Feasibility Assessment of Reporting Negotiated Slaughter Cattle Purchases in Separate Delivery Window Categories

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Executive Summary

Purpose and Undertaking

This study was undertaken to determine the feasibility of reporting slaughter steer and heifer purchases in separate 0-14 and 15-30 day delivery windows through possible realignment of reporting markets subject to confidentiality constraints. To accomplish this, we undertook a comprehensive statistical analysis of all 2014-18 negotiated transactions reported to the United States Department of Agriculture Agricultural Marketing Service (USDA AMS) under Livestock Mandatory Reporting (LMR) statute.

Challenges

Several complex challenges and tradeoffs became apparent in assessing ways to potentially reduce LMR confidentiality constraints in fed cattle negotiated price reporting separately for 0-14 and 15-30 day delivery windows:

- **Insufficient 15-30 day Transactions**. Nationally over the five-year period, 15-30 day trade represented only 15% of negotiated transactions. Combined with declining negotiated trade in fed cattle markets nationally over time, 15-30 day transactions represent a small share of what has become a relatively thinly traded negotiated market. The result is that 15-30 day trade is often not reportable in most regional markets.

- **Regionality where 15-30 day transactions occur**. The frequency of 15-30 day negotiated transactions has been relatively concentrated in two market reporting regions, NE and IA/MN, which represented nearly two-thirds of fed cattle purchased nationally in the 15-30 day window. In contrast, TX/OK/NM, CO, and KS, 15-30 day purchases were rare.

- **Confidentiality precludes reporting**. Because of the rarity of 15-30 day purchases, small numbers of negotiated trade in general, and a concentrated beef packing industry, especially in certain market regions, confidentiality guidelines often precluded reporting 15-30 day market information.

- **Can aggregation resolve the issue?** The most apparent way to attempt to address confidentiality constraints is to increasingly aggregate transactions across reporting categories, locations, or over time. For example, one can consider aggregating across characteristics of transactions within a region such as combining steers and heifers into a single category, combining live and dressed, combining FOB and delivered, and so forth. Another consideration is to aggregate spatially across geographic markets. Finally, one can consider combining multiple days or weeks in reported categories. Combining transactions reduces the content of the market information that is discernable from market reports. Furthermore, if dissimilar transaction characteristics with divergent market values are combined this can result in reported market information that is

difficult to interpret or of little value. The tradeoff is clear, aggregation might increase reportability, but at the cost of information content and value.

Conclusions and Recommendations

This study combined information across transaction characteristics and exhaustively considered alternative regional market alignments to assess viability of reporting relative to confidentiality guidelines and impacts of aggregating on reported market information. Combining several cattle types into a single aggregate price report (similar, but not identical, to what AMS does currently in the National Weekly Fed Cattle Comprehensive report) reduces chances that confidentiality will be compromised. Steers, heifers, mixed steers/heifers, dressed, live, delivered, FOB, types of transactions were all combined in an attempt to increase the chances confidentiality constraints would not preclude reporting of 15-30 day delivery market information. From this aggregated data, we examined 10 alternative geographic market alignments to investigate how different alignments impact confidentiality constraints as well as information content of reported prices.

Our recommendations were framed with the goal of providing as much market information for as many alternative geographic market regions as feasible given fed cattle market structure and marketing method usages over the 2014-18 period. However, the value of reported market information depends upon the level of aggregation in the reported data. Aggregating transactions across geographic regions with markets that are not well integrated can reduce the value of information. For example, combining a thinly traded market with a more liquid market region can reduce the value of information otherwise contained in the liquid region alone. We considered these types of tradeoffs carefully in forming the following recommendations.

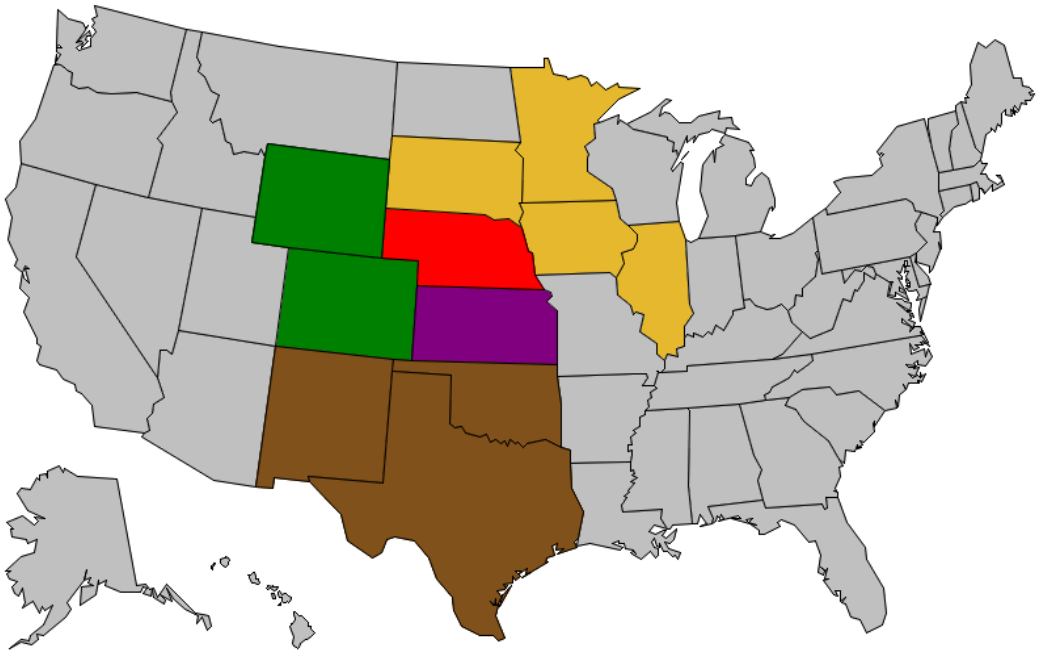
- Reporting of 15-30 day separately from 0-14 day trade is feasible only on a national reporting basis and is not feasible for regional market reports. About half the time in the IA/MN market (and other corn-belt added market alignments considered with these states as well) the 15-30 day trades could be reported. In no other market region could these two windows of trade be separately reported more than 20% of the time, at best, regardless of how alternative states in the region were aligned. The challenge is due to a confounding combination of confidentiality guidelines and small numbers of 15-30 day transactions in specific regions. A separate 15-30 day price could be reported about half the time for a 5-Area report (depending on what states were included in the alignment), but this would essentially be the same as the national report since the vast majority of 15-30 day trade occurs in states in the current 5-Area reporting regions.

- Realignment of fed cattle market reporting relative to the current alignment is recommended for reasons other than reporting 15-30 day trade separate from 0-14 day. Our recommended regional alignment for negotiated market information reporting is shown in the figure below.
    - We recommend adding SD to a regional market report. SD had the 4th largest volume of negotiated trade of all states. IL is next in line in terms of volume for states not currently included in regional reports. We would combine SD and IL

with IA/MN to create an IA/MN/SD/IL regional market. These markets have similar price structures so combining these together would not adversely impact IA/MN price reporting quality and would add important regional market volume for negotiated trade. IN and OH could be included in this region, however, collectively they represent less than 1% of combined negotiated transactions, adding them does little to impact reportability, and including them increases variation in reported prices.

- We recommend combining CO with WY for negotiated price reporting. These markets appear to have similar pricing patterns and combining these states would reduce confidentiality constraints for the CO market that are now present for even 0-30 and 0-14 day window transactions. WY has the 9th largest volume of negotiated trade and it appears to complement market information in CO and could potentially also improve the quality of market information otherwise reportable for just CO alone. However, our analysis also reveals that adding WY to CO will not alleviate challenges with reporting regular market information for the CO/WY region as there will likely be some weeks market information will not be reportable. Including WY helps marginally increase reporting viability subject to maintaining confidentiality in this region but does not resolve concerns. At some point, reporting even a combined CO/WY negotiated market report may no longer be viable.
- We recommend leaving NE and KS regional markets as they are now. NE and KS markets do not have an obvious additional state or states to combine with that would enhance the quality of information and they each have very high reportability for 0-14 and 0-30 day transactions. Neither of these markets are reportable for 15-30 day transactions.
- We do not have a recommendation for the TX/OK/NM market to improve reportability or quality of market information. One could combine KS with TX/OK/NM to get a reportable regional market that includes these states together, but this would slightly reduce the quality of information and the average price contained in the KS report and would not add enough volume to the KS negotiated trade report to justify. The TX/OK/NM region has similar challenges to CO/WY with few negotiated trades occurring and a concentrated packing sector confounding confidentiality concerns as it relates to negotiated market information reporting. The pragmatic outcome may inevitably be to discontinue publishing a separate TX/OK/NM negotiated report.

Recommended Alignment



Future LMR Considerations

- The way LMR data are currently reported by packers to AMS, the state of origin of cattle are the only origin identification for domestic purchases. Major cattle feeding states have feedlot and packer densities and structures that differ widely across individual states and certainly similar structures span across state lines. Consider for example Western KS, TX Panhandle, or Eastern CO where cattle densities differ more within the state than across state lines. Reporting cattle origin by zip code or another more granular level than states and evaluating market reporting from more refined origin locations that potentially divide states and combine across state lines is worth considering. We expect this could increase what we refer to as the quality or content of the market information reported. We also expect this would result in a different alignment for market reporting than what we recommend in this report.

- Although not part of this study's objective, but worthy of future assessment, is how specific clauses of the 3/70/20 confidentiality guidelines and associated unique attributes of the slaughter cattle market impact price reporting capability. Clearly confidentiality is the key concern and whether confidentiality can be maintained with other specific guidelines is worth considering. Exploration of alternative confidentiality guidelines might be worthwhile. However, we see little prospect for even liberal confidentiality guidelines enabling reporting of 15-30 day market information separately for anything other than a national market report.

- Negotiated trade market information reporting conditional on maintaining confidentiality has become challenging as fed cattle procurement methods have evolved over time. Modifying reporting regions cannot resolve thinning market trends. Addressing this issue is well beyond the scope of this study, but our analysis conducted here sheds even greater light on the significance of this issue for viable systematic reporting of negotiated trade fed cattle market information. This issue will continue to occupy industry attention.

- Because the fed cattle industry is undergoing considerable structural change in numerous aspects from the ways cattle are purchased by packers to location of cattle feeding, we recommend continued assessments of how to potentially group market information across states, regions, and by purchase types be done periodically. The pace of change in the fed cattle market is rapid and AMS needs to be able to assess and make adjustments to reporting as the market environment changes.

Introduction and Background

Livestock Mandatory Reporting (LMR) conducted by the Agricultural Marketing Service (AMS) of the U.S. Department of Agriculture (USDA) provides essential market information to industry participants enhancing decision making and market efficiency. The Livestock Mandatory Reporting Act of 1999 (1999 Act) established slaughter cattle market reporting requirements for beef packers slaughtering or processing 125,000 head or more annually. Protecting identity of reporting entities and maintaining confidentiality of individual transactions is required by the 1999 Act. AMS uses what is referred to as the 3/70/20 guideline[2] to ensure confidentiality of reported market information under LMR.

