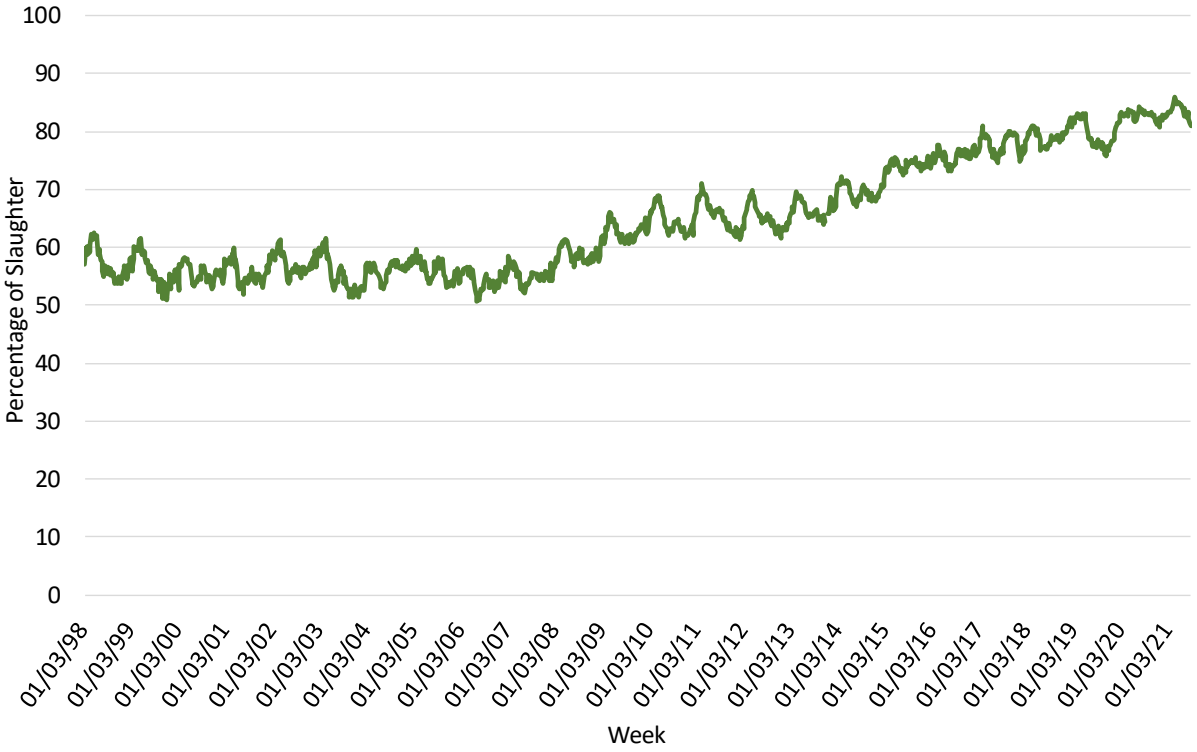
Figure 3.1. Beef Quality over Time, National Beef Quality Audits, 1991-2016.



Source: Boykin, et al., 2017. Quality Grade 100=Canner, 400=Commercial, 600=Select, 700=Choice, 800=Prime.
Marbling Score 100=Practically Devoid, 300=Slight, 400=Small, 500=Modest, 700=Slightly Abundant, 900=Abundant

Another way to measure how beef quality has changed over time is through review of USDA AMS quality grade data. USDA Market News publishes weekly in the NW_LS196 estimated grading percent report which contains the breakdown of steers and heifers offered for quality grading by grade category. Figure 3.2 illustrates the trend over time in percentage of steers and heifers grading Prime or Choice (the two highest grades) from 1998-June 2021. During the late 1990s to about 2007, the percentage of steers and heifers grading Choice or better remained at approximately 55%. Since 2007, this percentage has trended upward to greater than 80% in 2020-2021.

Figure 3.2. National Weekly Percentage of Steers and Heifers Grading Choice and Prime, 1998-June 2021.

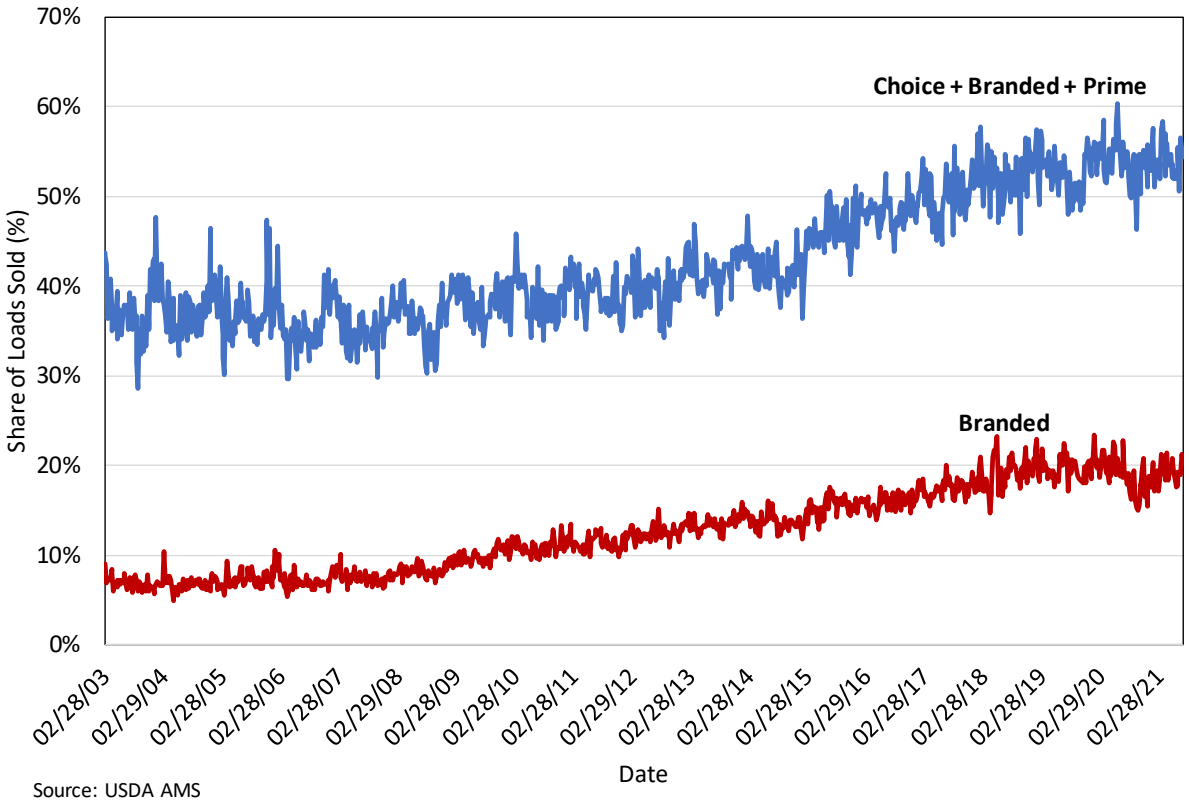


Source: Obtained from LMIC based on USDA Market News data.

USDA AMS (2021a) indicates around 80% of formula cattle purchases by packers include adjustments to the base price associated with quality and/or yield. The 5-market region net formula fed steer price averaged $1.75/cwt greater than the negotiated cash price, on a dressed basis, and for the 80% and greater Choice formula purchases $4.15/cwt greater than the negotiated cash price during 2015-2020. This clearly illustrates the premiums paid for cattle sold under formula marketing agreements are economically significant and provide incentives to improve cattle quality.

Further demonstration of increasing beef quality over time is apparent in wholesale boxed beef sales. Figure 3.3 illustrates sales of Choice and higher quality boxed beef (Choice + Branded + Prime) as well as just Branded boxed beef sales on a weekly basis starting in February 2003 when USDA AMS first started reporting Branded sales data separately. Choice and higher grade sales went from representing about 35% in the early 2000s to about 55% by 2017. Branded beef increased from about 7% to about 20% over the same time frame.

Figure 3.3. Shares of Choice and Higher Grade (Choice + Branded + Prime) and of Branded Boxed Beef Sales (Loads) , Weekly February 28, 2003 - July 31, 2021.



Source: USDA AMS

Incentivizing Cattle Quality Enhancement

Increasing quality of fed cattle over time is driven by economic signals. Generally, producing cattle with higher quality grade increases production costs. In the short run, fed cattle quality can be enhanced through feeding cattle for longer periods of time (May et al. 1992). However, cattle are less efficient as they gain additional weight when they are nearing finishing. As a result, incremental added weight for heavy cattle, is relatively expensive gain (Anderson and Trapp 1999).

Longer-run genetic selection at the cow-calf level can shift the cattle population toward having a greater propensity for higher quality grades. However, this takes several years to accomplish and requires expensive investment in genetics. Regardless of how fed cattle quality is enhanced over time, producers will be willing to incur the added costs only if they are paid more for enhanced quality of cattle they produce due to the increased cost.

Quality Signals through Formula and Grid Purchase Methods

Quality grade value signals to producers are incomplete, at best, when cattle are sold through live or dressed cash negotiated methods, which essentially set an average price for a group of cattle. This fact has been widely documented for a long time and was one of the major incentives motivating adoption of grid pricing of fed cattle (Schroeder et al. 1997; Schroeder and Graff 2000). Subjective cattle quality grade is difficult to accurately estimate on live cattle at the time when cash negotiated prices are discovered. Visual grading of live cattle is a poor predictor of carcass quality grade.

Quality Grade and Formula Pricing

RTI 2007 – Beef Quality

Cattle producers who market cattle using AMAs indicated they received a $15 to $17 per head premium for cattle relative to the cash market. A major motivation of some producers to form marketing agreements was to secure premiums for specific beef market programs. Likewise, packers indicated AMAs provided them ways to better meet specific customer demand for beef. Recall, from earlier discussion, 72% of packers indicated use of AMAs increased their flexibility in responding to consumer demand.

Using the October 2002 – March 2005 packer transaction data described in the Chapter 2, the RTI study determined the two dominant sources of fed cattle were direct cash trade (57%) and marketing agreements (29%) representing 86% of total volume. Auction barns and brokers; forward contracts; and packer-owned represented roughly 5% each. Direct trade cattle quality graded 60% Choice or higher and 63% of marketing agreement cattle graded Choice or higher. Direct trade had 7% yield grade 4 or worse and AMA had 6%. The transactions data also revealed marketing agreement cattle received a $0.57/cwt higher estimated value due to higher quality than direct trade.

Liu et al. Study

In a follow-up study to the RTI project, Liu et al. (2009) used transactions data collected from the 2007 RTI study to estimate the impact of AMAs (in this case forward contracts, marketing agreements, and packer fed cattle) on beef quality. Transaction data from 29 of the largest beef packing plants owned by 10 companies over the October 2002 through March 2005 period were analyzed. The data set contained about 572,000 observations (58 million cattle). During the study period, about 58% of the transactions were direct trade, 28% marketing agreements, 4% forward contracts and the rest were purchased through other minor trade methods. Tobit models were estimated to determine how AMAs affected yield and quality grades of the lots.

The highest quality grade cattle were those purchased from auction barns, however, this represented a very small portion of the transactions (the precise amount was not reported because of confidentiality, but it was likely about 3% of transactions based on the overall data set used as described in RTI 2007). Cattle purchased under AMAs realized slightly higher quality grades than direct trade cattle with about 2% more Prime or Choice.

Liu et al. constructed a quality index as the sum of the proportionally weighted-average market premiums or discounts for cattle quality. They regressed the quality index as a function of whether the lot was purchased using an AMA, season, and plant. Cattle purchased through marketing agreements had higher quality associated with $0.57/cwt greater value than direct trade. Cattle quality for marketing agreements was also less variable than direct trade.
The study concluded:

> *"…we found that the carcass weight basis valuation method with grid provided better price signals to fed cattle producers than the live-weight basis valuation method…tighter vertical coordination through use of AMAs and more precise price signaling through use of different cattle valuation methods help improve beef quality because these mechanisms facilitate information exchange enabling producers to respond better to consumer demand*" (Liu et al. 2009, p 161).

Our Beef Quality Model
We utilize a similar model to Liu et al. in this study to explore whether AMA use and fed cattle quality are correlated using more recent data. However, Liu et al. used proprietary transaction data in their analyses that we do not have access to in this study. The use of more detailed transaction type data in such a study is valuable because more specific local market conditions can be better controlled for differences in cattle quality, market structures, and pricing methods by using much more detailed data than what we use here.

To add further assessment to whether formula pricing is associated with improving fed cattle quality over time we developed a regression model similar to the one used in the RTI 2007 study only with important differences.

In the RTI study, and the later follow-up study published by Liu et al. (2009), the authors developed regression models to determine the relationships among AMAs and fed cattle quality. Using transactions data from 29 beef packing plants over the October 2002-March 2005 period, they found cattle purchased from auction barns were the highest quality and least consistent (though auction barn purchases represented a very small percentage of all purchases which could not be reported in the study due to confidentiality). Marketing Agreement cattle and packer owned cattle each had greater than 2% more cattle grade Choice or higher than negotiated cash market trade. The RTI study also estimated a model using aggregate purchase data collected by USDA under livestock mandatory price reporting using monthly observations over the April 2001 through December 2005 period. This was a short time series to attempt to find a relationship between AMAs and quality grade. They found a small impact of AMAs on quality grade with a 1% increase in formula procurement, increasing quality by only 0.009%.

We modify the RTI study modeling effort here and estimate a model explaining the percentage of cattle grading Choice and Prime. We use several of the same variables used in the RTI study and estimate the model using monthly data over the May 2001 – May 2020 time period. The model we estimate is:

$$QGIndex_t = \beta_0 + \beta_1\left(\frac{Steer_t}{Corn_t}\right) + \beta_2 COF_t + \beta_3 Formula\&Grid_t + \beta_4 Forward_t$$

$$+ \beta_5 PackerOwned_t + \beta_6 QTR1 + \beta_7 QTR2 + \beta_8 QTR3 + e_t$$

Where subscript *t* refers to month,

QGIndex is a value-weighted percentage of beef grading Prime plus Choice relative to all graded beef (calculated using USDA AMS data),

Steer/Corn is the steer to corn price ratio calculated as the number of bushels of corn equal in value to 100 pounds of steer and heifer live weight (source: USDA-NASS Agricultural Prices as reported by LMIC),

COF is the monthly US total cattle on feed (1,000 head) in 1,000+ capacity feedlots (source: USDA-NASS as reported by LMIC),

Formula&Grid is the percentage of cattle purchased by reporting packers that is categorized as formula trade *plus* negotiated grid (source: USDA-AMS as reported by LMIC),

Forward is the percentage of cattle purchased by reporting packers that is categorized as forward contracts trade (source: USDA-AMS as reported by LMIC),

PackerOwned is the percentage of cattle purchased by reporting packers that is categorized as packer-owned trade (source: USDA-AMS as reported in DataMart),

QTR1, QRT2, and *QTR3* are quarterly dummy variables for each respective quarter (*QTR4* is the default),

and *e* is a random error term.

The quality grade index used here is a value-weighted index of the highest quality cattle calculated as:

$$QGIndex_t = \frac{[(Prime\ Weight \times Premium\ of\ Prime\ Dressed\ Steer) + Choice\ Weight]}{[Prime\ Weight + Choice\ Weight + Select\ Weight + Other\ Weight]} \times 100$$

Where the weights used in the above equation are the total carcass weights of beef assigned each respective quality grade and the *Premium of Prime Dressed Steer* is the average USDA AMS Choice Dressed Steer price over the time period of $166.68/cwt plus the average premium paid for Prime grade of $9.20/cwt divided by the Choice Dressed Steer price ((166.68+9.20)/166.68). Essentially, the quality grade index weights Prime higher than Choice since it receives a premium relative to Choice and is generally more costly to produce.

The steer-to-corn price ratio is included in the model as an indicator of net returns in cattle feeding. When net returns are greater, we expect producers may be enticed to keep cattle on feed longer (since the fed price is higher relative to the feed price) leading to an increase in the quality grade index. The number of cattle on feed is included to capture potential changes in quality as the cattle numbers on feed vary. If large cattle on feed numbers encourage feeders to sell cattle sooner to make more room in the feedlot, COF would be expected to have a negative sign.

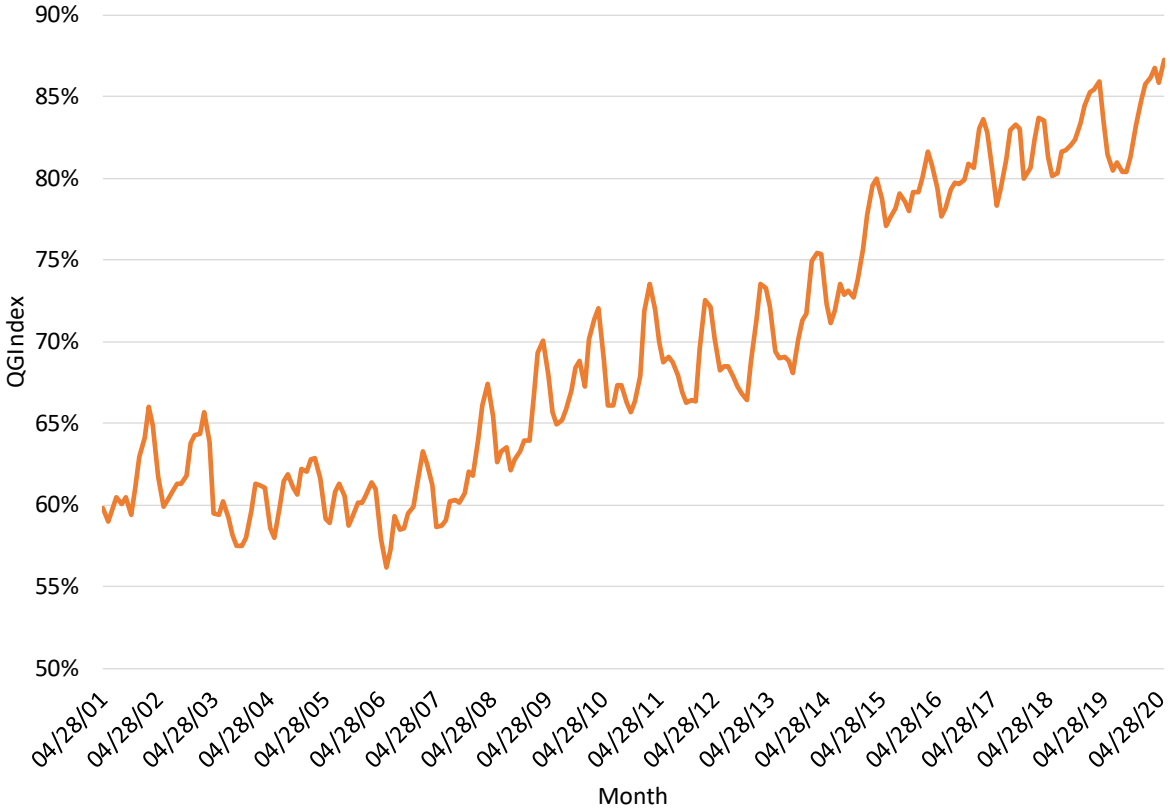
The formula and grid pricing purchase percentage was a key variable of interest. If formula and grid cattle tend to be of higher quality than negotiated direct trade cattle, then this parameter estimate would be positive. If they were of lower quality grade then it would be negative. Similar interpretation would hold for forward contract purchases and for packer-owned fed cattle. Finally, seasonality was allowed for through quarterly dummy variables as higher quality grades are easier to realize in mild weather.

Summary statistics of the data used in the regression are reported in Table 3.1. The average QGIndex was 71 with a range from 56 to 87. A graph of the QGIndex is presented in Figure 3.4 The combined formula plus grid purchased cattle averaged 53% with a range from 34% to 69%.

Table 3.1. Summary Statistics of Monthly Data Used in the Regression Model Explaining the Quality Grade Index, May 2001-May 2020.

Variable	Mean	Std. Dev.	Minimum	Maximum
QGIndex (%)	71.08	8.51	56.20	87.20
Steer/Corn	31.12	9.39	15.50	54.90
COF (1,000 head)	1890.42	276.82	1391.00	2788.00
Formula&Grid (%)	53.05	10.19	34.36	69.39
Forward (%)	10.11	3.70	2.53	22.41
PackerOwned (%)	4.57	1.75	1.07	9.54

Figure 3.4 Quality Grade Index (QGIndex), Monthly May 2000 - May 2020.



The model was estimated adjusting for first-order autoregressive errors. The model was also tested for generalized heteroskedasticty but it was not statistically significant. Regression estimates are reported in Table 3.2. The overall R-squared is 0.86 and most of the parameter estimates are different from zero at the 0.05 significance level. All parameter estimates for which we had sign expectations, had the anticipated signs, though COF was not statistically different from zero.

Table 3.2. Regression Results Explaining QGIndex, Monthly May 2001 - May 2020.

Variable	Parameter	Std. Error	P-value
Intercept	35.043	3.158	<0.0001
Steer/Corn	0.145	0.026	<0.0001
COF	-0.00052	0.0009	0.58
Formula&Grid	0.621	0.031	<0.0001
Forward	0.345	0.078	<0.0001
PackerOwned	-0.968	0.167	<0.0001
QTR1	3.202	0.686	<0.0001
QTR2	-1.431	0.711	0.05
QTR3	0.134	0.727	0.85
Lagged Error	0.66	0.056	<0.0001
R-Squared	0.86		
RMSE	3.21		
Observations	184		

Of most interest for this study are how AMAs are related to improving fed cattle quality grade over time. As formula and grid cattle increase by one percentage point, the quality index increases by 0.62 percentage points. Another way to interpret this is that increasing formula and grid cattle from 40% to 50% of fed cattle purchases, is associated with increasing the percentage of cattle grading Choice from 60% to 66.2% assuming no change in percent grading Prime. We do not know that this is a causal relationship (i.e., that formula and grid cattle purchased cause the increase in quality grade). However, we know that most (80%) formula (USDA, AMS 2021a) and all grid cattle are purchased with quality grade premium/discount incentives. Thus, it is logical that at least some of this relationship is causal.

Forward contract cattle also are associated with increased cattle quality grade, but the impact overall is much smaller than for formula and grid cattle. First, forward contracting is less common than formula representing on average about 10% compared to formula and grid of 53%. Second, forward contracting has a coefficient impact roughly half the size of formula and grid purchases. So, with only one-fifth of the volume and about half the incremental magnitude of impact, forward contracting has a relatively small impact on changing quality grade over time.

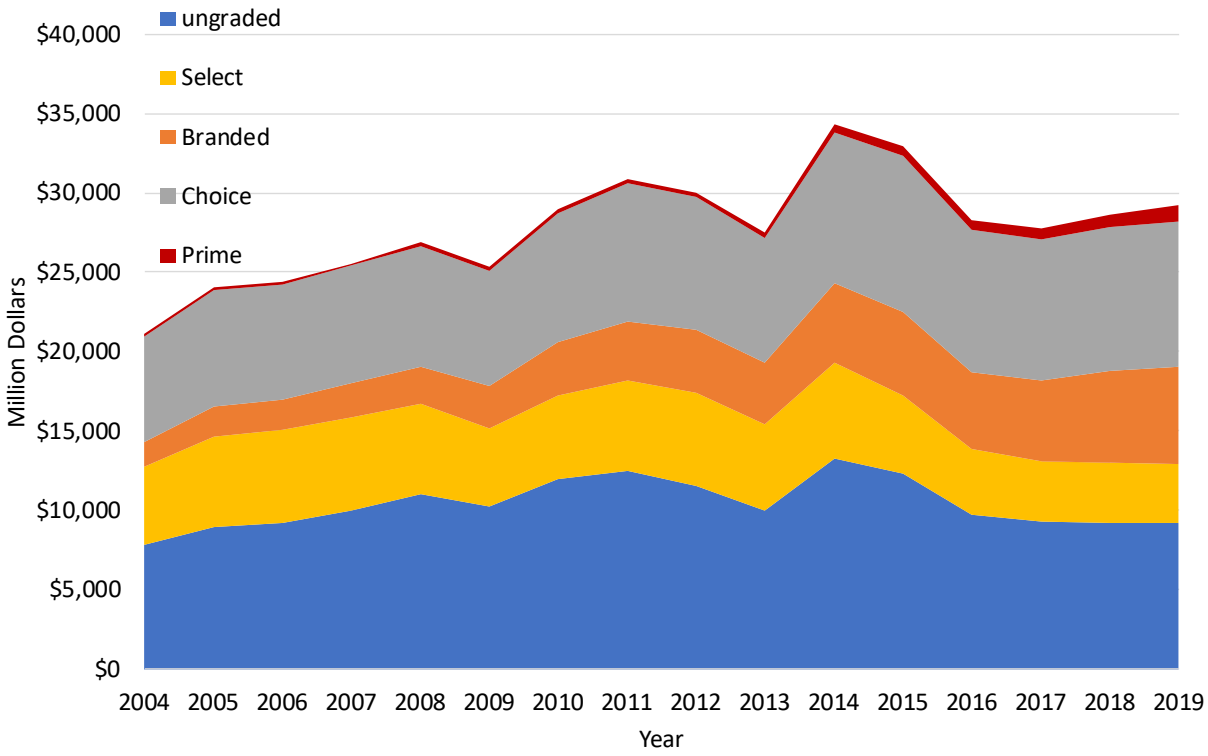
Packer-owned cattle, which have declined over time from just under 10% in the early 2000s to less than 3% in recent years, has a negative coefficient suggesting when packer-owned cattle purchases increase, quality grade declines. One possible explanation of this is that packer-owned cattle often have been used to fill seasonal plant volume needs and as such have been used more for plant utilization than for targeting high quality products.

Value of Enhanced Beef Quality

The previous sections illustrated how fed cattle and beef quality have improved over time as well as the relationship between quality enhancements and increased use of AMAs. This section illustrates how the combination of quality enhancements and associated price premiums associated with higher quality beef have translated into greater industry beef value.