The 2008 LMR reauthorization modified terms of trade for negotiated transactions for steers and heifers. Prior to this time, *negotiated* transactions referred to cattle scheduled for delivery not later than 14 days after the purchase date. Cattle scheduled for delivery beyond 14 days were considered *forward contracts*. Beginning with the 2008 reauthorization, a revised category for negotiated purchases of cattle scheduled for delivery more than 14 days but fewer than 30 days was added to *negotiated* transactions.[3] As such, two negotiated purchase categories, 0-14 and 15-30 day delivery windows, for each dressed and live slaughter steers and heifers could conceivably be reported by AMS. However, confidentiality constraints have precluded AMS from separating these two delivery windows in negotiated purchase price reporting. Instead, negotiated purchases for regional fed cattle markets have been reported under a single 0-30 day delivery window.

A concern with grouping negotiated transactions into a 0-30 day delivery window is when cattle prices are forward trending, combining transactions across the 30-day delivery window could result in averaging out and masking the market trend. This could result in reported negotiated prices being greater for nearby delivery trades compared to more distant deliveries during a downtrend and vice-versa during an uptrend in the market which would not be discernable in reported negotiated transactions that combine 0-14 and 15-30 day deliveries into a single weighted-average price quote. Industry participants have keen interest in assessment of whether negotiated transactions could be separated into 0-14 and 15-30 day delivery windows.[4] Currently, AMS reports separate 0-14[5] and 15-30 day delivery window weekly negotiated average prices combining live and dressed transactions on a national basis in the *National Weekly Fed Cattle Comprehensive* report.[6] The challenge is the 3/70/20 confidentiality constraint often precludes separating these two delivery window reporting categories for

[2] The 3/70/20 guideline requires: 1) at least three reporting entities need to provide data at least 50 percent of the time over the most recent 60-day time period; 2) no single reporting entity may provide more than 70 percent of the data for a report over the most recent 60-day time period; and 3) no single reporting entity may be the sole reporting entity for an individual report more than 20 percent of the time over the most recent 60-day time period. https://www.ams.usda.gov/sites/default/files/media/ConfidentialityGuidelines.pdf

[3] https://www.federalregister.gov/documents/2008/05/16/E8-10185/livestock-mandatory-reporting-reestablishment-and-revision-of-the-reporting-regulation-for-swine

[4] https://nebraskacattlemen.org/wp-content/uploads/2019/01/live-cattle-final.pdf

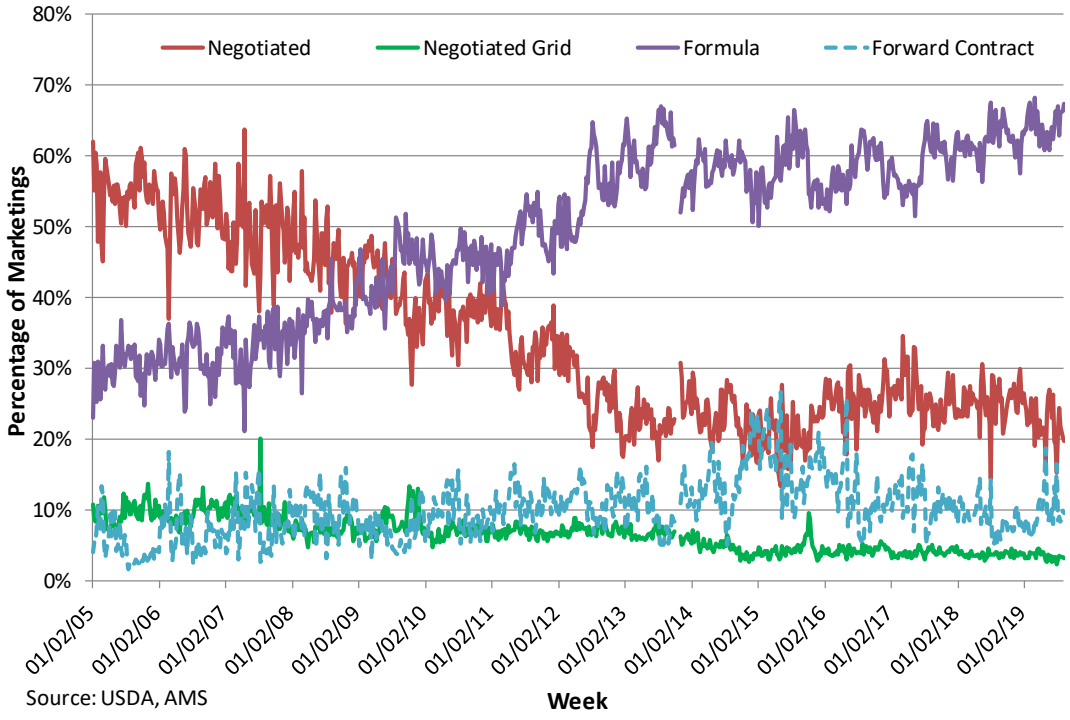
[5] AMS reports separate 0-14 day (which is labeled as "1-14" in the published market report).

[6] https://www.ams.usda.gov/mnreports/lswfedcc.pdf

individual state (e.g., NE, CO, or KS) or multi-state (TX/OK/NM or IA/MN) negotiated purchase reports or the current 5-Area regional market report.

The 5-Area market reporting region, currently comprised of fed cattle purchases from producers located in the 1) Minnesota, Iowa; 2) Nebraska; 3) Kansas; 4) Oklahoma, New Mexico, Texas; or 5) Colorado market regions, was established in 1989. Since that time, significant changes have occurred in regional fed cattle production. Moreover, since the changes made to negotiated purchase price reporting in 2008, substantial structural changes have occurred in slaughter cattle markets. Negotiated trade has declined from around 55% of cattle purchases down to 25% (Figure 1) with some regions such as TX/OK/NM declining even more, challenging individual state or multi-state negotiated price reporting consistency. Formula purchases increased from about 35% to more than 60% of slaughter cattle purchases since 2008. Furthermore, in recent years several packing plants have changed ownership; some plants have ceased operations; others have substantially expanded capacity; and large packer-owned cattle feedyards have been sold to non-packing entities. These structural changes all directly influence reporting of negotiated fed cattle purchases especially regionally by modifying the makeup of firms and purchase shares driving 3/70/20 confidentiality. No formal assessment has been made to determine how these, and other changes occurring in cattle market structure, have impacted negotiated fed cattle market information reporting.

Figure 1. Ways Domestic Fed Cattle are Purchased and Priced, Weekly, 2005- August 2019



Source: USDA, AMS

The weekly 5-Area weighted average negotiated dressed steer price over the 2014-18 is reported in Figure 2. Apparent is the variation in prices ranging from $270/cwt in early 2015 to less than $155/cwt in late 2016. The variability in price reinforces the importance of regular, accessible, and reliable price data informing industry participants of recent market information. Rapidly evolving industry market structure together with volatile prices challenges price reporting, further motivating this study.

Figure 2. 5-Area Weighted-Average Weekly Dressed Steer Price, 2014-2018

Source: USDA AMS

Objectives

The main purpose of this study is to assess the feasibility of reporting negotiated slaughter steer and heifer purchases in separate 0-14 and 15-30 day delivery windows through possible realignment of the 5-Area reporting markets while maintaining confidentiality of reporting entities and proprietary transactions.

Objectives include:

1. To determine whether transaction data for 0-14 day and 15-30 day delivery period negotiated trade prices can be consistently reported separately on national and regional bases while complying with 3/70/20 confidentiality guidelines.

2. To determine how possible changes in the 5-Area reporting region through realignment of included states of cattle origin influence the feasibility of consistently reporting the two delivery window negotiated trade prices separately while complying with 3/70/20 confidentiality guidelines. This objective includes assessing how adding cattle from selected additional states of origin to existing 5-Area reporting regions might impact confidentiality constraints as well as the quality of price information being reported by AMS.

3. To outline options for consideration and suggestions that may improve reporting negotiated slaughter steer and heifer purchases.

Procedures

To accomplish the objectives of this project, we first met with AMS market news personnel from the Des Moines and St. Joseph regional offices to review details of negotiated transaction fed cattle purchase data. We also obtained five years (2014-18) of national transaction data reported to AMS through LMR for negotiated purchases. We conducted a *baseline analysis* followed by assessing *alternative alignment*s of the regions included in the 5-Area reports.

Baseline Analysis

Statistical analyses of negotiated beef cattle steer and heifer transactions data were used to assess how confidentiality guidelines impact consistency of price reporting now for the individual reporting regions and the 5-Area report for 0-30, 0-14, and 15-30 day delivery windows. The analysis included assessing how including 15-30 day delivery with the 0-14 impacts reported weighted-average prices over time, frequency of price reporting consistency, and trend in consistent reporting conditional on the 3/70/20 confidentiality guidelines for the current 5-Area reporting regions and the combined 5-Area using states of origin included in current reporting. The baseline analysis served as a benchmark for understanding how alternative alignments of including additional states of cattle origins might impact price reporting consistency.

Alternative Alignments

To determine how the individual regional and 5-Area negotiated price reporting consistency would be affected under alternative regional market alignment, we evaluated how price reporting was impacted by adding more states of cattle origin to individual price reporting regions and the 5-Area. Candidate states of origin were ranked initially by volume of negotiated purchased cattle from each state. Markets not included in the current 5-Area report that had the largest negotiated number of transactions and cattle volume represented were the most highly ranked in this first step.