Figure 3.5 illustrates the total inflation-adjusted total value of boxed beef sales by quality grade based on data compiled by USDA AMS in the Comprehensive Boxed Beef Cutout of all fed steer and heifer sales over the 2004-2019 period. Key points from this chart include: 1) the real value of beef sales including all quality grades increased by about $8 billion or 38%, 2) value growth was especially apparent in Prime (+613%), Branded (+301%), Choice (+37%), and Ungraded (+18%) sales, and 3) Select value declined by 25%. Clearly, higher quality grade beef has translated into considerably greater industry value, especially for the highest quality Prime and Branded beef products.

Figure 3.5. Total Real (2019=100) Value of Boxed Beef Sales by Quality Grade, Annual 2004-2019.

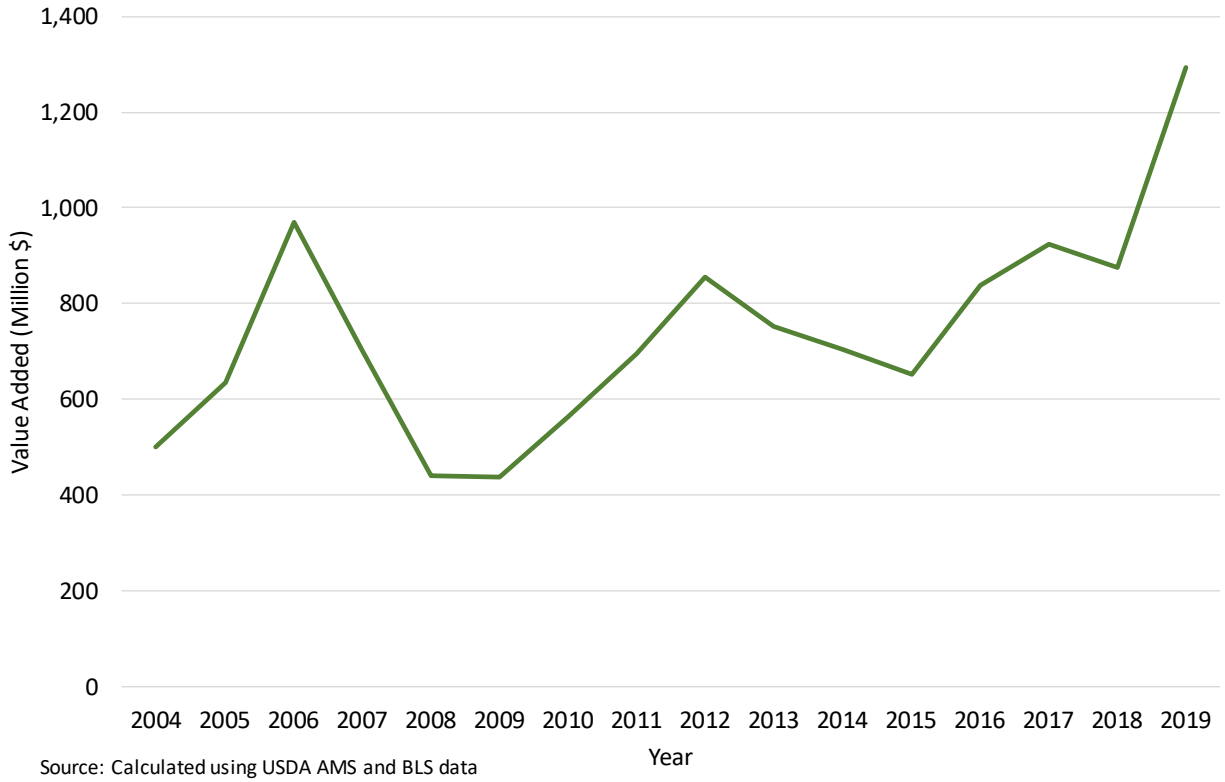


Source: Calculated using USDA AMS and BLS data

Further insights regarding beef value over time can be discerned from Figures 3.6-3.8. Figure 3.6 was constructed as follows: The inflation-adjusted premiums for Prime, Branded, and Choice boxed beef cutout values relative to Select were multiplied by the volumes of each of these respective quality grade categories. These values were then summed together to obtain a

gross real value added relative to Select. Of most interest here were long-term trends. If this gross value added increased, it implies higher quality grades are resulting in greater industry gross beef value. In contrast, reductions in the gross value added would suggest declining overall revenue. In 2004, the gross value added of the three highest quality grade categories was approximately $500 million. This means the premiums associated with Prime, Branded, and Choice beef sales created a gross value of $500 million added relative to if these products all graded Select. Since 2009 this gross value added has trended upward to where in 2019 the gross value added had more than doubled 2009 levels attaining almost $1.2 billion.

Figure 3.6. Gross Real (2019=100) Dollars Added by Prime, Branded, and Choice Graded Boxed Beef Relative to Select, Annual 2004-2019.

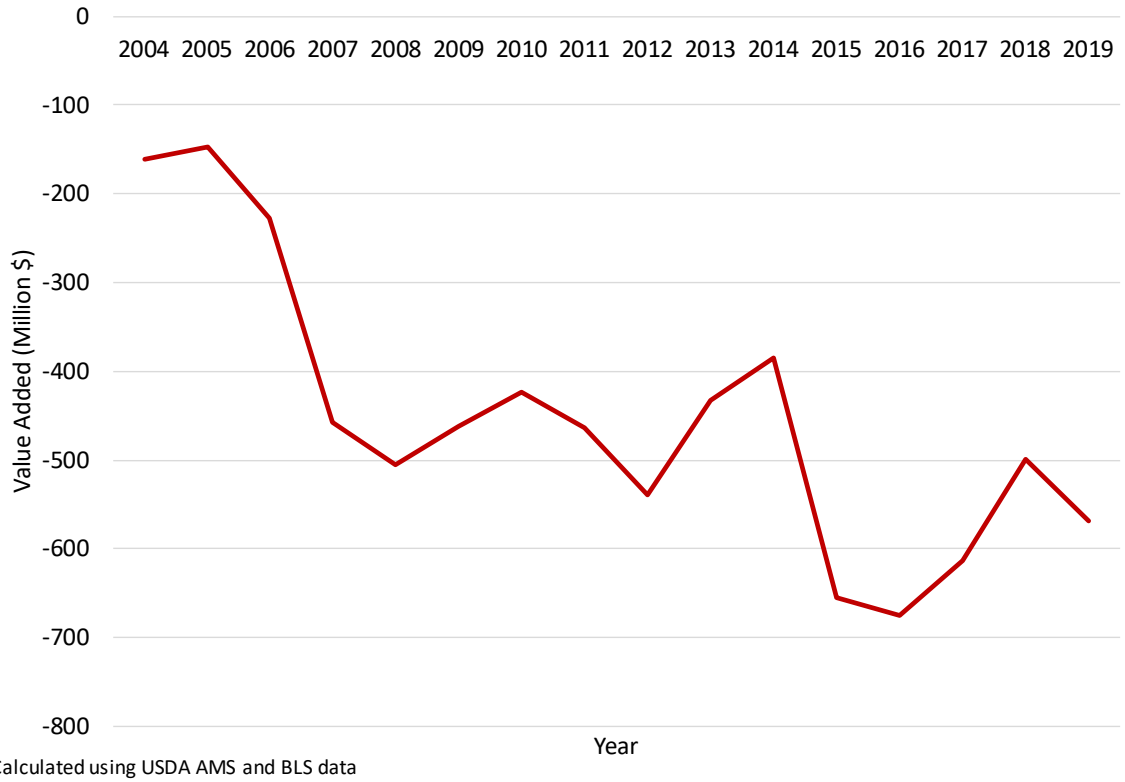


Source: Calculated using USDA AMS and BLS data

Important to realize in assessment of added value associated with greater quality beef is to also account for changes in value associated with lower quality beef to determine the overall impact on the industry of beef products shifting across quality grades. Every beef carcass has beef that is trimmed or ground and as such goes into products that are blended across carcass of varying grades and end up ungraded when sold. On average, historically from about 38% to 43% of boxed beef sales from fed steers and heifers has been sold as ungraded product. Ungraded products bring discounts relative to Select grade (and all other higher grades). Figure 3.7 illustrates the gross value added (discount times volume) of ungraded boxed beef relative to Select. This chart shows the lower gross value of ungraded product sales compared to if they would have graded Select (but of course realize many of these products would simply not even

be graded because of blending). The decline in gross value going from about $150 million lower value of ungraded product relative to Select in 2004 to $650 by 2016 is caused largely by a widening discount for ungraded product. However, in recent years (since about 2017 or 2018) the percentage of all boxed beef sales being sold as ungraded has declined to less than 35% of all boxed beef perhaps reflecting value opportunities for packers to maintain quality grades on more trim or ground products (ungraded boxed beef product discounts have gotten larger over time going from less than $4/cwt in the early 2000s to more than $10/cwt (in inflation adjusted terms) since 2015).

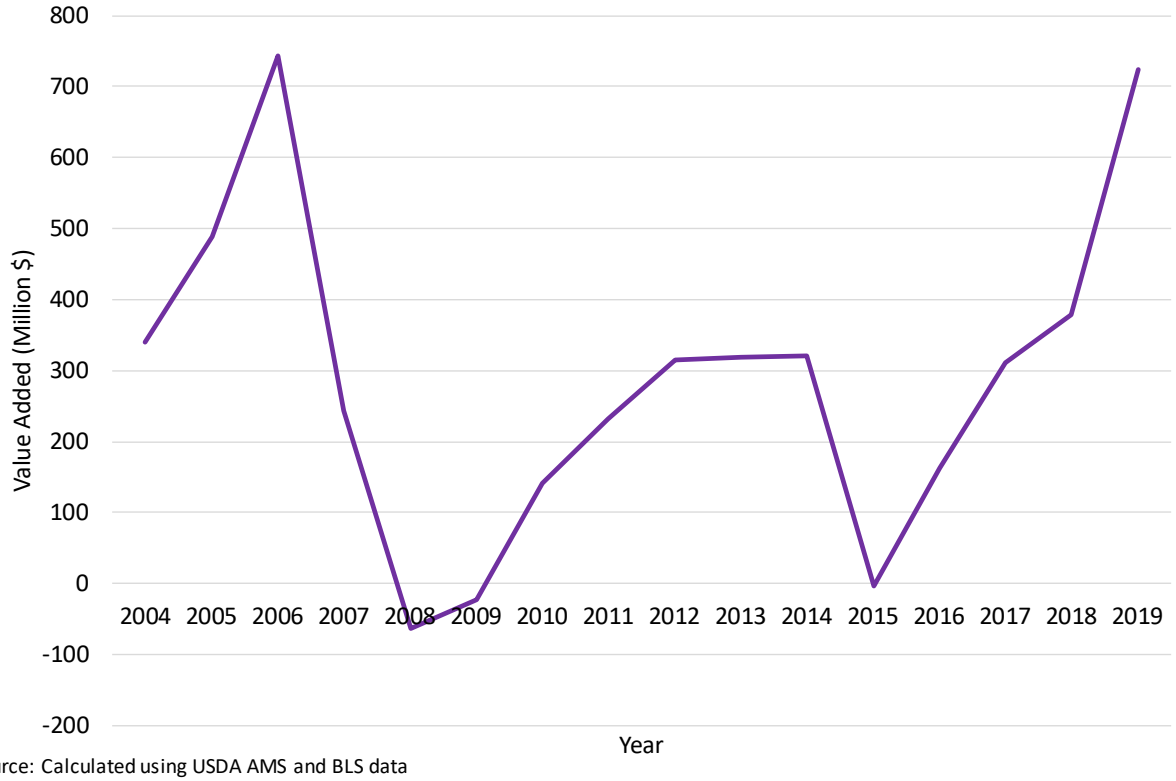
Figure 3.7. Gross Real (2019=100)Dollars Added by Ungraded Boxed Beef Relative to Select, Annual 2004-2019.



Source: Calculated using USDA AMS and BLS data

The combination of Figures 3.6 and 3.7 (adding the two values together) in Figure 3.8 provides a net measure of the impact of changing premiums/discounts as well as changing volumes of beef quality. The main takeaway is the net of value added from higher quality and from lower quality boxed beef sales relative to Select grade has bounced around since 2004. This does not at all negate the value that has been created by higher quality beef over time (that is clear in Figure 3.6). On the contrary, without the gain in value associated with higher quality the net value would be much smaller and negative most of the time.

Figure 3.8. Net Gross Real (2019=100) Dollars Added by Prime, Branded, Choice, and Ungraded Boxed Beef Relative to Select, Annual 2004-2019.



Source: Calculated using USDA AMS and BLS data

Changing Customer and Consumer Demand

This section has documented the increase in value creation for the beef sector due to increased production of high-quality and branded beef. This value creation exists only if there is sufficient demand for such beef. That is, because customers and consumers will only pay the associated premiums, relative to Select or Ungraded beef, if they value the attributes of enhanced beef more than those premiums. A comprehensive demand analysis of high-quality beef is beyond the scope of this study. However, the data used in this section reveal some unambiguous and relevant demand insights.