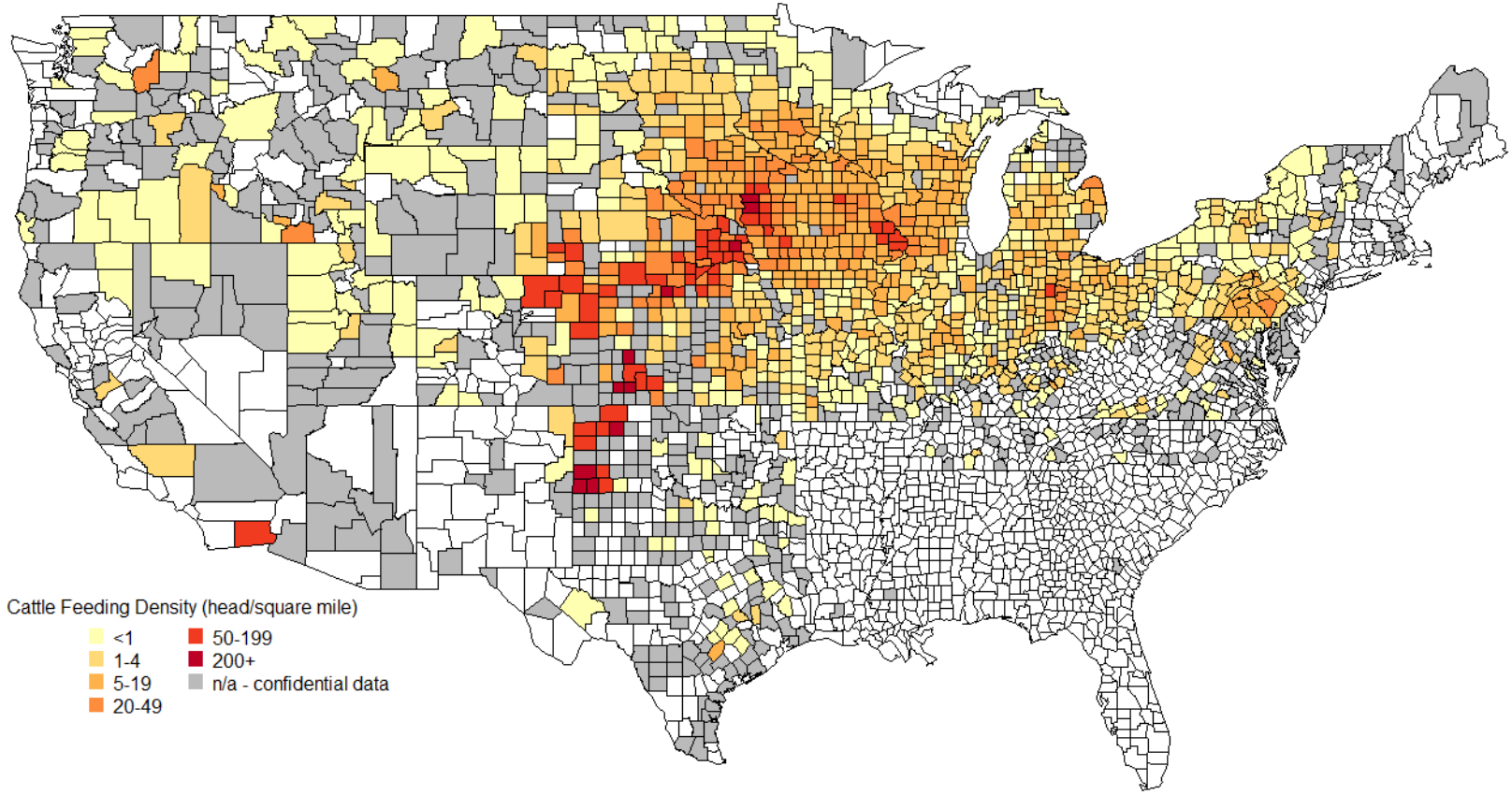
Useful in this first step of assessing candidate states to potentially include in alternative market information reporting realignments is to review locations of cattle on feed inventory. In Figure 3 we used 2017 Census of Agriculture data to estimate cattle on feed density (head per square mile) by county across the mainland US (excluding AK and HI). Because of confidentiality, cattle on feed inventory is not reported in Census publications in several counties (shaded in gray on the map). Cattle feeding is densely concentrated in the IA, IL, CO, SD, NE, KS, and TX regions though certainly not spread uniformly across these states.

Transaction prices from candidate states of origin to include in an alternative alignment assessment were statistically compared to any potential region they might be considered being combined with to assess impact on the following metrics:

1. Transaction numbers and cattle volumes included,
2. Impact on ability to report weighted average prices sensitive to 3/70/20,
3. Reported weighted-average price levels, and
4. Price variability.

For example, we considered adding SD to the NE data to determine how this influenced the relevant metrics. It is possible that including SD transactions together with NE transactions could improve all the characteristics we measure of price reporting. Alternatively, this realignment could reduce the quality of the existing NE report if transaction prices in SD are not well aligned or integrated with transaction prices in NE over time. Statistical analysis is necessary over the 5-year period to make an informed assessment. Important to recognize is there are quantity of transactions in included packer buying regions that impact 3/70/20 constraints *as well as* how any possible realignment might impact the quality of reported market information. Our study was designed to assess these essential components of potential market information reporting.

Figure 3. Estimated 2017 Cattle on Feed Density by County



Source: Estimated from 2017 Census of Agriculture data. We acknowledge Justin Bina for preparing this chart.

Results

Data Filters Applied

Prior to conducting analyses in this section, we applied several filters to the original data files provided to us by AMS. These filters included:

1. Negotiated Grid Net and Negotiated Grid Base purchase types were dropped so only negotiated cash purchases remained,
2. Transactions representing less than 11 head (consistent with AMS procedures) or more than 6,000 head were dropped,
3. Transactions having missing source of origin state were dropped,
4. Only Steers, Heifers, and Steer/Heifer Mixed (non-dairy) purchase classes were retained,
5. Transactions with average live weight<800 or >2000 lbs were dropped,
6. Transactions with average dressing percentage<50 or >70 were dropped,
7. Transactions with live price < $30/cwt or dressed price < $40/cwt were dropped, and
8. Transactions that were not domestic purchases were not included in analysis conducted.

To identify candidate states or cattle purchase origins to potentially add to, or combine with, existing 5-Area fed cattle negotiated market information reporting we calculated the number of negotiated transactions, head purchased, and market shares for the 13 largest volume states and NM (included because it is part of the current TX/OK/NM AMS market report). In assessing alternative regional negotiated transactions, we combined all negotiated purchases of:

Purchase Classes:
Steers
Heifers
Mixed Steer/Heifer

Selling Basis:
Live
Dressed
Both FOB and Delivered purchases were included for both live and dressed

Table 1 summarizes results of negotiated trade volumes over the 2014-18 period. For the 0-30 day transactions, NE had the largest number of transactions with more than 58,000 comprising more than 9 million head representing a 37% share of total domestic negotiated purchases. IA was next with some 47,000 transactions, over 5 million head, and a 21% share followed by KS with 34,000 transactions, more than 4 million head, representing a 17% market share. SD, a state not currently included in one of the major 5-Area reporting regions was the 4th largest volume state in the negotiated market with over 13,000 transactions, 1.7 million head, with almost a 7% share. This alone provides motivation to consider combining SD transactions with

another market in regional reporting, as currently SD transactions are not included in the weekly 5-Area or individual regional reports. However, with such significant volume, including SD negotiated purchases would significantly increase regional reporting volume.

Geographically, where the bulk of negotiated trade has occurred in recent years is highly concentrated. The market shares of 0-30 day negotiated purchases for the states listed in Table 1 are summarized in Figure 4. NE had the largest share represented at 37% followed by IA at 21%, and KS at 17%. The 5 largest volume states (in share-ranked order NE, IA, KS, SD, and TX) accounted for 86% of the national negotiated purchases. Adding MN and CO to the largest 5 volume states, cumulatively accounted for 93% of negotiated purchases. Finally, next in line for volume was IL which if included resulted in the largest 8 states representing 96% of negotiated purchase volume. This geographic concentration illustrates from at a volumetric basis where the depth of market information for negotiated transactions has been present, suggesting areas of most importance in negotiated purchases market information reporting.

Also noteworthy in Table 1, purchases within the 0-14 day delivery window are much more common than the 15-30 day window. Nationally, 85% of domestic negotiated purchases over the 2014-2018 period were 0-14 day and 15% were 15-30 day delivery windows. Furthermore, in some prominent cattle feeding states, the 15-30 day delivery purchases represent tiny, if any, trade volume. For example, only 3% of negotiated transactions in TX and in KS were 15-30 day delivery window over the 5-year horizon. NE and IA represent the largest majority of 15-30 day delivery window purchases with 63% of the entire national 15-30 day negotiated purchase transactions (71% by cattle volume) originating in just these two states over the 2014-18 period. This clearly illustrates potential difficulty of reporting purchases for 15-30 day delivery window separately in some regions such as TX or KS where they sparsely occur. However, if data from states are combined for regional reporting purposes, this could alleviate some of the confidentiality challenges with reporting 0-14 and 15-30 day purchases separately. We explore that specific question subsequently in this report.

Weekly shares of 0-14 day and 15-30 delivery purchases nationally over the 2014-18 period are summarized in Figure 5. During more than 80% of weeks, 0-14 delivery purchases represented at least 75% of weekly volume (head) purchased in the negotiated market. Figure 6 reports the same information as Figure 5 aggregated to an annual basis. No apparent trend is present, though during 2018, 19% of negotiated volume was represented by 15-30 day delivery purchases, the most of any of the five years. However, we would want to see data from post-2018 before we would conclude the share of 15-30 day purchases are trending upward.

Table 1. Number of Transactions, Total Head, and Shares of Head Transacted in Negotiated Domestic Market by State of Cattle Producer, 2014-2018 (Steers, Heifers, and Mixed Steers/Heifers combined; Dressed and Live combined; 0-30 day Delivery combined)

	2014	2015	2016	2017	2018	2014-18	2014	2015	2016	2017	2018	2014-18	2014	2015	2016	2017	2018	2014-18
States	Domestic Transactions						Total Domestic Head						Market Share (% of Total Domestic Head)					
CO																		
0-30	999	711	1,286	1,568	1,046	5,613	150,386	107,516	216,319	269,732	201,010	944,963	3.4%	2.6%	4.2%	4.9%	3.4%	3.8%
0-14	977	680	1,208	1,368	893	5,129	147,243	101,822	202,434	232,389	170,614	854,502	3.3%	2.5%	3.9%	4.2%	2.9%	3.4%
15-30	22	31	78	200	153	484	3,143	5,694	13,885	37,343	30,396	90,461	0.1%	0.1%	0.3%	0.7%	0.5%	0.4%
IA																		
0-30	10,270	9,194	7,967	8,923	10,664	47,047	1,109,924	1,034,694	866,555	952,678	1,242,281	5,206,132	25.0%	25.5%	16.7%	17.3%	20.8%	20.7%
0-14	8,578	7,759	6,296	7,297	8,419	38,376	892,664	849,393	646,398	723,589	932,485	4,044,529	20.1%	20.9%	12.5%	13.2%	15.6%	16.1%
15-30	1,692	1,435	1,671	1,626	2,245	8,671	217,260	185,301	220,157	229,089	309,796	1,161,603	4.9%	4.6%	4.2%	4.2%	5.2%	4.6%
IL																		
0-30	2,115	1,938	1,503	1,924	2,336	9,817	131,636	123,471	94,158	108,283	128,175	585,723	3.0%	3.0%	1.8%	2.0%	2.1%	2.3%
0-14	1,475	1,482	984	1,549	2,024	7,513	92,933	91,791	59,363	85,245	109,694	439,026	2.1%	2.3%	1.1%	1.6%	1.8%	1.7%
15-30	640	456	519	375	312	2,304	38,703	31,680	34,795	23,038	18,481	146,697	0.9%	0.8%	0.7%	0.4%	0.3%	0.6%
IN																		
0-30	436	444	427	444	469	2,226	23,392	22,430	20,087	20,903	22,299	109,111	0.5%	0.6%	0.4%	0.4%	0.4%	0.4%
0-14	332	324	249	325	346	1,582	17,840	16,394	11,448	15,338	15,770	76,790	0.4%	0.4%	0.2%	0.3%	0.3%	0.3%
15-30	104	120	178	119	123	644	5,552	6,036	8,639	5,565	6,529	32,321	0.1%	0.1%	0.2%	0.1%	0.1%	0.1%
KS																		
0-30	5,200	4,484	8,355	8,486	7,505	34,036	599,020	508,903	1,034,565	1,048,716	1,019,708	4,210,912	13.5%	12.5%	19.9%	19.1%	17.1%	16.7%
0-14	4,912	4,320	8,264	8,078	7,348	32,928	565,450	492,609	1,026,187	1,000,994	995,774	4,081,014	12.7%	12.1%	19.8%	18.2%	16.7%	16.2%
15-30	288	164	91	408	157	1,108	33,570	16,294	8,378	47,722	23,934	129,898	0.8%	0.4%	0.2%	0.9%	0.4%	0.5%
MN																		
0-30	1,268	1,240	1,383	1,640	1,736	7,268	171,457	172,742	187,606	222,255	239,300	993,360	3.9%	4.3%	3.6%	4.0%	4.0%	3.9%
0-14	1,142	1,070	944	1,226	1,228	5,611	149,146	142,067	121,779	151,541	149,616	714,149	3.4%	3.5%	2.3%	2.8%	2.5%	2.8%
15-30	126	170	439	414	508	1,657	22,311	30,675	65,827	70,714	89,684	279,211	0.5%	0.8%	1.3%	1.3%	1.5%	1.1%
NE																		
0-30	11,182	10,932	12,261	12,322	11,871	58,590	1,732,512	1,543,532	1,937,454	1,945,105	2,170,529	9,329,132	39.0%	38.0%	37.4%	35.4%	36.3%	37.1%
0-14	10,006	9,591	10,762	10,141	9,004	49,526	1,503,907	1,356,439	1,682,850	1,577,689	1,659,399	7,780,284	33.8%	33.4%	32.4%	28.7%	27.8%	30.9%
15-30	1,176	1,341	1,499	2,181	2,867	9,064	228,605	187,093	254,604	367,416	511,130	1,548,848	5.1%	4.6%	4.9%	6.7%	8.6%	6.2%
NM																		
0-30	2	2	4	18	1	27	104	140	265	1,863	74	2,446	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
0-14	2	2	4	11	1	20	104	140	265	934	74	1,517	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
15-30	-	-	-	7	-	7	-	-	-	929	-	929	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
OH																		
0-30	512	414	391	554	577	2,452	23,710	20,320	19,587	25,465	26,514	115,596	0.5%	0.5%	0.4%	0.5%	0.4%	0.5%
0-14	475	372	327	466	493	2,137	22,044	18,550	16,488	21,389	22,421	100,892	0.5%	0.5%	0.3%	0.4%	0.4%	0.4%
15-30	37	42	64	88	84	315	1,666	1,770	3,099	4,076	4,093	14,704	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%

Table 1. Continued

	2014	2015	2016	2017	2018	2014-18	2014	2015	2016	2017	2018	2014-18	2014	2015	2016	2017	2018	2014-18
States	Domestic Transactions						Total Domestic Head						Market Share (% of Total Domestic Head)					
OK																		
0-30	116	127	375	527	347	1,493	12,706	14,224	34,805	58,740	32,974	153,449	0.3%	0.4%	0.7%	1.1%	0.6%	0.6%
0-14	110	121	374	501	345	1,452	10,953	13,757	34,694	55,804	32,768	147,976	0.2%	0.3%	0.7%	1.0%	0.5%	0.6%
15-30	6	6	1	26	2	41	1,753	467	111	2,936	206	5,473	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%
SD																		
0-30	2,246	2,420	2,989	2,655	3,056	13,372	263,558	300,454	378,709	332,318	422,634	1,697,673	5.9%	7.4%	7.3%	6.0%	7.1%	6.7%
0-14	1,963	2,117	2,596	2,260	2,420	11,361	224,108	258,651	330,447	283,835	326,516	1,423,557	5.0%	6.4%	6.4%	5.2%	5.5%	5.7%
15-30	283	303	393	395	636	2,011	39,450	41,803	48,262	48,483	96,118	274,116	0.9%	1.0%	0.9%	0.9%	1.6%	1.1%
TX																		
0-30	763	717	2,093	2,721	2,359	8,653	111,860	93,293	258,323	365,595	295,191	1,124,262	2.5%	2.3%	5.0%	6.6%	4.9%	4.5%
0-14	683	679	2,079	2,615	2,304	8,360	93,441	87,768	256,526	350,394	285,707	1,073,836	2.1%	2.2%	4.9%	6.4%	4.8%	4.3%
15-30	80	38	14	106	55	293	18,419	5,525	1,797	15,201	9,484	50,426	0.4%	0.1%	0.0%	0.3%	0.2%	0.2%
WI																		
0-30	397	288	279	432	550	1,947	15,396	15,100	15,488	22,551	30,226	98,761	0.3%	0.4%	0.3%	0.4%	0.5%	0.4%
0-14	313	231	207	378	489	1,619	11,349	11,578	9,973	18,695	26,296	77,891	0.3%	0.3%	0.2%	0.3%	0.4%	0.3%
15-30	84	57	72	54	61	328	4,047	3,522	5,515	3,856	3,930	20,870	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
WY																		
0-30	227	280	327	309	235	1,378	44,150	50,996	66,934	58,770	51,694	272,544	1.0%	1.3%	1.3%	1.1%	0.9%	1.1%
0-14	226	272	314	304	223	698	43,824	48,963	64,740	58,326	49,521	265,374	1.0%	1.2%	1.2%	1.1%	0.8%	1.1%
15-30	1	8	13	5	12	680	326	2,033	2,194	444	2,173	7,170	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%
All Other																		
0-30	755	787	814	1,066	1,215	4,640	53,225	54,805	56,393	66,504	90,521	321,448	1.2%	1.3%	1.1%	1.2%	1.5%	1.3%
0-14	698	713	696	956	1,099	4,165	49,178	48,592	46,461	58,649	81,526	284,406	1.1%	1.2%	0.9%	1.1%	1.4%	1.1%
15-30	57	74	118	110	116	475	4,047	6,213	9,932	7,855	8,995	37,042	0.1%	0.2%	0.2%	0.1%	0.2%	0.1%
All States																		
0-30	36,488	33,978	40,454	43,589	43,967	198,559	4,443,036	4,062,620	5,187,248	5,499,478	5,973,130	25,165,512	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
0-14	31,892	29,733	35,304	37,475	36,636	170,477	3,824,184	3,538,514	4,510,053	4,634,811	4,858,181	21,365,743	86.1%	87.1%	86.9%	84.3%	81.3%	84.9%
15-30	4,596	4,245	5,150	6,114	7,331	28,082	618,852	524,106	677,195	864,667	1,114,949	3,799,769	13.9%	12.9%	13.1%	15.7%	18.7%	15.1%

Figure 4. Shares of 0-30 Day Negotiated Purchase Volume, 2014-2018

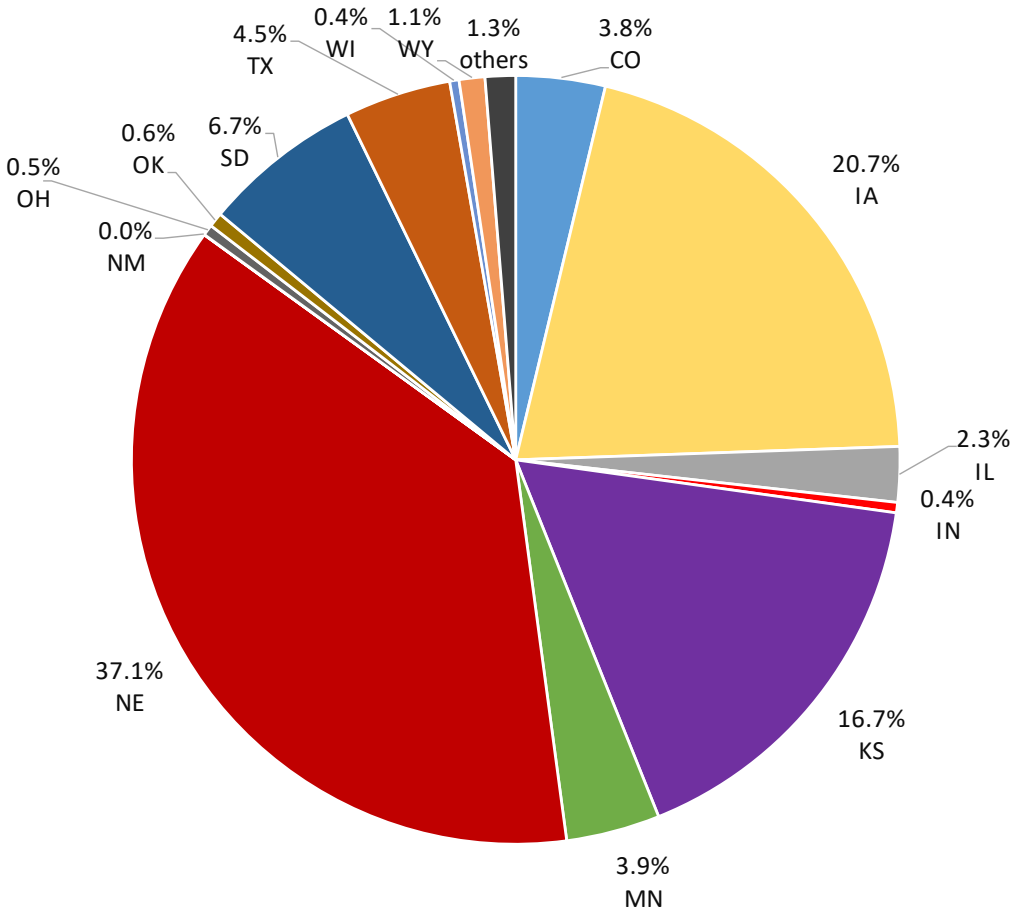


Figure 5. Weekly Shares of 0-14 Day and 15-30 Day Negotiated Purchases, Nationally, 2014-2018