The law of demand states that, all else equal, consumers buy more (less) of a good when price decreases (increases). If that relationship does not hold, then a fundamental shift in demand, or the way consumers view a product, has occurred. For example, if price increases and consumers buy more of a good then we know their demand for that good has increased and they would buy more of it, at any given price, than before. In the context of high-quality boxed beef, the premium relative to Select is the "price" customers pay to have Prime, Choice, or Branded beef. The number of loads of each category is the quantity purchased. A year-over-year change where premiums increase *and* customers buy more high-quality beef, is an unambiguous increase in demand. Table 3.3 summarizes these changes over the past several years.

Table 3.3 Year-Over-Year Changes in Load Shares and Premiums for High-Quality Boxed Beef.

Year	Prime		Branded		Choice		Ungraded	
	Premium	Load Share	Premium	Load Share	Premium	Load Share	Premium	Load Share
2005	Dec	Dec	Dec	Dec	Inc	Dec	Inc	Dec
2006	Inc	Dec	Inc	Dec	Inc	Dec	Dec	Dec
2007	Inc	Dec	Dec	Inc	Dec	Dec	Dec	Dec
2008	Dec	Inc	Dec	Inc	Dec	Dec	Dec	Dec
2009	Dec	Inc	Dec	Inc	Dec	Inc	Inc	Dec
2010	Inc	Inc	Inc	Inc	Inc	Dec	Inc	Dec
2011	Inc	Inc	Inc	Inc	Inc	Inc	Dec	Dec
2012	Inc	Dec	Inc	Dec	Inc	Dec	Dec	Dec
2013	Dec	Dec	Dec	Dec	Dec	Dec	Inc	Dec
2014	Inc	Inc	Dec	Inc	Dec	Dec	Inc	Dec
2015	Dec	Inc	Dec	Inc	Dec	Inc	Dec	Dec
2016	Inc	Inc	Inc	Inc	Inc	Inc	Dec	Dec
2017	Inc	Inc	Inc	Inc	Inc	Inc	Inc	Dec
2018	Dec	Inc	Dec	Inc	Dec	Dec	Inc	Dec
2019	Inc	Inc	Inc	Inc	Inc	Dec	Dec	Dec

Note: Load Share is said to have Increased only if the portion of loads for a given category increased and portion of loads of Select beef decreased year over year. Years of obvious demand increases are highlighted in green.

The table illustrates several important trends. The relative share of Ungraded beef has declined each year since 2005 and there have been no years of obvious demand growth for Ungraded beef. On the other hand, Prime, Branded, and Choice have seen multiple years of obvious demand growth. In fact, demand for Prime beef increases in at least six of the last fifteen years. Branded and Choice saw at least five and three years of demand increases, respectively. This analysis demonstrates the increasing demand for enhanced beef. This is a very conservative method of identifying the minimum years of demand growth.

The relationships between AMAs and beef quality, combined with the trends of customers demanding higher quality beef, underline the importance of AMAs to the beef industry. AMAs provide the proper incentives and structures to deliver the type of beef customers desire.

CHAPTER 4: SUPPLY CHAIN COORDINATION DRIVERS

Objective 4

Synthesize evolving changes in domestic and global markets that are influencing the cattle and beef industry supply chain structure and evolving coordinating mechanisms. This objective will focus on why market coordinating mechanisms have evolved as they have and where they are headed in the future with emphasis on how the coordinating mechanisms are being influenced by associated market forces. Special attention will be given to how coordinating mechanisms may introduce or mitigate risk of beef supply chain disruptions.

Motivations for Alternative Marketing Arrangements

Directly measuring how and why the beef supply chain has evolved over time to increase vertical coordination is a multi-faceted and challenging endeavor. There are numerous dimensions to this topic and many of these are based on patterns observed in evolving market conditions, societal food preferences, consumer demands, information, and technology.

Societal Food Preferences

Publications Index

One way to measure evolving societal changes is to conduct counts of specific keywords appearing in published sources. The concept of publication counts affecting consumer preferences is often credited to work by Brown and Schrader (1990). They demonstrated that counts of published articles supporting a link between cholesterol and heart disease minus those questioning the link influenced consumer demand for shell eggs. Publication counts and associated consumer meat product demand changes has been demonstrated in numerous studies since that time (e.g., Burton and Young 2010; Piggott and Marsh 2004; Tonsor, Mintert, and Schroeder 2010).

Here, we use publication counts to demonstrate prevalence over time in certain key words as evidence of changing societal awareness and preferences. We use the ProQuest electronic database to search for the number of publications over time using specific keyword phrases. ProQuest is a search engine cataloging content on 90,000 sources of various publications. For the count conducted here, we selected English language only publications selecting all “Source Types” listed in Table 4.1 and specific “Document Types” listed in Table 4.2. The goal was to get a wide spectrum of publication sources and documents that provide a comprehensive measure over time of popularity or density of the selected terms across a broad set of media.

Table 4.1. List of "Source Types" Selected to Form Beef Descriptor Keyword Publication Counts in ProQuest Database.

1	Audio & Video Works	11	Newspapers
2	Blogs, Podcasts, & Websites	12	Other Sources
3	Books	13	Pamphlets & Ephemeral Works
4	Conference Papers & Proceedings	14	Reports
5	Dissertations & Theses	15	Scholarly Journals
6	Encyclopedias & Reference Works	16	Speeches & Presentations
7	Government & Official Publications	17	Standards & Practice Guidelines
8	Historical Newspapers	18	Trade Journals
9	Historical Periodicals	19	Wire Feeds
10	Magazines	20	Working Papers

Table 4.2. List of "Document Types" Selected to Form Beef Descriptor Keyword Publication Counts in ProQuest Database.

1	Advertisement	19	Dissertation/Thesis	37	Pamphlet
2	Annual Report	20	Editorial	38	Panel Discussion
3	Archival/News Footage	21	Essay	39	Patent
4	Article	22	Evidenced Based Health Care	40	Recipe
5	Blog	23	Feature	41	Reference Document
6	Book	24	Front Page/Cover Story	42	Report
7	Book Chapter	25	Fund/Grant/Fellowship/Award	43	Review
8	Business Case	26	General Information	44	Speech/Lecture
9	Business Plan	27	Government & Official Document	45	Standard
10	Case Study	28	Illustration	46	Statistics/Data Report
11	Catalog	29	Image/Photograph	47	Technical Report
12	Commentary	30	Industry Report	48	Template/Form
13	Company Profile	31	Interview	49	Trademark
14	Conference	32	Letter to the Editor	50	Transcript
15	Conference Paper	33	Literature Review	51	Website/Webcast
16	Conference Proceeding	34	Market Report	52	Working Paper/Preprint
17	Correspondence	35	Market Research		
18	Country Report	36	News		

We searched the ProQuest references containing any of the nine selected keyword phrases listed in Table 4.3. The selected keyword search phrases were not intended to be a comprehensive list of all potential beef descriptors. The selected keywords represent a set of phrases often used to describe production protocol claims on beef products. The production protocol claims in Table 4.3 are attributes that cannot be discerned by looking at, or even consuming, the beef from the animal. These are all what are referred to as credence attributes. Beef containing these production claims would need to be verified through some type of

vertical assurance from the cattle producer to the packer/processor. That is, these production claims all require formal vertical coordination in some fashion between the cattle producer and the beef packer. Common ways to translate this information from the producer to the packer is through certification procedures, audits, and other verification methods. Furthermore, cattle produced under such protocols would likely be either contracted in some fashion with the packer to ensure a market premium or owned by the producer through processing. All of these production claims fit well under marketing agreements between producers and packers and do not generally fit with cash negotiated commodity marketing methods.

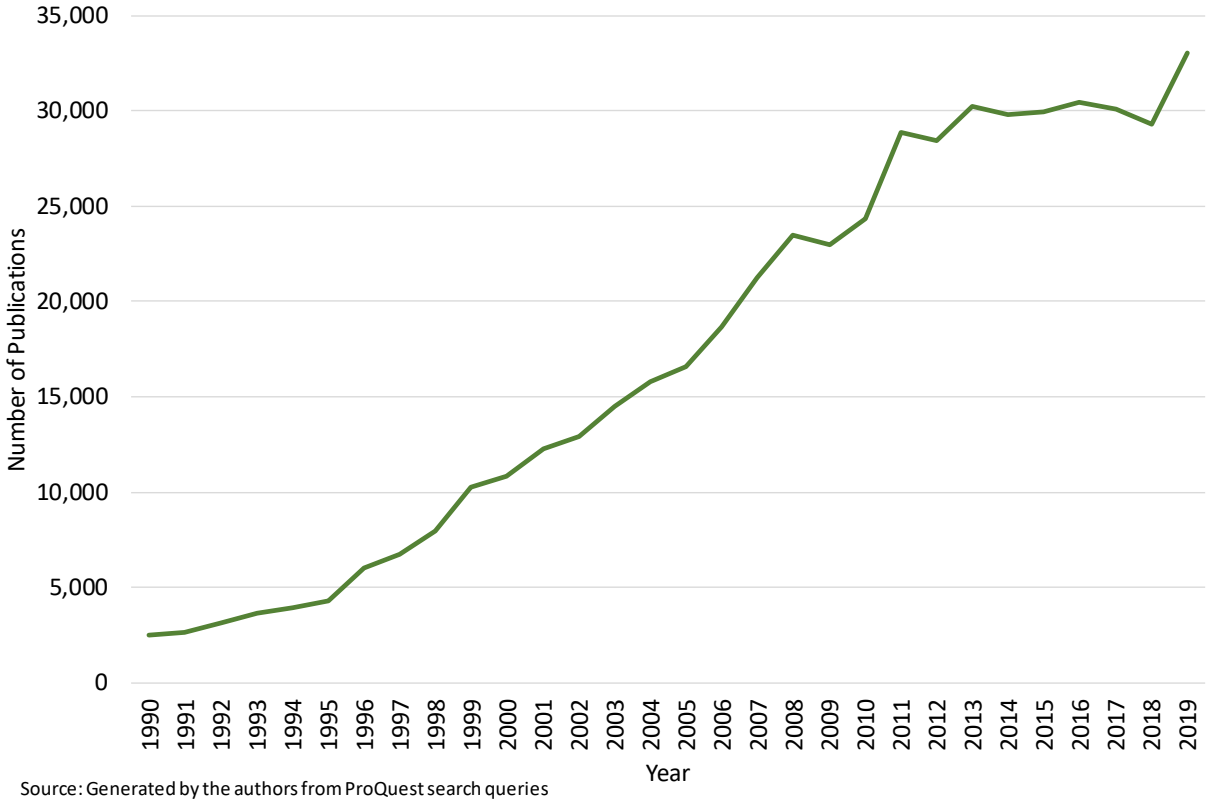
Table 4.3. List of Beef Descriptor Keyword Phrases Used to Construct Publication Counts in ProQuest Database.

1	Antibiotic Free Beef	6	Naturally Raised Cattle
2	Cattle Animal Welfare	7	Non-GMO Beef
3	Grass Fed Beef	8	Organic Beef
4	Hormone Free Beef	9	Sustainable Beef
5	Naturally Raised Beef		

The publication counts for the selected beef descriptor keyword phrases over the 1990-2019 period are presented in Figure 4.1. Several important points are noteworthy in the publication counts. There was a steady upward trend in the counts through the 1990s to 2011. In 1990, the publication count totaled just over 2,500, in 2012 the count increased more than ten-fold to just under 29,000. During the 2013-2018 period, the count held relatively stable at about 30,000 each year and it grew to just over 33,000 in 2019.[6] What this clearly shows is societal interest and associated publications referencing beef production claims has skyrocketed over the past three decades. Driven by consumer demand to know more about food, the food manufacturing industry has evolved to meet specific customer and consumer preferences. Meeting demand for these types of production protocols is greatly facilitated by contracts and agreements between producers and packer/processors.

[6] Over time, the number of sources ProQuest captures information from changes as new sources become relevant or old sources disappear. We did not attempt to calculate how the number of reference sources changed over time or adjust the number of references for the number of sources because we wanted to count the overall number of exposures consumers were getting and not the number adjusted for the number of sources publishing information.

Figure 4.1. Number of References Containing Specific Beef Production Descriptors by Year in ProQuest Electronc Database Publications, 1990-2019.



Source: Generated by the authors from ProQuest search queries

Power of Meat Evidence

Another source of information that demonstrates strength of consumer demand for credence attributes in beef are the *Power of Meat* studies conducted annually by the Food Industry Association and the Foundation for Meat Poultry Research and Education (a foundation of the North American Meat Institute). The *2012 Power of Meat Report* conducted a survey of 1,425 US consumers that included a question on how much influence meat package labels influence their purchases. Results from the study are summarized in Table 4.4.

Notable is that more than half of respondents indicated steroid free, hormone free, natural, and Angus beef have at least some influence on their meat purchase decisions. Further, more than 40% indicate grain fed, grass fed, free range, animal welfare ratings, cage free, and organic labels influence meat purchase decisions. All these product traits are credence attributes that necessarily include some type of certification or assurance between the producer and the packer/processor to assure these production protocols are being followed. This is another motivation to enter into vertical marketing agreements between the farmer and the packer to facilitate the supply chain coordination to assure these protocols.

Table 4.4. Percentage of Consumers Indicating How Much Meat Label Callouts Influence Purchase Decisions.

Product Label Attribute	Total No/Not Too Much Influence	Total Somewhat and Major Influence
USDA Beef Grading (Choice/Select/Prime)	33%	67%
Steroid free	41%	59%
Hormone free	44%	56%
Natural	46%	54%
Angus beef	46%	54%
Grain fed	51%	49%
Grass fed	52%	48%
Free range	55%	45%
Animal welfare ratings	55%	45%
Cage Free	55%	45%
Organic	59%	41%
Gluten free	68%	32%

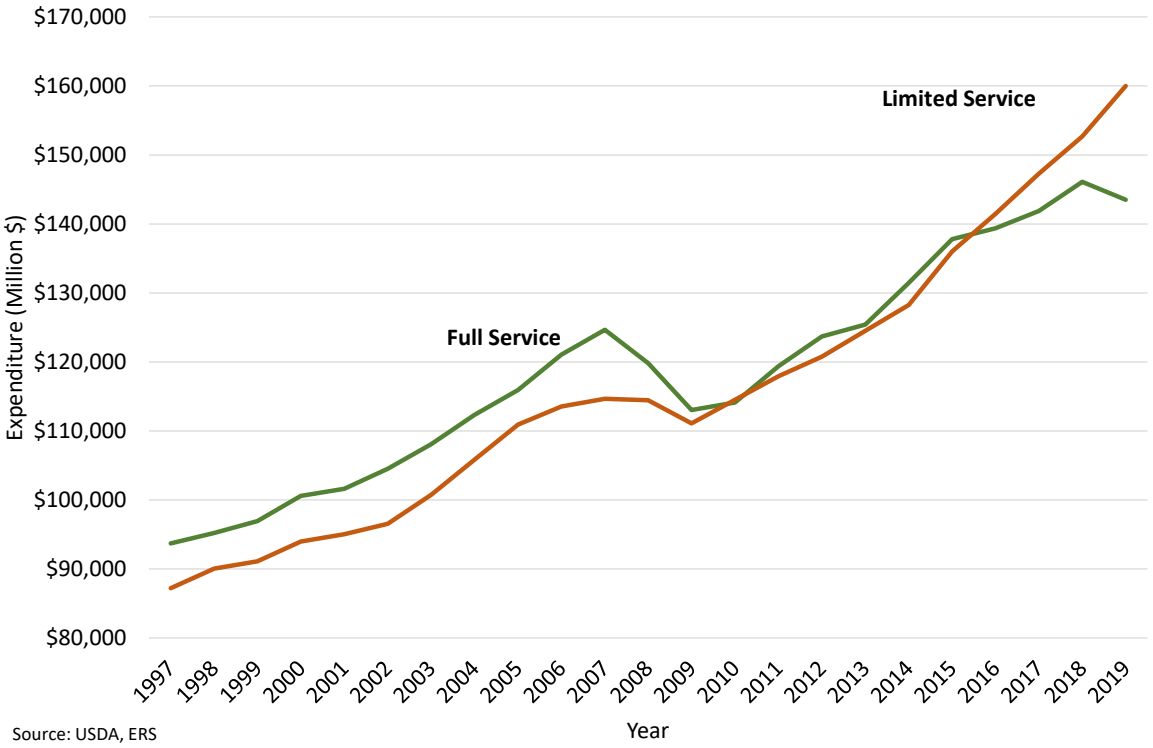
Source: 2012 *Power of Meat Report*

Food-Away-from-Home Expenditures

Apart from the departure in consumer behavior directly related to Covid-19 (Tonsor and Lusk 2020), over time US consumers have shifted more food expenditures toward food consumed at restaurants and food service establishments relative to at-home consumption. Figure 4.2 illustrates this pattern over the 1997-2019 period. Over this time frame, food expenditures away-from-home increased by almost 60% whereas food expenditures for food at home increased 38%. We report a more detailed expenditure breakdown across just full-service and limited-service restaurants (Figure 4.3). Both of these have seen similar growth rates to overall away-from-home consumption with limited-service growing at a slightly higher rate. Full-service eating establishments likely sell a greater proportion of higher quality beef cuts whereas limited-service establishments likely utilize more ground beef.

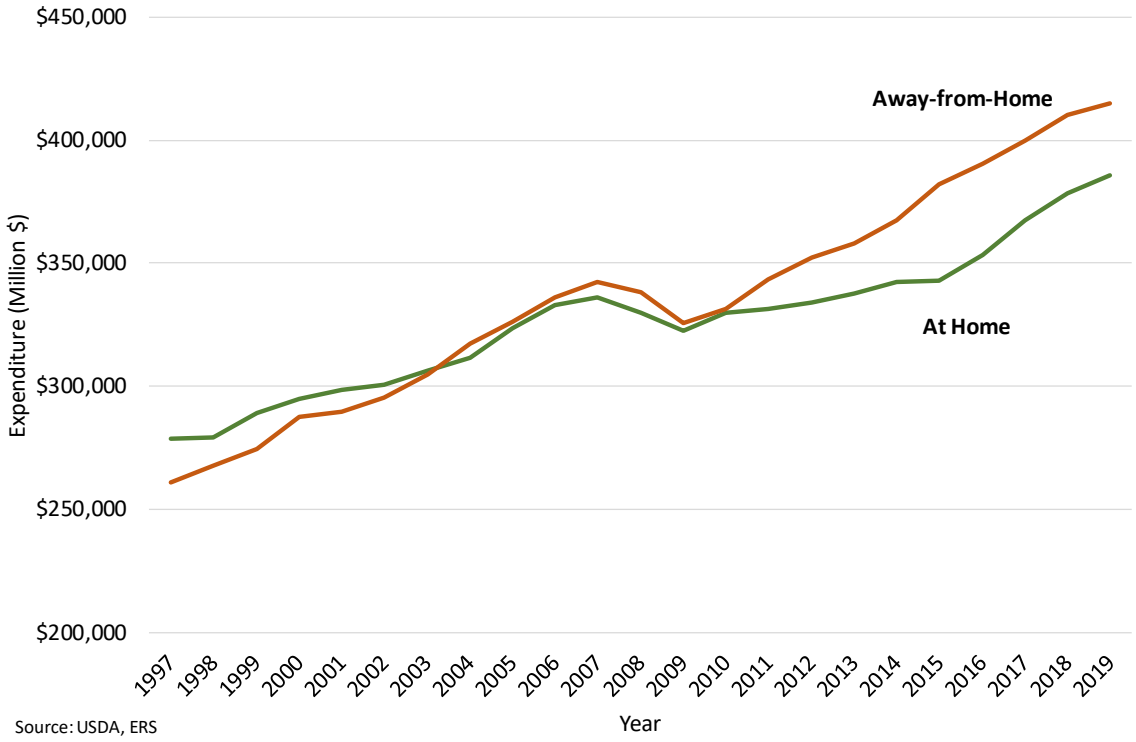
The relevance of the marked shift toward more expenditures on food-away-from-home is food service establishments have stricter product specification requirements than typical retail settings. Restaurants also need consistent supply of specific products so menu items are available to consumers. As such, suppliers to food service have considerable vertical supply chain coordination and product specifications that must be adhered to. Increased food service demand necessitates beef packers to increase control over types of cattle purchased to supply specific meat products demanded by food service. Having tighter specifications on beef products encourages packers to form agreements with producers to supply cattle that more consistently meet product specifications. As such, stronger food service demand, increases packer incentives to enter into trusted agreements for fed cattle purchases with producers.

Figure 4.2. Constant Dollar (1988=100) Annual US Consumer Food Expenditures Full Service and Limited Service Restaurants, 1997-2019.



Source: USDA, ERS

Figure 4.3. Constant Dollar (1988=100) Annual US Consumer Food Expenditures At Home and Away-from-Home, 1997-2019.



Source: USDA, ERS

Beef Trade Implications

International trade in beef products has become a major factor driving industry prosperity. For example, beef product exports add $37.25 per head of value to fed cattle according to the US Meat Export Federation.[7] The top US beef importers in 2019 are summarized in Table 4.5. The ten largest importers represented 90% of beef export volume with Japan and South Korea each representing more than 20%.

Table 4.5. US Beef Imports by Country, 2019.

Country	1,000 pounds carcass weight	Share (%)
Japan*	799,227	26%
South Korea*	683,791	22%
Mexico	424,455	14%
Canada	267,990	9%
Hong Kong	231,942	8%
Taiwan*	197,843	6%
Philippines	45,729	1%
Vietnam	37,783	1%
Indonesia	33,734	1%
China*	32,098	1%
Subtotal	**2,754,592**	90%
Others	303,087	10%
Total	**3,057,679**	100%

* Indicates restrictions placed on animal age, requires export verified systems, and/or zero tolerance restrictions on specified residues.

Source: USDA, ERS https://www.ers.usda.gov/data-products/livestock-and-meat-international-trade-data/livestock-and-meat-international-trade-data/#Annual%20and%20Cumulative%20Year-to-Date%20U.S.%20Livestock%20and%20Meat%20Trade%20by%20Country

Meat trade in general, and beef trade in particular faces numerous trade restrictions (US Trade Representative 2021).[8] For example, exports to Japan, South Korea, and Taiwan (three of the top ten importers) each require a USDA Quality System Assessment (QSA) Program verifying the products were derived from cattle less than 30 months of age (USDA, FSIS 2020). Several countries require beef products were produced ensuring the product is free of specific residues. Restrictions also apply to where the animal was raised and/or slaughtered. China has zero tolerance for ractopamine in beef products as well as stringent maximum residue limits for

[7] https://www.usmef.org/news-statistics/member-news-archive/guide-to-major-destinations-for-u-s-pork-and-beef-cuts-variety-meat/

[8] https://ustr.gov/sites/default/files/files/reports/2021/2021NTE.pdf

Zeranol, Trebulone Acetate, and Melangesterol Acetate which are used to enhance feed efficiency and weight gain (USDA FSIS 2020). Also important to recognize are countries that because of their stringent import rules greatly restrict import of US beef. For example, EU member countries preclude meat imports from livestock treated with hormonal growth promotants (USDA FSIS 2020).

Synthesizing the requirements for US beef by importing countries, it is apparent cattle production protocols matter for export market access and vary by country. Age and source verification requirements are present in some countries. Restrictions on feed additive residue levels are common. Prohibiting use of feed additives and/or hormonal growth promotants is prevalent. While verification of these production protocols can be accomplished in several ways, all entail some form of assurance, third party verification, and potentially formal documentation from the producer to the packer. This provides another incentive for marketing agreements and contracts that reward producers for adhering to production protocols required by customers of the packer and enable packers to maintain a consistent supply of beef which satisfies customer requirements. In general, adoption of many export requirement protocols by producers increases production costs. Producers will not take on the added costs without an agreement in place to market the cattle with associated premiums to offset added costs.

CHAPTER 5: BOXED BEEF SALES METHODS INFLUENCE CATTLE PURCHASE TYPES

Objective 5

Determine economic incentive of meat packers to have a predictable, stable supply of live cattle for at least two weeks in advance and the increasing desire of retailers to schedule and price beef weeks in advance.

Boxed Beef Sales Methods

How beef packers market wholesale boxed beef will influence how they prefer to purchase fed cattle. For example, if forward beef sales become more common, packers have increased incentives to likewise increase forward purchases of fed cattle. Here we review several components of boxed beef sales data by packers to illustrate changing patterns in boxed beef sales methods over time.