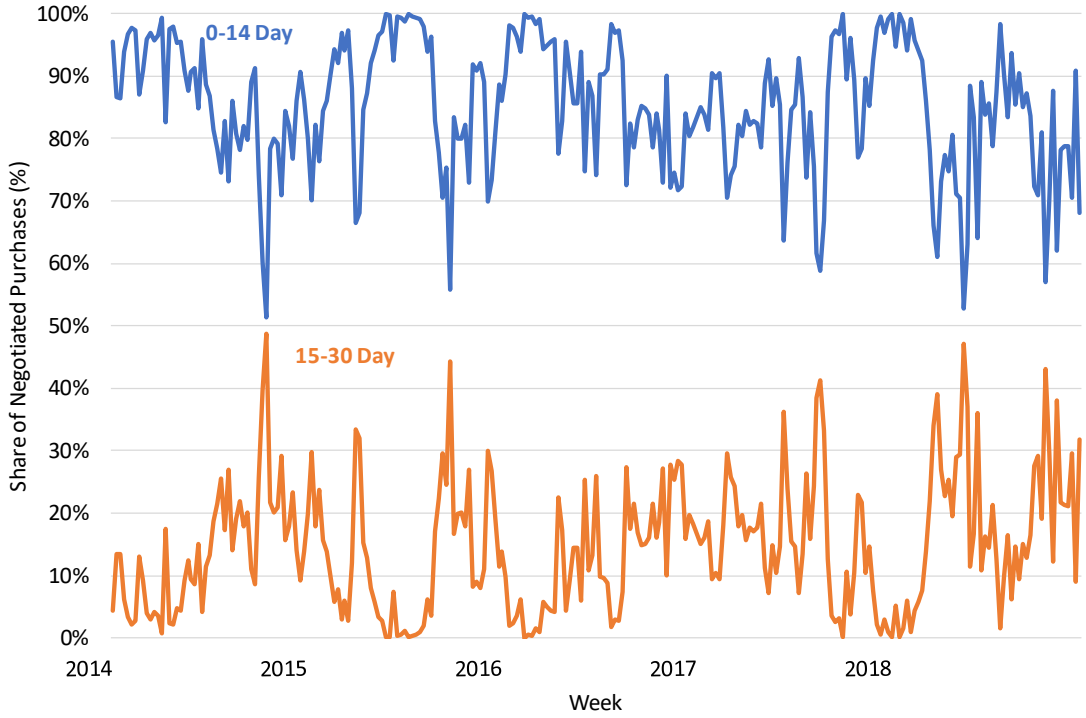
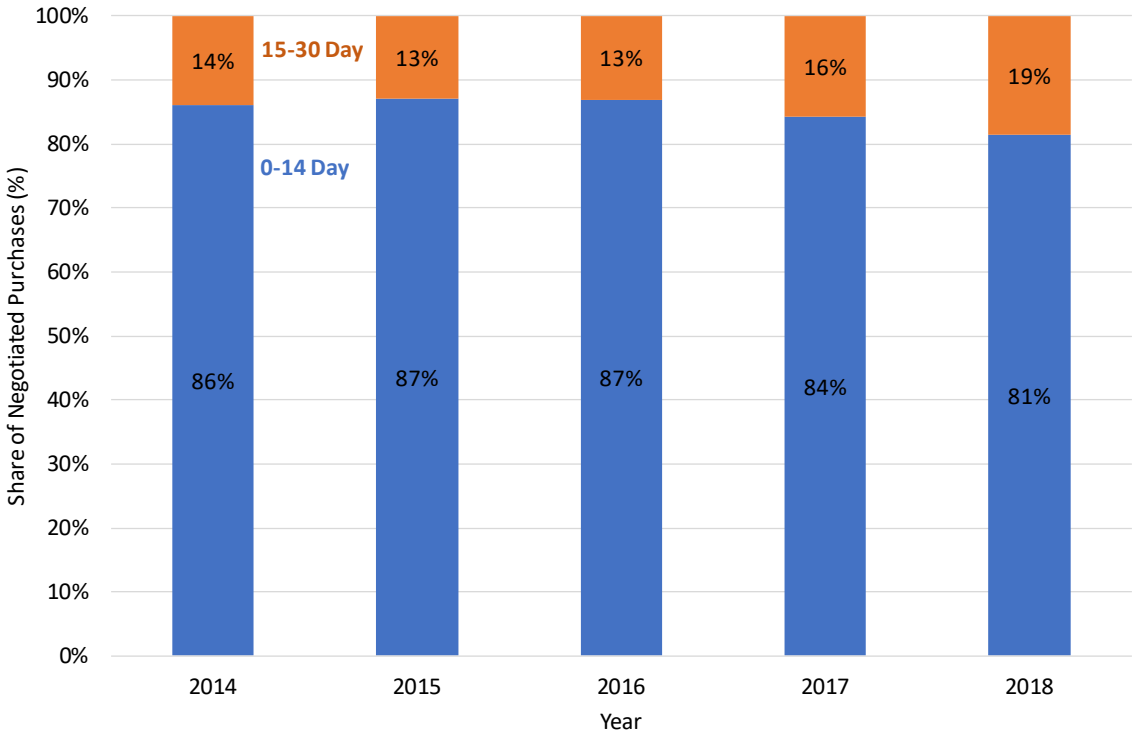


Figure 6. Annual Shares of 0-14 Day and 15-30 Day Negotiated Pruchases, Nationally, 2014-2018



Alternative Market Region Alignments

We explored several alternative regional market alignments to assess how 3/70/20 confidentiality guidelines would have influenced information reporting over the 2014-2018 period. LMR data identifies the origin state of cattle with no further refinement in specific origin location within a state. An argument could be made for considering splitting cattle purchases from any particular state into different reporting regions (e.g., eastern NE with western IA or western KS with eastern CO), but current LMR reporting protocol precludes such assessments. As such, alternative market reporting region alignments are constrained to consider only alternative, whole states of origin. We selected and tested 10 alternative origin alignments to assess how they would have impacted confidentiality guidelines for reporting 0-14, 15-30, and 0-30 day reporting windows.

The following criteria guided our selection of alternative alignments to consider:

1. Geographic proximity – only contiguous states were considered candidates to combine, they did not need to be all contiguous to each other, but contiguous to at least one state in the grouping.
2. Market share – only states having sufficient negotiated volume, as identified separately in Table 1, were considered candidates to include in potential re-alignments. We see little value in including states with insignificant negotiated volume in any potential realignment because of the limited impact on the quantity or quality of market information including additional states provides.
3. Reliable price data – only states where we deemed reported price data were reliable, or where if apparent data errors were present, we could correct or drop them from further analyses, were considered as candidates to combine with other state or origin data.

Alternative market regions considered are summarized in Table 2 and Figure 7 illustrates these alignments in US maps. Alignment 1 is the current regional market reporting by AMS. Each subsequent alterative regional alignment modifies the origin states to enable us to determine how these realignments affect confidentiality guideline reporting constraints. Important to recognize is that some of these potential realignments can be assessed independently and others cannot. For example, the IA/MN Alignment 1, can be evaluated alone or compared with any other alignment option below without consideration of any of the other regions. This is because the only states included in the alternative alignments that include IA/MN are not included in any other region (one exception to this is Alignment 2, because we move SD around to other regions in other alignments).

Table 2. Alternative Alignments for Regional Market Reporting Considered

Alignment	Region 1	Region 2	Region 3	Region 4	Region 5
1	IA/MN	NE	KS	TX/OK/NM	CO
2	IA/MN/SD/IL	NE/CO/WY	KS/TX/OK/NM		
3	IA/MN/IL/IN/OH	NE	CO/WY/SD	KS	TX/OK/NM
4	IA/MN/IL/IN/OH	NE/SD	CO/WY	KS	TX/OK/NM
5	IA/MN/IL/IN/OH	NE	CO/WY/SD	KS/TX/OK/NM	
6	IA/MN/IL/IN/OH	NE/SD	CO/WY	KS/TX/OK/NM	
7	IA/MN/IL/IN/OH	NE/CO/WY/SD	KS	TX/OK/NM	
8	IA/MN/IL/IN/OH	NE/SD	KS/CO/WY	TX/OK/NM	
9	IA/MN/IL/IN/OH	NE/SD/WY	KS	TX/OK/NM/CO	
10	IA/MN/IL/IN/OH	NE/CO/WY/SD	KS/TX/OK/NM		

In Region 1, we originally considered including WI as well as the other listed states in Alignments 3-10. However, reported transaction prices in the WI data were problematic. Frequent apparent data recording errors in WI data with no clear way to fix, resulted in us not being able to use these data in alternative regional alignments. Table 3 illustrates the magnitude of problems with the WI data where the average coefficient of variation in weekly reported prices was more than three times the magnitude of any other state included in the alternative regional alignments. WI typically had only about 7 negotiated transactions per week in the non-dairy Steers, Heifers, and Mixed Steers/Heifers categories. As such, using filters to delete problematic data in the WI market would result in too few transactions per week to be informative. WI only represented 0.4% of negotiated purchase volume (Figure 4), the 13th largest. So, dropping WI data does not materially affect volume in any alternative alignment.

Table 3. Simple Average of Weekly Coefficient of Variation of Negotiated Transaction Prices, 2014-2018

State	Weeks with Negotiated Transactions	Average Coefficient of Variation of Negotiated Prices (%)
CO	254	1.27
IA	260	1.31
IL	260	1.67
IN	260	1.56
KS	260	1.09
MN	260	1.79
NE	260	1.10
NM	13	0.46
OH	260	1.88
OK	227	0.99
SD	260	1.26
TX	256	1.01
WI	**258**	**5.73**
WY	251	0.78