Under LMR USDA AMS summarizes boxed beef sales by packers on a weekly basis in the *National Comprehensive Boxed Beef Cutout* report[9] for fed steers and heifers. The report provides several breakdowns in beef sales types:

1) Sales types separated into (reported since 2002):
    a. Negotiated Sales 0-21 day delivery
    b. Negotiated Sales 22/up day delivery
    c. Formula
    d. Forward Contract

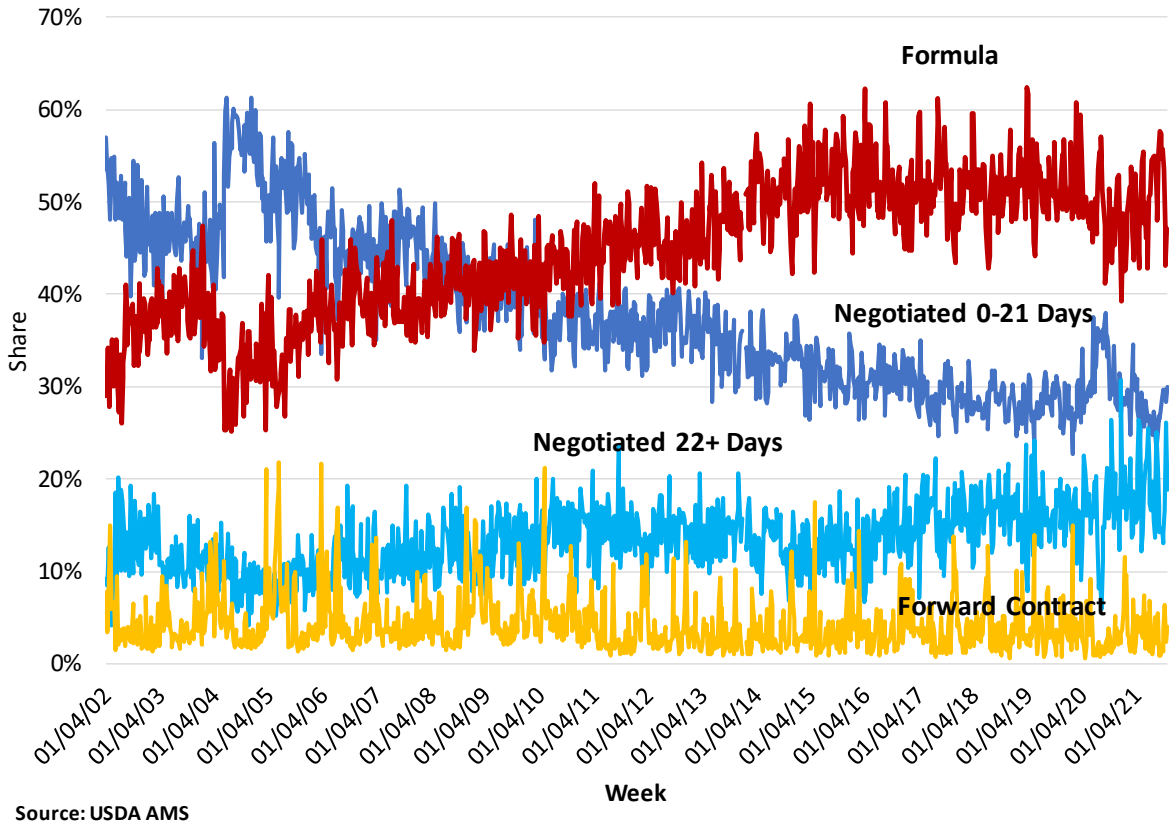
2) Delivery periods broken into (reported since 2014):
    a. 0-21 days to delivery
    b. 22-60 days to delivery
    c. 61-90 days to delivery
    d. 91+ days to delivery

Boxed beef sales types over 2002 - July 2021 are illustrated in Figure 5.1. Most apparent is the increase in formula pricing. Formula pricing went from about 30-40% of sales in the early 2000s to commonly around 50% since 2014. During the same time frame, 0-21 day negotiated trade when from about 50% to 30% and 22+ day trade increased from typically around 10-15% to roughly 20%. These patterns are somewhat similar to patterns observed for fed cattle purchase methods by packers (Figure 1.1) where formula trade has largely displaced negotiated trade. Though boxed beef sales and fed cattle purchase methods would not be expected to match up perfectly, they are undoubtedly related. More forward pricing of boxed beef beyond 21 days for example, suggests to manage margin risk, packers will likely strive to secure purchase prices for more cattle in advance. Likewise, if boxed beef is being formula priced, this creates

[9] https://www.ams.usda.gov/mnreports/lm_xb463.txt

incentives for more fed cattle formula pricing as well since similar factors motivate this pricing method for each procurement and sales.

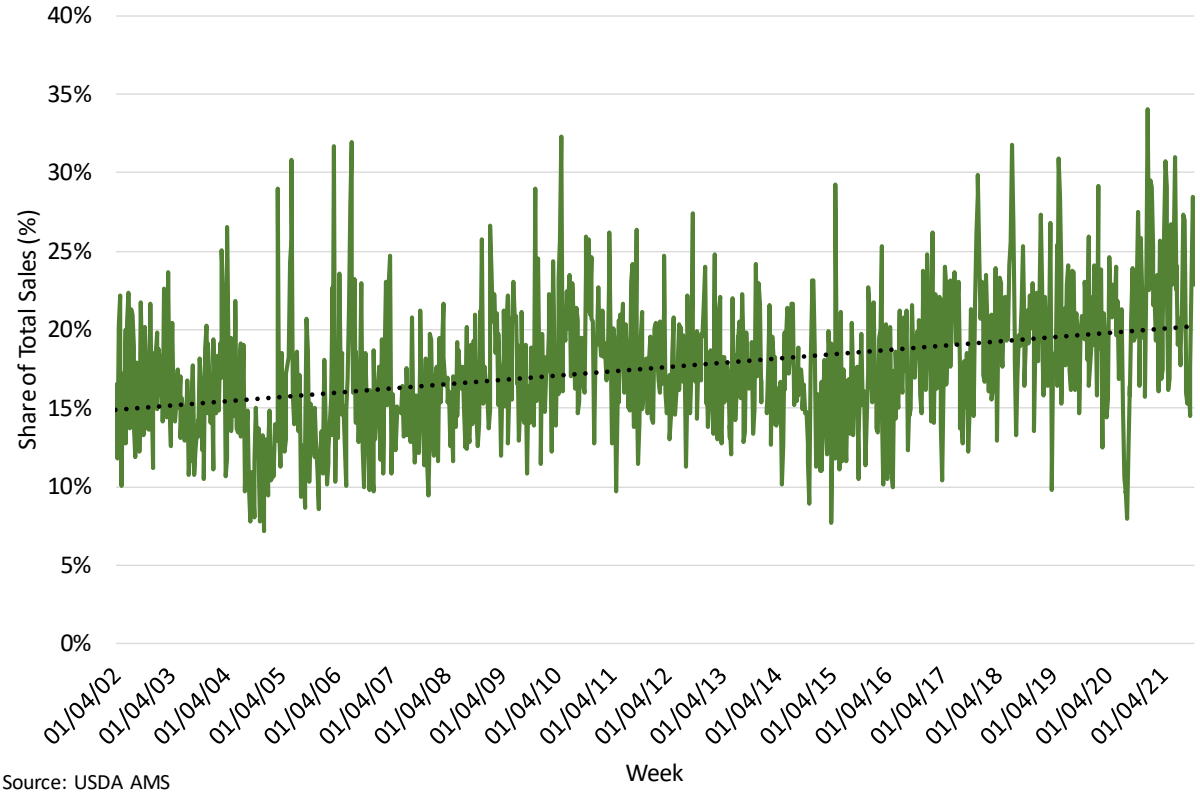
Figure 5.1. Boxed Beef Selling Methods, Weekly 2002 - July 2021.



Source: USDA AMS

We often hear anecdotally that food service and retail establishments price wholesale purchases well in advance of delivery. To formally assess this claim, we review two USDA AMS boxed beef sales data series in more detail. First, over the 2002-2021 period, we can combine forward contract and negotiated 22+ days sales shares from the above graph into a single combined series. This is illustrated in Figure 5.2. This combination represents a lower-bound estimate on the share of boxed beef that is priced in advance of 21 days prior to delivery (there could be some formula trade also priced that far in advance, but we do not have a breakdown of days to delivery for forward trade so we assume it is zero here – this problem is alleviated in the next graph). Over the 2002-2020 period boxed beef priced in advance of 21 days of delivery has gradually increased from about 15% of trade in the early 2000s to about 20% of boxed beef trade by 2020. Furthermore, during some weeks, more than 30% of boxed beef is priced more than three weeks forward.

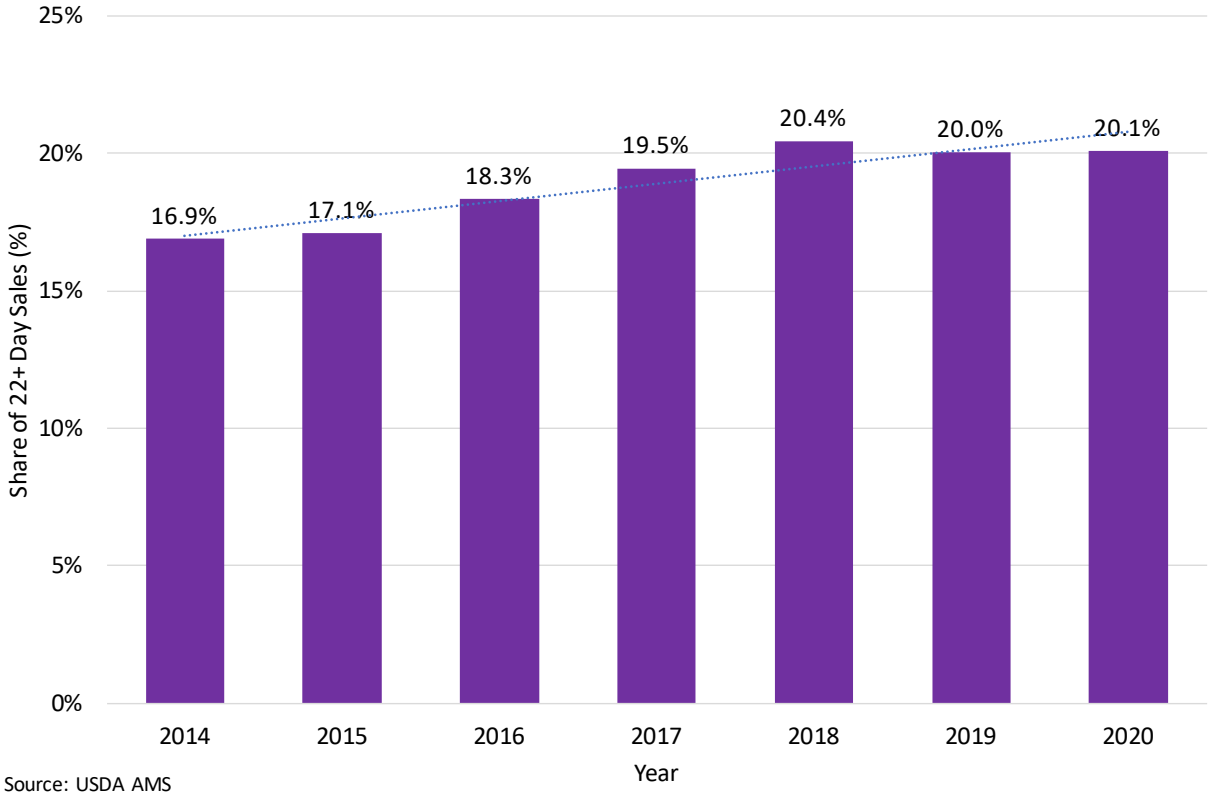
Figure 5.2 Shares of 22+ Day Delivery Negotiated Plus Forward Contract Boxed Beef Sales, Weekly 2002-July 2021.



Source: USDA AMS

Since 2014, the AMS has provided detailed information on days forward sales in boxed beef reports. The percentage of boxed beef sold on average by year beyond three weeks in advance is illustrated in Figure 5.3. This is a more complete measure of the share of beef being purchased in advance than that illustrated in Figure 5.2 because formula trade is included in the data compiled in Figure 5.3. Though covering a shorter time frame, the trend is similar to that discussed above where boxed beef sales made beyond three weeks into the future are common and have increased in recent years with about 20% of boxed beef being sold beyond three weeks prior to delivery.

Figure 5.3 Shares of 22+ Day Delivery Period Boxed Beef Sales, Annual 2014- 2020.



Source: USDA AMS

CHAPTER 6: MARKET INFORMATION NEEDS

Objective 6

Review concerns related to thinning cash negotiated markets. Assess market information needs and surveillance mechanisms to ensure longer-term fed cattle marketing contracts and agreements do not deteriorate market efficiency if cash negotiated trade becomes progressively less reliable and relevant. Included in this is analysis will be assessing alternative ways formula prices might be configured including wholesale boxed beef cutout values, negotiated bases, and/or longer-term rolling averages of alternative base prices.

Concerns Related to Declining Cash Negotiated Trade

As discussed in Chapter 1, nationally, shares of fed cattle procured using cash negotiated methods have been declining since 2004. In the early 2000s more than 50% of fed cattle purchases were negotiated cash trade. By 2020 the share of trade represented by negotiated purchases had declined to about 24% (negotiated cash plus negotiated grid purchases). Furthermore, in certain market regions (e.g., CO), cash negotiated trade dwindled to nearly zero.

The rapid decline in cash negotiated trade, often used synonymously with price discovery, raised concerns about possible thinly traded fed cattle markets. Thinly traded negotiated fed cattle markets raise concerns about representativeness and reliability of individual transactions and associated reported prices. For example, do 30% of cattle traded on the negotiated cash market, and the weighted-average price of those animals, accurately represent US cattle market conditions? Some argue the spot market is not representative and that either voluntary or mandated action is needed to resolve the issue. Recent proposals have included requiring minimum percentages of fed cattle to be purchased in the cash negotiated market or encouraging an increase in negotiating on a voluntary basis (Peel et al. 2020). The argument underlying these proposals is summarized in Peel et al. (2020, p 3) as:

> "*Cash price discovery represents a public good nature in that the industry values price discovery, but individuals have incentives not to participate in price discovery. This type of market failure can eventually result in less price discovery than is optimal and may require intervention*."

This quote reflects concerns some industry participants and policy makers have regarding thinly traded fed cattle markets. We generally agree that cash market price discovery provides timely market information to industry participants and serves as a source of base prices for many, if not most, formula purchase agreements. However, mandating minimum negotiated purchase shares would be a costly endeavor which would be difficult to enforce. If the mandate were effective and more negotiated trade happened, there is no guarantee as to what the outcome of this would be. For example, there is no way to know what type or quality of cattle would be diverted into spot markets and if those would increase the representativeness of negotiated trade. Also, simply counting number of cattle in the spot market does not consider how many buyers are participating. Finally, such a mandate would likely result in industry participants

figuring out ways to reconfigure formula marketing agreements to comply with regulations while not being materially different from current agreements.[10] In short, we do not expect mandating minimum purchases in negotiated cash markets would be effective at accomplishing its stated, intended purpose. The threat of regulation aside, we also are skeptical sufficient incentives to adopt cash negotiated trade in a sizeable and sustainable way via voluntary participation are present. As outlined in previous sections, years of market developments have facilitated movements away from negotiated trade to AMAs and strong economic incentives exist for all parties involved to remain on that course. We question whether increasing cash negotiated trade is a beneficial goal overall for the industry to pursue.

Reported Negotiated Prices as Public Goods

Price discovery, particularly in the form of LMR reported prices, has been argued to have public good attributes of being non-rival (one user does not preclude or diminish the value of the good, in this case price information, to other users) and non-exclusive (one user cannot own or exclude other users from using the price information). The natural conclusion has been since negotiated trade has thinned together with price discovery having public good attributes in traditional measures, private incentives to invest in price discovery are smaller than overall public value resulting in less discovery occurring than optimal (see Peel et al. 2020 for detailed discussion). However, it is important ask some pointed questions in this matter. Have thinly traded negotiated cash markets resulted in a *market failure* (Randall 1983) suggesting the need for public intervention? Is market inefficiency resulting from declining negotiated cash market trade costlier than gains associated with AMAs? Negotiating cash trade is costly and information generated is valuable to market participants. However, over time its value could increase or decrease as other forms of market information evolve with changing marketing methods.

The argument that because price discovery has public good characteristics, industry may be underinvesting in it is incomplete and potentially misleading. The public good characteristics of price discovery have always been present in the fed cattle industry. It is only because the negotiated cash market has thinned that the public good argument has surfaced. The reason less investment in negotiated cash purchases is now occurring is likely because the value offered by alternative marketing arrangements has increased considerably over time. This increased value of AMAs has motivated producers and packers to increase their use thus reducing cash negotiated trade. If the value of AMAs outweighs any potential cost of having reported spot prices based on fewer cattle, this is a rational economic outcome and there is no aggregate market failure in this substitution. Alternative marketing methods simply offer greater value to market participants. If a reduction in AMA purchases were forced upon the industry to increase negotiated trade, there would be a direct private loss associated with that policy.

We propose the observed transition is not an underinvestment in price discovery. Instead, it is an adoption of an economically better way for some to value and market fed cattle. As we have

[10] A similar argument is set forth by Peel et al. (2020).

demonstrated in this report, AMAs result in better supply chain coordination, reduced risks for both parties involved, they incentivize higher quality beef production, and they directly facilitate producing products with credence attributes consumers are demanding. As such, while some suggest those negotiating cash trade could be subsidized to continue offering the service (Peel et al. 2020) a more compelling argument should be made that if AMAs were limited with the goal of increasing cash negotiation, those who must reduce use of AMAs should be reimbursed for the direct losses they incur as a result. We do not advocate either of these subsidization alternatives but rather we pose a plausible counter argument.

Fed Cattle Exchange

Among voluntary efforts attempted by the cattle industry to encourage more cash negotiated fed cattle trade was the launch of the Fed Cattle Exchange (FCE) in 2016. As this was a concerted effort by the industry to encourage negotiated trade, we include a brief discussion of FCE. The FCE began as an electronic auction market where cattle feeders would offer lots of fed cattle for sale weekly and packers could bid on the cattle. Details of how the market functioned are discussed in Herbst (2018). The cattle traded on the exchange were eventually included in weekly fed cattle negotiated transaction data reported by USDA. Despite efforts to encourage cattle feeders to use the online platform to market at least some portion of their cattle, the FCE has not been able to generate sufficient sustained volume of trade to be viable or serve as an important source of additional negotiated fed cattle trade.

Conceptually, the FCE offers a low-cost way for cattle feeders who were not actively negotiating trade to list lots of cattle ready for market on the electronic exchange. Cattle could be offered with a minimum sell price which if not met have the option of not being sold and incur a modest listing fee of $1 per head, increasing to $2 per head in 2021. As such, the goal was to try to attract some cattle feeders using formulas to sell their cattle to place some of those lots on the FCE, thus increasing negotiated marketing activity. However, the economic disincentive for producers using formulas to switch some of those cattle over to the FCE apparently exceeded the value associated with their adding trade to the negotiated cash market. Recall the higher net prices we found for formula steers of $1.75/cwt and $4.15/cwt for 80%+ Choice relative to cash negotiated in the 5-market region over 2015-2020. As such, FCE was has been unsuccessful at accomplishing its intended goal. Though FCE was operating as of December 2020, volumes traded were low, typically less than 10 lots (less than 1,000 head) per week.

In late 2020, the FCE launched what they refer to as a Bid-The-Grid™ as a way to offer a grid pricing structure to cattle sellers. The grid premiums and discounts are based on weekly USDA AMS reported weighted averages. This is a similar grid to that used by CME Group for cattle delivered against short positions in live cattle futures. Whether this market offering will encourage more use of the FCE is yet to be determined. Furthermore, whether it encourages current formula trade to move cattle to FCE or simply displaces negotiated cash or negotiated grid volumes will impact whether it increases overall weekly volume of negotiated cattle. If volume sold using Bid-The-Grid™ mostly displaces negotiated cash or negotiated grid sales, then it will not add notable volume to overall negotiated trade.

Market Information and Base Prices

The primary value associated with cash negotiated trade has been the market information generated to help facilitate competitive fed cattle markets. Information is critical to well-functioning efficient markets. However, there is clearly a tradeoff between the frequency and type of market information generated by negotiated cash market trade and other marketing agreements. Arguably market information about negotiated cash trade is of most direct use to others who are negotiating cash fed cattle trade. If cattle sellers and buyers know what is being paid for other fed cattle, they can presumably use that information to better set offers and bids. Such information is of considerably less direct value to those not involved in daily price discovery beyond perhaps serving as a benchmark by which to compare their net prices. Of more direct importance to those in longer-term marketing agreements is the nature of longer run negotiations and relationships. That is, the nature of the contractual agreement (written or verbal) is what differentiates and motivates use of AMAs.

USDA AMS currently reports fed cattle trade in one of four categories:

1) Negotiated cash - live and dressed purchases by packers made for delivery within the next 30 days
2) Negotiated grid – base price negotiated on a grid-based purchase
3) Forward contract – price or basis established more than 30 days from delivery
4) Formula – remaining purchases that are not included in 1-3

Base Prices

Base prices, which are the beginning price for fed cattle that is then adjusted based on carcass performance or other traits are used in formula trade. Base prices are often negotiated cash prices which were reported one to two weeks earlier. The role of reported cash prices in determining the price of formula cattle elevates the importance of efficient negotiated cash market price discovery and market reporting. However, there are presently viable substitutes to using a reported negotiated cash fed cattle price as the base in a formula trade. Alternatives include futures market prices (or basis contracts); downstream prices such as wholesale boxed beef cutout values or retail prices; cost of production indexes; or some combination of these. If packers and/or cattle feeders do not trust a particular base price being used to value cattle in a formula, they will negotiate alternative base price/value sources.

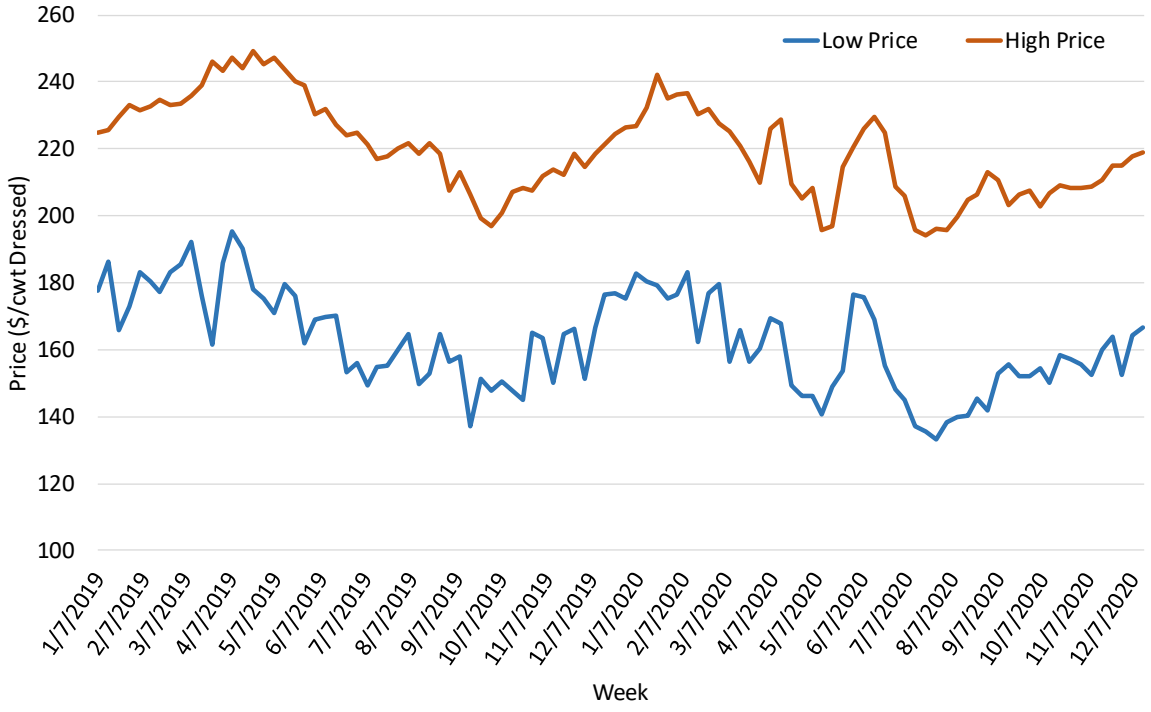
Quality/Value Net Formula Price Information

The most important price information available to those who market cattle using formula trade is the net price received. Under LMR, USDA AMS has until recently reported only weekly low, high, and weighted average prices for formula trade separately for steers and heifers, broken down by quality grade categories as well as by live and dressed prices. A weakness in the reported price information is that because of the variation in types of cattle and marketing agreements included in formula trade, the price range is of limited value. We illustrate the issue here in several charts. First, the high and low weekly dressed formula net prices for steers grading 80% and greater Choice during 2019-2020 as reported by USDA AMS are provided in Figure 6.1. The range, as a percentage of the weighted-average price, is reported in Figure 6.2. The weekly high-to-low reported price range averaged $58/cwt from a minimum of about

$40/cwt to $84/cwt. The price range averaged 31% of the weekly weighted-average price. The price range information is so wide in part because even though cattle in the category are steers and grade at least 80% Choice, other valuation factors create large disparities in values. These include naturally raised, non-hormone treated cattle (NHTC), various process verifications or certifications, branded programs, and other attributes. Recall the definition of Formula Trade as "trades that do not fit in any other category".

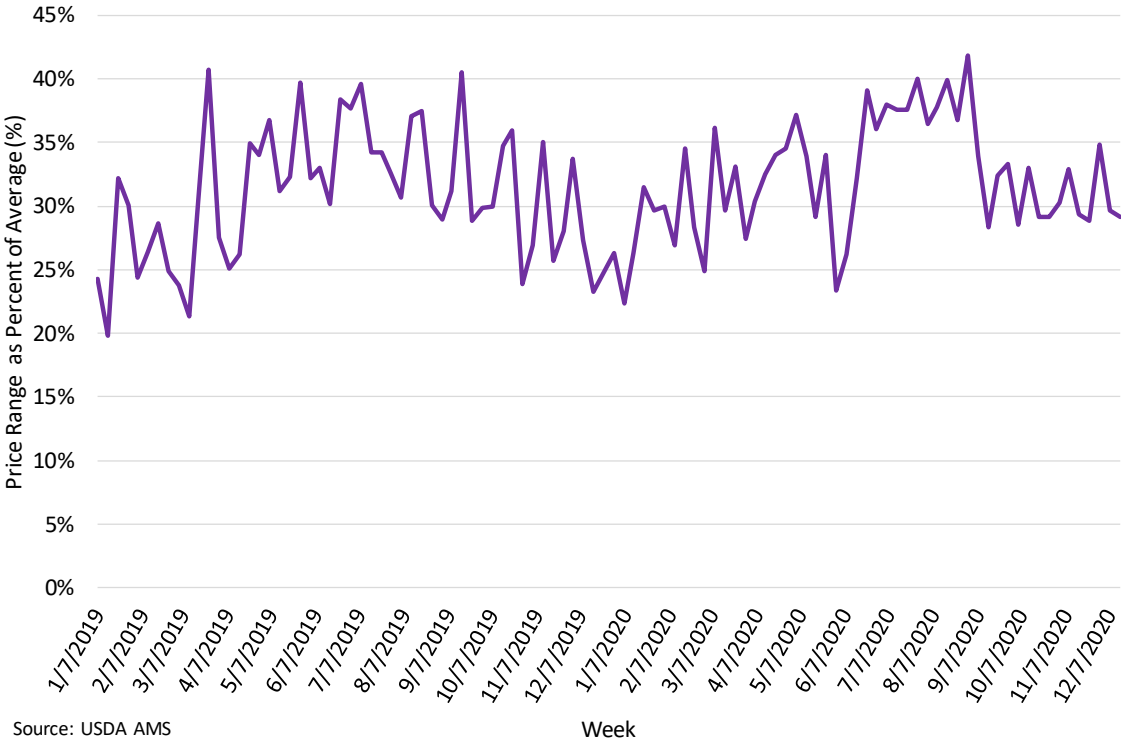
As an effort to increase information content reported by USDA AMS on formula traded fed cattle, USDA announced changes in the way market information will be reported for formula traded cattle (USDA, AMS 2021b). Two new reports were launched on August 9-10, 2021: the National Daily Direct Formula Base Cattle providing more information about base prices and the National Weekly Cattle Net Price Distribution showing the volume of cattle purchased at various price levels for formula, grid, and contract purchases. These reports are new and the information content and value of the information provided will become more apparent over time as the data are assessed and analyzed.