Figure 7. Alternative Regional Market Alignments

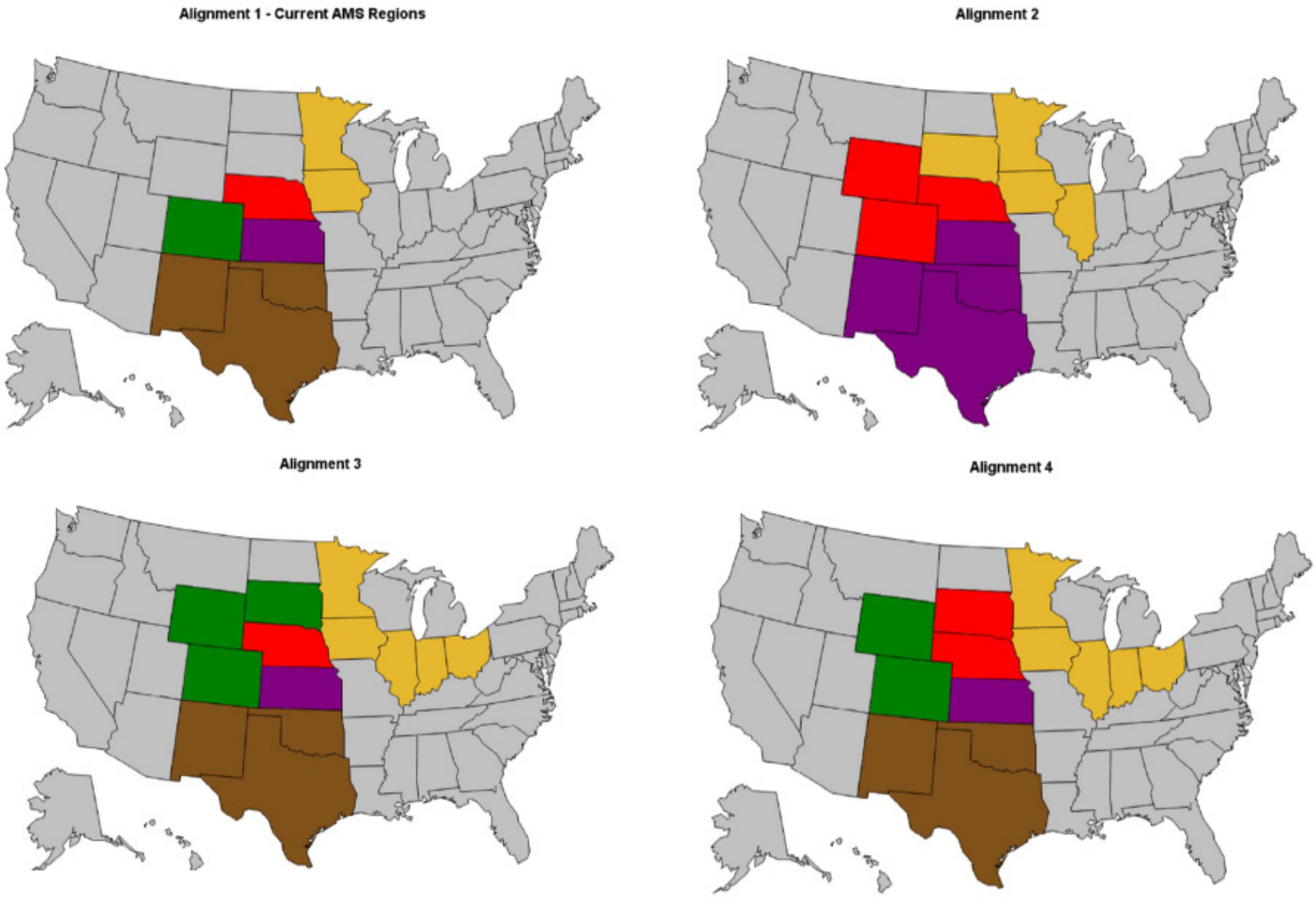


Figure 7 continued

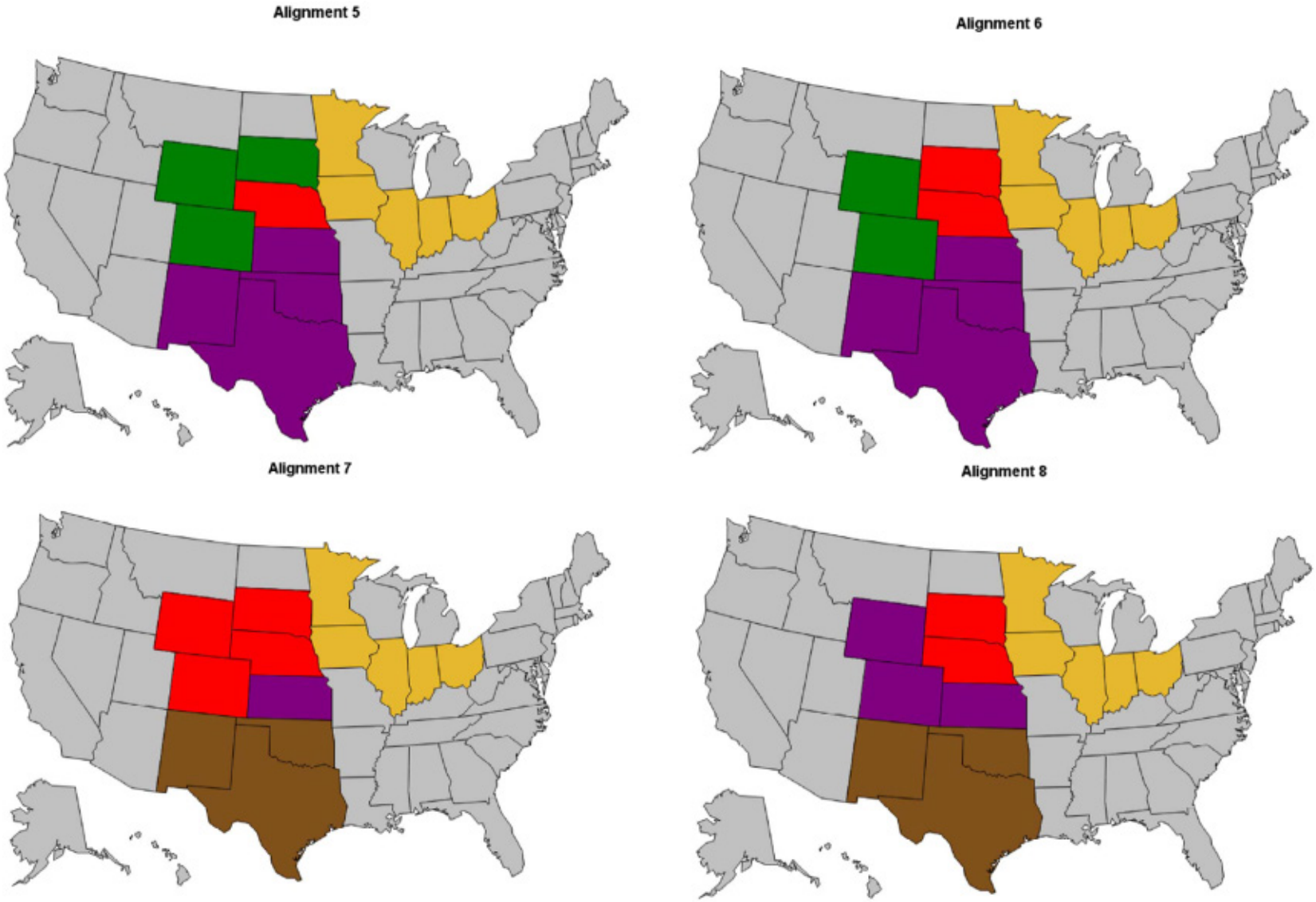
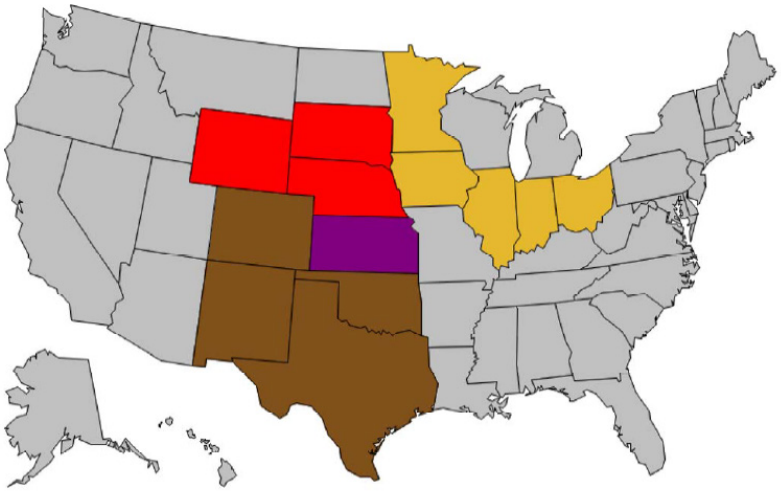
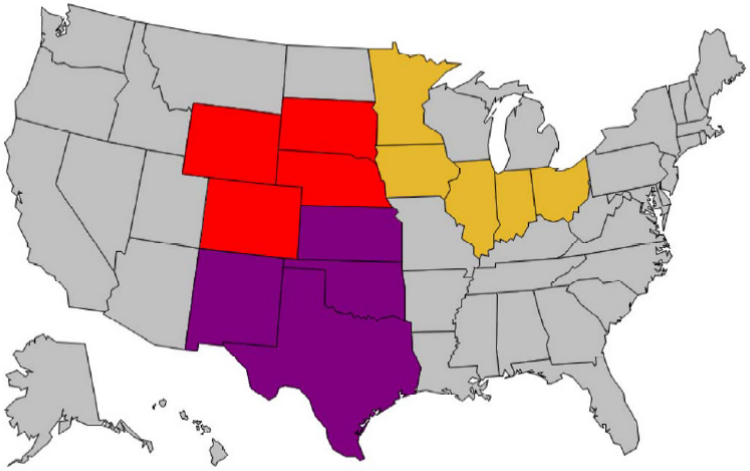


Figure 7 continued

Alignment 9



Alignment 10



Confidentiality for Alternative Market Alignments

The alternative market alignments were evaluated to determine how confidentiality guidelines for market reporting would impact 0-14, 15-30, and 0-30 day purchase window information over the 2014-18 period. In this assessment we maintained combining transactions that include Steers, Heifers, and Mixed Steers/Heifers; and dressed and live purchases that were either delivered or FOB. As such, the confidentiality guideline assessment conducted here determines how confidentiality guidelines would have impacted composite market information reporting for this aggregated set of purchase types. Separating genders and/or live/dressed purchase methods would increase the likelihood of confidentiality guidelines not allowing market information reporting relative to what we report here.

Figure 8 illustrates how for just Steers (charts for Heifers and Mixed Steers/Heifers would be equivalent), the number of possible categories of market reporting quickly expand to numerous reports as one considers the different combinations of transaction characteristics. If for example, AMS were to report each sex, live or dressed, delivery options, and days forward windows, the number of different weighted average prices potentially reportable for a single market area would be 24 (3 genders × 2 weight bases × 2 delivery options × 2 delivery windows) ignoring quality grade breakdowns which would make this number even larger. However, the tradeoff to more granular reporting is confidentiality guidelines rapidly prevent reporting for many of the 24 categories. Therefore, combining categories becomes essential to being able to regularly report market information.

Figure 8. Illustration of how Market Reporting Categories Expand with Transaction Types

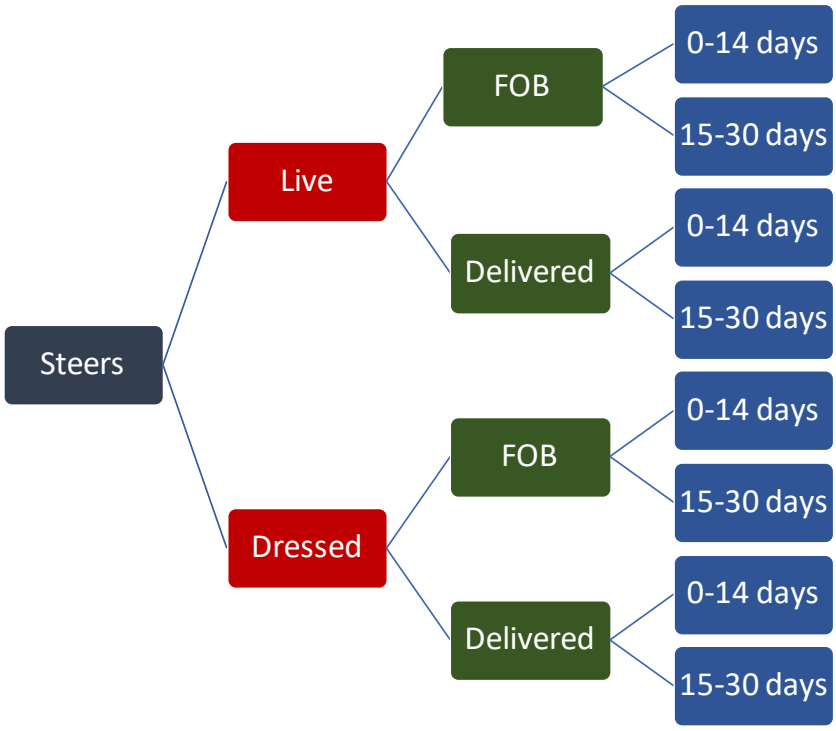


Table 4 further illustrates how numbers of negotiated transactions and percentage of weeks with reportable market information conditional on confidentiality guidelines are affected by data aggregation (i.e., alternative paths in Figure 8). All transactions for Steers, Heifers, Mixed Steers/Heifers; Dressed and Live (both Delivered and FOB); and 0-30 Day delivery are the starting point for the information in Table 4. This is the most fully aggregated negotiated purchases data for each market region. Each subsequent summary information breaks the aggregate data into progressively smaller data subsets. For example, "Steers" drops Heifers and Mixed Steers/Heifers but retains the rest of the aggregation. "Dressed Delivered Steers" further drops from "Steers" all live and any FOB dressed purchases. The final two filters in Table 4 report the "Dressed Delivered Steers" broken down into 0-14 and 15-30 day delivery windows.

Apparent in Table 4 is the number of transactions and percentages of reportable trade due to confidentiality both decline rapidly, especially for CO and TX/OK/NM, as further data filters are applied disaggregating the data into the example reporting categories (moving vertically down the table). For example, in CO, 87% of weeks the most highly aggregated trade is reportable over the 2014-18 period but this drops to 69% if Heifers and Mixed transactions are filtered out and to 0% if live transactions are filtered out so that only Dressed Delivered Steers are included. In contrast, in NE, where dressed purchases are much more common, reportable trade remains viable until one filters down to just Dressed Delivered Steers 15-30 Day delivery window where only 8% of weeks have reportable trade.

There are several important implications of the information summarized in Table 4. Market reporting for more disaggregated negotiated purchases by region, gender, dressed or live purchase, and delivery window for current market regions quickly become problematic from volume and confidentiality considerations. Aggregating data for market reporting purposes is essential. Without aggregating, especially for certain purchase types in certain market regions, no market information is reportable. Certainly, as will be apparent in subsequent analyses as well, consistently reporting market information for 0-14 and 15-30 day delivery windows separately is not feasible under current confidentiality guidelines, especially in regional markets. Important to realize is that any disaggregation of reporting market information in finer granularity reduces the chances of being able to report market information together for each category. That is, disaggregation adversely affects reportability for all disaggregated categories.

Fed cattle are being marketed in different ways across different regional markets. This is not news to anyone who participates in these markets. However, it certainly challenges consistent market information reporting. With different ways negotiated fed cattle are being traded, what might work well for reporting different breakdowns of market information in one region, will result in many blank market reports in another market region. Standardized reports across market regions are desirable for many reasons, but they are certainly challenged by heterogeneity in marketing methods without considerable data aggregation.

Table 4. Illustration of how Data Aggregation Impacts Transaction Numbers and Confidentiality Reportability, 2014-2018

Data Aggregation[a]	Market Region				
	NE	IA/MN	KS	CO	TX/OK/NM
All					
Transactions	58,590	54,315	34,036	5,613	10,173
% of weeks trade reportable	100	100	100	87	85
Steers					
Transactions	31,610	27,299	16,094	3,011	4,952
% of weeks trade reportable	100	100	100	69	68
Dressed Delivered Steers					
Transactions	16,815	12,077	658	127	6
% of weeks trade reportable	100	100	1	0	0
0-14 Days Dressed Delivered Steers					
Transactions	13,266	9,542	539	120	6
% of weeks trade reportable	98	99	0	0	0
15-30 Days Dressed Delivered Steers					
Transactions	3,549	2,535	119	7	0
% of weeks trade reportable	8	28	0	0	0

[a] **All** combines Steers, Heifers, Mixed Steers/Heifers; Dressed and Live (both FOB and Delivered); and 0-30 day delivery window

Steers includes Steers; Dressed and Live (both FOB and Delivered); and 0-30 day delivery window

Dressed Delivered Steers includes Steers; Dressed Delivered; and 0-30 day delivery window

0-14 Days Dressed Delivered Steers includes Steers; Dressed Delivered; and 0-14 day delivery window

15-30 Days Dressed Delivered Steers includes Steers; Dressed Delivered; and 0-14 day delivery window

Table 5, reported on the ensuing pages, summarizes confidentiality guideline market reporting analyses for the 0-14, 15-30, and 0-30 delivery window negotiated purchases across the current and alternative market alignments presented in Table 2. Because of the amount of information contained in Table 5, it spans several pages with each page presenting results for an alternative market alignment from Table 2. All confidentiality guideline assessments reported in Table 5 are made with the aggregated negotiated transactions for each region that include Steers, Heifers, Mixed Steers/Heifers; and Live and Dressed (FOB and Delivered). These aggregated transactions are evaluated across 0-30, 0-14, and 15-30 day delivery windows for selected alternative potential market reporting alignments. Important to realize is that with the aggregations we have used here any disaggregation by breaking the information down by sex or dressed/live, etc. would certainly reduce data reportability due to confidentiality constraints relative to what is contained in Table 5.

The first alignment in Table 5 is for current regional market reporting by AMS with the 5 regional markets and the national domestic market. For most of the current market region designations, the 0-30 day market information is generally reportable every year. IA/MN, NE, and KS all had 100% of weeks with reportable data for this trading window. However, reporting for CO and TX/OK/NM regions is more frequently constrained with CO only being reportable 87% of weeks and TX/OK/NM only 85% of weeks over the entire 5-year period. For IA/MN, NE, and KS market information for 0-14 day is 100% reportable. However, CO and TX/OK/NM are somewhat constrained with 79% and 83% reportable weeks. The 15-30 day reporting is more problematic across all market regions including the national domestic market. While being reportable just under half of the weeks in IA/MN, it is only reportable 18% of weeks in NE, and never reportable in KS, CO, or TX/OK/NM.

Table 5. Confidentiality Guidelines Impact on Reportable Trade, 2014*-2018

Alignment 1

Region / Delivery Window	2014	2015	2016	2017	2018	2014-18
	% of Weeks Trade Reportable					
IA/MN						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	59%	21%	0%	63%	90%	46%
NE						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	0%	0%	0%	36%	43%	18%
CO						
0-30 Day	78%	85%	85%	100%	85%	87%
0-14 Day	66%	73%	77%	100%	77%	79%
15-30 Day	0%	0%	0%	0%	0%	0%
KS						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	0%	0%	0%	0%	0%	0%
TX/OK/NM						
0-30 Day	90%	47%	90%	100%	100%	85%
0-14 Day	85%	40%	90%	100%	100%	83%
15-30 Day	0%	0%	0%	0%	0%	0%
5-Area						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	93%	12%	14%	62%	75%	50%
National Domestic						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	93%	52%	14%	62%	75%	58%

*2014 excludes first 11 weeks of data because confidentiality guidelines require 12 weeks of data.

The alternative market alignments considered attempt to address challenges with reporting 0-14 and 15-30 day data separately. Alignment 2 adds SD and IL to IA/MN; combines NE/CO/WY and combines KS/TX/OK/NM. This is the most condensed reporting region alignment (similar to Alignment 10 discussed later) of any we consider with only three regions. As such, this is a highly regionally aggregated reporting alternative. This reporting alignment would enable more reportable frequency across each region than the current alignment (Alignment 1) as 100% of 0-30 and 0-14 day trade weeks are reportable in each region. However, 15-30 day is still highly constrained, especially in the NE/CO/WY and the KS/TX/OK/NM with less than 20% of weeks over the five-year period being reportable.

Table 5. Continued

	Alignment 2					
	2014	2015	2016	2017	2018	2014-18
	% of Weeks Trade Reportable					
IA/MN/SD/IL						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	73%	57%	0%	63%	90%	56%
NE/CO/WY						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	0%	0%	0%	37%	44%	19%
KS/TX/OK/NM						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	24%	0%	0%	0%	0%	5%

Alignment 3 contains five market regions similar to current AMS reporting but it adds more states to the IA/MN and the CO regions. For IA/MN, IL/IN/OH are added as what could be considered major Corn Belt markets to increase represented regional negotiated volume traded. Because of clear challenges in reporting CO independently, it was combined with WY and SD. The other regions remain the same as in Alignment 1. The IA/MN/IL/IN/OH region has nearly the same confidentiality status as the IA/MN region simply because the bulk of the volume of this region is represented by IA and MN. IA and MN represent 85% of the negotiated volume (head) over the 5-year period of this 5-state region. For this region, 100% of the 0-30 and 0-14 day weeks are reportable and just under 50% of 15-30 day is reportable. For the CO/WY/SD market 100% of the 0-30 and 0-14 day weekly information is reportable, but only 7% of the 15-30 day is reportable (CO alone had 0%).

Table 5. Continued

	Alignment 3					
	2014	2015	2016	2017	2018	2014-18
	% of Weeks Trade Reportable					
IA/MN/IL/IN/OH						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	51%	57%	0%	62%	78%	49%
NE						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	0%	0%	0%	36%	43%	18%
CO/WY/SD						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	0%	0%	0%	4%	27%	7%
KS						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	0%	0%	0%	0%	0%	0%
TX/OK/NM						
0-30 Day	90%	47%	90%	100%	100%	85%
0-14 Day	85%	40%	90%	100%	100%	83%
15-30 Day	0%	0%	0%	0%	0%	0%

Alignment 4 is identical to 3 except SD is combined with NE instead of CO/WY. This enables assessment of how much including SD transactions alone with CO resolved issues with confidentiality. There may be some argument that SD fed cattle are similar to NE given geographic proximity and cattle feeding environments. CO/WY performs much like CO, which is not surprising given CO represents 78% of the negotiated volume (head) of the combined CO/WY region. As such, CO/WY behaves much like CO alone with most 0-30 and 0-14 day trade reportable and no 15-30 day reportable. There is a noticeable improvement in 0-14 day reportability for CO by adding WY as it increases from 87% (Alignment 1) to 93% of reportable weeks. NE/SD performs about the same as NE alone which is not surprising as NE represents 85% of the volume (head).