Figure 6.1. Weekly Low and High Dressed Formula Price Reported by USDA AMS , Steers 80%+ Choice, 2019-2020.



Source: USDA AMS

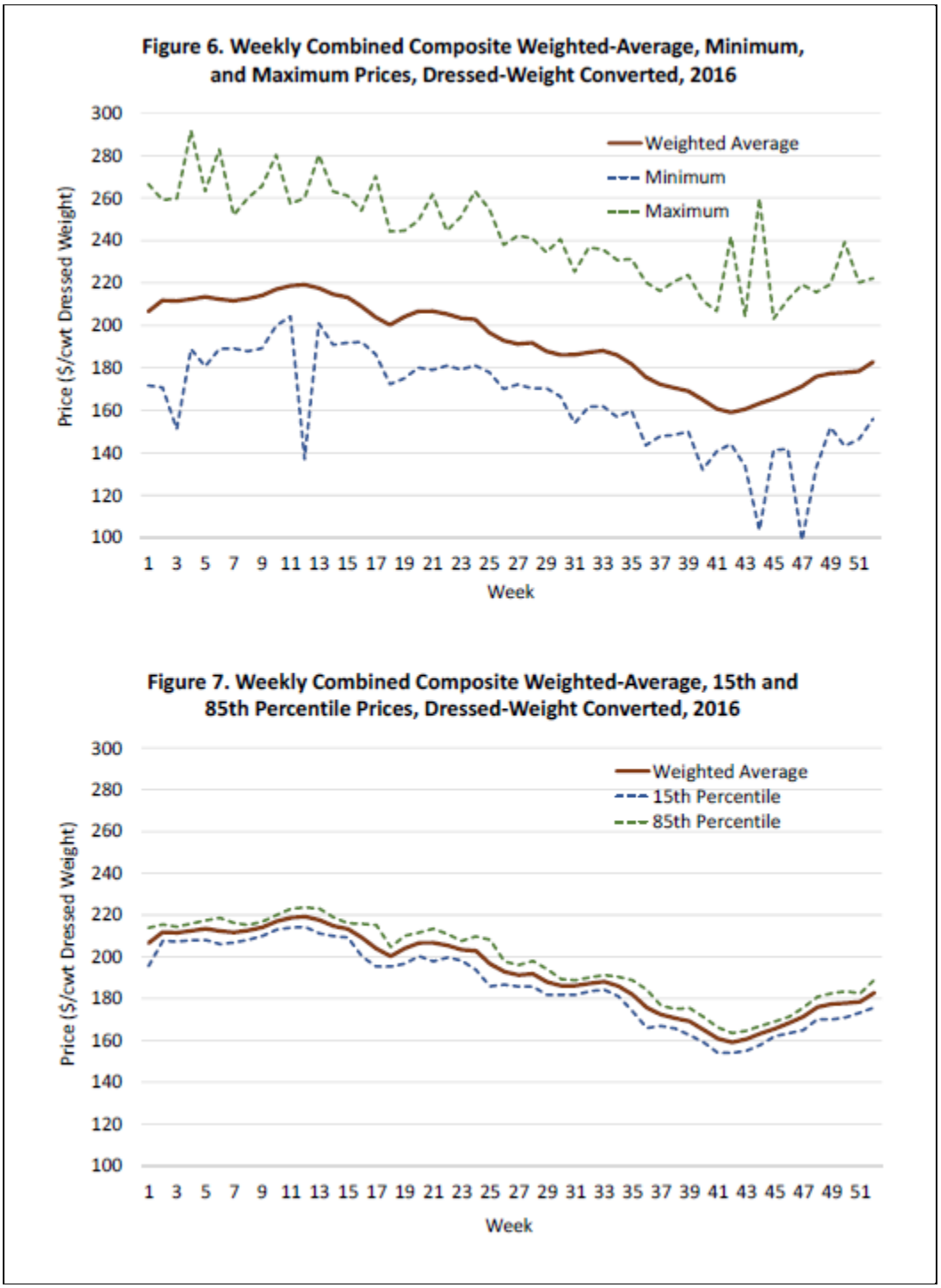
Figure 6.2. Weekly Dressed Formula Price Range as Percentage of the Weighted Average Reported by USDA AMS, Formula Steers 80%+ Choice, 2019-2020.



Source: USDA AMS

Schroeder and Tonsor (2017) used confidential transaction-level data reported to USDA AMS under LMR during 2016 to demonstrate a more informative way to report the price information from formula trade. In particular, they suggested using a range of the lowest 15th and highest 85th percentiles as the low and high instead of the minimum and maximum prices as current reported by USDA. They advised against reporting a standard deviation of price because the transaction prices were not normally distributed. Using their proposed percentile range would provide a reported price range that encompasses 70% of the transactions during any given week. This would provide better focus on prices which are associated with more common transactions and avoid the distractions of the extreme minimum and maximum values. They published the following charts in their study to illustrate how much narrower of price ranges this type of reporting would provide (Figure 6.3). Our recommendation is to use a rule similar to that suggested by Schroeder and Tonsor (2017) in reporting formula trade price ranges.

Figure 6.3. Illustration of using 15th% to 85th% Price Ranges in Formula Prices. Copied verbatim from Schroeder and Tonsor (2017).



Hedonic Modeling for Price Reporting

The heterogeneity apparent in the formula trade cattle category, extremely wide range in reported prices, and the fact this category by far represents the largest volume of fed cattle (more than 60% most weeks), strongly suggests an opportunity for improving net formula and negotiated grid price reporting. Schroeder and Tonsor (2017) explored using an hedonic pricing model to estimate and report premiums and discounts associated with attributes of lots of formula- and grid-priced fed cattle. Hedonic modeling has long been used by other federal agencies in price reporting (most notably the Bureau of Labor Statistics in Consumer Price Index reporting). Schroeder and Tonsor (2017) demonstrated that such an approach, has considerable promise in LMR price reporting for especially formula and grid trade.

However, to most effectively utilize such hedonic modeling to facilitate price reporting in fed cattle would require more transaction-level details to be submitted by reporting packers than are currently reported. The additional information would include data such as special attributes of the lot (e.g., NHTC, naturally raised, age and source verified, etc.) Some attributes in the hedonic models might be restricted from reporting given existing confidentiality rules being used by AMS for fed cattle price reporting. Confidentiality might be more readily maintained through aggregation schemes for some attributes (e.g., across space, time, and/or quality traits). More research needs to be done on this specific topic to collect the necessary data and construct and test associated hedonic models for price reporting. We believe it is both feasible and could greatly improve price reporting.

Considerations in LMR Reauthorization

LMR is set for reauthorization by Congress September 31, 2021 after being extended for a year in 2020. As preparation for the planned reauthorization, in 2018 USDA AMS submitted a report to Congress analyzing marketing practices in the livestock industry as well as assessing industry stakeholder concerns and recommendations regarding market reporting. Parcell, Tonsor, and Schroeder (2016) noted in a baseline study leading up to the 2018 AMS report:

> "*Changes in the structure and ownership of reporting packers; how trade occurs in the industry; livestock production methods and technology; meat processing technology; product mix; product form; importance of export markets; and policy all impact LMR design, data collection, and information reporting methods*." (p 1).

Much of LMR information collecting and market reporting, especially for fed steers and heifers and boxed beef, are similar to when LMR was launched in 2001. The cattle and beef industries and their associated markets, as we have discussed extensively in this report, have changed immensely over that time. Several concerns surround current discussions of the upcoming LMR reauthorization debate. These include thinly traded negotiated cash markets, market transparency, data confidentiality, market access, packing plant capacity constraints, labor availability, market power, and ransomware attacks to mention a few. Many of these are outside the bounds of LMR, however, most of them will affect LMR either directly or indirectly going forward.

Though this report is not intended to address the host of complex concerns surrounding the cattle and beef supply chain, we offer thoughts here on how LMR might update and improve reporting going forward.

Negotiated Fed Cattle Price Reporting

Negotiated fed cattle trade has thinned over the last 20 years, though it has remained relatively stable at roughly 20% of fed cattle purchases over the last 10 years. However, in some market regions negotiated trade has thinned to where it is often not reportable due to confidentiality. Schroeder, Schulz, and Tonsor (2019) (SST) studied potentially combining existing market regions for USDA AMS reporting of fed cattle trade. There are important tradeoffs for this we will not delve into here as they are discussed in detail in the SST study. However, what was clear from the SST study is that confidentiality is often constraining in existing negotiated fed cattle reporting methods and aggregating reports in several different ways can reduce confidentiality constraints. These include aggregating transactions 1) across purchase types (e.g., steers, heifers, dressed, and live); 2) across purchase windows (14-day and 30 day); 3) across geographic regions; and 4) over time. These together with reviewing whether the current 3-20-70 confidentiality guideline is the most effective to use for its intended purpose are all worth assessing going forward.

Claims have been made that LMR, through increasing trust in reported negotiated prices, helped incentivize formula trade using negotiated prices as a base price in formulas. As we have discussed in this report, though this might be one factor of consideration in formula trade, it is minor relative to the major incentives associated with marketing agreements. That said, if negotiated trade thins to the point where it is not reliable or trusted as a viable base price, likely marketing agreements will shift to other base price sources. This has likely occurred already in market regions where negotiated cash trade is particularly thin. In hog markets there are more marketing agreements incorporating the pork cutout price in base prices, but as we noted earlier, the negotiated hog market is much thinner relative to fed cattle with less than 1% of hog purchases being cash negotiations. Other options for base prices in fed cattle marketing agreements have been suggested including live cattle futures or boxed beef. Tradeoffs are present for all alternative base price formulations.

Formula Pricing of Fed Cattle Reporting

The formula category USDA AMS currently uses to report fed cattle trade is a catchall category that includes all fed cattle purchases not categorized as negotiated, forward contract, or negotiated grid. The formula category represents some 70% of fed cattle transactions. The result is, the range in reported prices as discussed previously in this report is too large to be interpretable. We offered suggestions above on how this might be improved upon including reporting percentiles of prices, using more rigorous statistical models (e.g., regression modeling) to report more refined market information by cattle type, quality, and special program cattle.

The most important consideration in maintaining efficient markets in light of AMAs being the preferred marketing method is ensuring market information associated with AMAs gives a reasonable picture of trade that is occurring. Because they are proprietary and highly variable across firms, AMAs require a different type and frequency of market information reporting. For example, base prices on many formula trades are reported by packers to USDA for cattle delivered in the future. USDA now reports base prices for formula and forward contracts the week they are established and net prices when formula cattle are delivered to the packer. Components of AMA trade that we view as being beneficial to report include:

1. Net prices received weekly for AMA purchased cattle by market region, much like current LMR reporting.

2. Premiums and discounts paid weekly for quality, yield, and specific production attributes (e.g., naturally raised, age-and-source verified, etc.) much like is done now under LMR. Volumes associated with these premiums would also be beneficial to understand if the premiums are simply offers or if trade is occurring.

3. Detailed daily and weekly wholesale beef market information are valuable under LMR. However, because of evolving wholesale beef product value adding and differentiation; increasing product branding; and more product labeling claims, wholesale beef market reporting needs continual assessment and updating to reflect these changes. A baseline study of market trends affecting LMR came to similar conclusions (Parcell, Tonsor, and Schroeder 2016). This may be the most important market information going forward in the cattle and beef industry. Targeted efforts to determine additional ways to summarize and report market information in this segment are highly recommended.

4. Detailed weekly retail beef market prices are increasingly important. Retail price data reported by USDA currently fall well short of being adequate given weaknesses in Bureau of Labor Statistics (BLS) retail meat price data which are the key source for USDA retail price information. Schroeder et al. (2019) illustrate economically important and non-systematic biases present in BLS retail price data compared to scanner prices. They show at times 20-30% upward bias in BLS compared to scanner data. Furthermore, Pozo, Bachmeier, and Schroeder (2020) conclude that while BLS retail price data change vertically asymmetrically with upstream markets, retail scanner data respond vertically symmetrically. Thus, BLS data are at times a poor barometer of retail meat prices. We recommend retail scanner data be considered for use in regular reporting by USDA.

5. A contract library with general agreement conditions available publicly similar to what are published now in the swine industry. Such a library would at least provide cattle feeders with reference points regarding what sorts of opportunities exist and would serve as starting points for negotiating new AMAs.

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