Table 5. Continued

	Alignment 4					
	2014	2015	2016	2017	2018	2014-18
	% of Weeks Trade Reportable					
IA/MN/IL/IN/OH						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	51%	57%	0%	62%	78%	49%
NE/SD						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	0%	0%	8%	55%	43%	20%
CO/WY						
0-30 Day	98%	90%	90%	100%	87%	93%
0-14 Day	83%	90%	90%	100%	87%	90%
15-30 Day	0%	0%	0%	0%	0%	0%
KS						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	0%	0%	0%	0%	0%	0%
TX/OK/NM						
0-30 Day	90%	47%	90%	100%	100%	85%
0-14 Day	85%	40%	90%	100%	100%	83%
15-30 Day	0%	0%	0%	0%	0%	0%

Alignment 5 goes back to CO/WY/SD of Alignment 3, but combines KS/TX/OK/NM. Part of the motivation for considering this alignment is it attempts to address both the TX/OK/NM and CO challenges. The KS/TX/OK/NM performs nearly identical to KS alone. Since KS had full reportability for 0-30 and 0-14 day but none for 15-30 day, this is essentially what shows up in the combined alignment with only slight increase to 5% of weekly trades reportable for 15-30 day.

Table 5. Continued

	Alignment 5					
	2014	2015	2016	2017	2018	2014-18
	% of Weeks Trade Reportable					
IA/MN/IL/IN/OH						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	51%	57%	0%	62%	78%	49%
NE						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	0%	0%	0%	36%	43%	18%
CO/WY/SD						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	0%	0%	0%	4%	27%	7%
KS/TX/OK/NM						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	24%	0%	0%	0%	0%	5%

Alignment 6 contains alignments already considered in previous alignments, just in different combinations. This alignment is the same as Alignment 4 except it combines KS/TX/OK/NM into one region. Nothing noteworthy is revealed from this alignment not already discussed in Alignment 4 and Alignment 5. Problems in reporting 15-30 day persist in this alignment for NE/SD, CO/WY, and KS/TX/OK/NM.

Table 5. Continued

	Alignment 6					
	2014	2015	2016	2017	2018	2014-18
	% of Weeks Trade Reportable					
IA/MN/IL/IN/OH						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	51%	57%	0%	62%	78%	49%
NE/SD						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	0%	0%	8%	55%	43%	20%
CO/WY						
0-30 Day	98%	90%	90%	100%	87%	93%
0-14 Day	83%	90%	90%	100%	87%	90%
15-30 Day	0%	0%	0%	0%	0%	0%
KS/TX/OK/NM						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	24%	0%	0%	0%	0%	5%

Alignment 7 reverts to having KS and TX/OK/NM as separate reporting regions but combines NE/CO/WY/SD into a single region. This new alignment again looks similar to NE alone though reportability for 15-30 does increase in some years (e.g., 36% to 55% in 2017), but remains similar (18% vs. 24%) across the overall five years.

Table 5. Continued

	Alignment 7					
	2014	2015	2016	2017	2018	2014-18
	% of Weeks Trade Reportable					
IA/MN/IL/IN/OH						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	51%	57%	0%	62%	78%	49%
NE/CO/WY/SD						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	0%	0%	10%	55%	44%	24%
KS						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	0%	0%	0%	0%	0%	0%
TX/OK/NM						
0-30 Day	90%	47%	90%	100%	100%	85%
0-14 Day	85%	40%	90%	100%	100%	83%
15-30 Day	0%	0%	0%	0%	0%	0%

Alignment 8 is identical to Alignment 6 with one change; KS is moved from the TX/OK/NM region to the CO/WY region so a KS/CO/WY is considered as a new possible alignment. This alignment ends up with KS/CO/WY being nearly identical to KS alone. Since, KS represents 78% of the negotiated volume (head) this was expected.

Table 5. Continued

	Alignment 8					
	2014	2015	2016	2017	2018	2014-18
	% of Weeks Trade Reportable					
IA/MN/IL/IN/OH						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	51%	57%	0%	62%	78%	49%
NE/SD						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	0%	0%	8%	55%	43%	20%
KS/CO/WY						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	0%	0%	0%	0%	5%	1%
TX/OK/NM						
0-30 Day	90%	47%	90%	100%	100%	85%
0-14 Day	85%	40%	90%	100%	100%	83%
15-30 Day	0%	0%	0%	0%	0%	0%

Alignment 9 is novel in that NE is combined with SD and WY (NE/SD/WY) and TX/OK/NM/CO are combined. NE/SD/WY, as expected, performs nearly identical to NE alone. TX/OK/NM/CO is appealing in that nearly all 0-30 and 0-14 day weekly information is reportable. This is an increase over CO or TX/OK/NM alone where they had 80-90% reportable for these categories. The 15-30 day remains largely unreportable for the TX/OK/NM/CO market combination (at 6% over the 2014-18 period).

Table 5. Continued

	Alignment 9					
	2014	2015	2016	2017	2018	2014-18
	% of Weeks Trade Reportable					
IA/MN/IL/IN/OH						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	51%	57%	0%	62%	78%	49%
NE/SD/WY						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	0%	0%	8%	55%	43%	23%
KS						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	0%	0%	0%	0%	0%	0%
TX/OK/NM/CO						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	93%	96%	100%	100%	100%	98%
15-30 Day	0%	0%	0%	0%	32%	6%

Alignment 10 is another alignment with only 3 market regions, like Alignment 2. However, the alternative market combinations are quite different across the two alignments. In Alignment 10 NE/CO/WY/SD are combined as in Alignment 7 and the KS/TX/OK/NM combination like Alignment 6 with the IA/MN/IL/IN/OH Corn Belt alignment again repeated. Nothing noteworthy not already discussed is revealed from this alignment.

Table 5. Continued

	Alignment 10					
	2014	2015	2016	2017	2018	2014-18
	% of Weeks Trade Reportable					
IA/MN/IL/IN/OH						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	51%	57%	0%	62%	78%	49%
NE/CO/WY/SD						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	0%	0%	10%	55%	44%	24%
KS/TX/OK/NM						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	24%	0%	0%	0%	0%	5%

Considering all ten alternative market region alignments, relative specifically to confidentiality, several generalizations surface. First, 0-30 and 0-14 day reporting is relatively liquid across most combinations, though of the current AMS reporting regions most constrained are in CO and TX/OK/NM. Issues in reporting in TX/OK/NM and CO can be reduced by combining these two into a single reporting region without adversely impacting other regions. Combinations of other candidate cattle origins with TX/OK/NM such as KS, results simply in the KS/TX/OK/NM region mirroring the KS market where more negotiated trade occurs.

Second, adding more states to the overall reporting regions appears worthwhile. The most apparently obvious market to add is SD but where best to combine it cannot be addressed solely from this segment of this report. This will be explored in subsequent sections more fully. From a confidentiality perspective, SD information could help CO and adding WY to this mix may have merit as well. However, SD market information may make more sense to combine with a region more similar to SD such as IA/MN or NE. We leave this question unanswered at this stage and address it more fully later.

Third, we found no alignment that effectively enables reporting consistently 15-30 day window negotiated purchases regionally. Even where they are most prominent, in IA/MN, they still can only be reported about half the time. Where they are less common, KS, CO, TX, NM, OK, and even NE and SD, market information for 15-30 days are not reportable for these regions either alone or in various combinations. Stated differently, across the 10 alignments considered none presented a case where over the 2014-18 period all reported regions would have 15-30 reported more than 10% of the weeks. About the only viable regions to consistently report separate 0-14 and 15-30 day purchases are the 5-Area or a national report.

Statistical Price Modeling

In addition to understanding how adding cattle from selected additional states of origin to existing 5-Area reporting regions might impact confidentiality constraints, it is important to understand how the quality of price information being reported by AMS might be impacted by realignment. A criticism of realignment might be that prices in one state or region may not reflect the negotiated prices in another state or region. To determine how negotiated price information would be affected under alternative regional market alignment, we evaluated how price levels and variability was impacted by adding more states of cattle origin to the price reporting regions.

This price analysis complements the confidentiality guideline market reporting analyses. Recall, that analysis found adding more states to the overall reporting regions appeared worthwhile. For example, the most apparently obvious market to add is SD but where best to combine it cannot be addressed solely from the confidentiality guideline market reporting analyses. From a confidentiality perspective, SD information could help CO and adding WY to this mix may have merit as well. However, SD market information may make more sense to combine with a region more similar to SD such as IA/MN or NE. Information on mean price and price variability across alternative alignments can aid in clarifying realignment implications on the quality of price information.

Before implementing any statistical price analysis, it was important to check whether outliers were present in the data because their existence could induce significant errors and biases. Outliers with considerable leverage can indicate a problem with the measurement or data recording. In such cases, it is recommended to remove these values. But the judgement about this should be based on reasons external to the data. Either the values are known to be "impossible", e.g. recordings of a price or dressing percent were incorrect, or other outlying but not-impossible values might be caused by special circumstances. It is important to note that in either of these cases, USDA AMS staff would have attempted to resolve the measurement or data recording issue and subsequently fixed the data or would have removed the data for reporting purposes.[7]

[7] For further detail on the LMR data validation process see https://www.ams.usda.gov/rules-regulations/mmr/lmr/excluded-transactions.

The identification and removal of outliers followed a multi-step process. First, any known outliers were removed based on industry standards or missing data. These filters were discussed on page 12 and drop many of the "impossible" values which included transactions with average live weight less than 800 lbs or greater than 2,000 lbs, average dressing percentage less than 50% or greater than 70%, and live price less than $30/cwt or dressed price less than $40/cwt. Second, any known special circumstances were identified and removed from the data. For example, when a plant breakdown occurred and cattle were transferred to another plant the transfer got recorded as a "new" transaction in the system. USDA AMS removes these transactions for reporting purposes. Other cases where USDA AMS would have corrected transactions or removed them for reporting purposes occur when there are cattle quality issues, a "fat finger" input of the data, and where a transaction was for dairy-bred fed cattle but recorded as a beef-type transaction, among others.

Beyond these identifiable reasons, a statistical approach was used to identify and remove additional outliers in the data.[8] This was done because when looking at multivariate outliers, it becomes difficult to identify the reasons, but known outliers exist and could induce significant issues. This is especially the case, for our analysis, as live prices were converted to a dressed basis using the estimated dressing percentage for each transaction as reported in the LMR data base by reporting packers. Similar to the confidentiality guideline market reporting analyses we also combine transactions that include Steers, Heifers, and Mixed Steers/Heifers, and 0-14 day and 15-30 day delivery window transactions that were either delivered or FOB. All prices were converted to weekly weighted averages (dressed weight basis) for statistical analyses.

The most common method to detect outliers, under the condition the data follow a normal distribution, is to use a criterion based on z-scores. We take a conservative approach under this criterion because of the highly individualized and somewhat idiosyncratic nature of fed cattle transactions data. Outlier detection and elimination was done separately on six categorizations of transactions. Namely, 1) dressed heifers, 2) live heifers, 3) dressed steers, 4) live steers, 5) dressed mixed steers/heifers, and 6) live mixed steers/heifers. We eliminate from our analysis only those transactions that are +/- three standard deviations away from the sample mean for dressed price (for dressed transactions), live price (for live transactions), and dressing percent (for all transactions). Values that occur only in 0.13% of all cases is conservative as other research[9] suggests being less demanding, and using 2.5 or even 2 standard deviations around the mean. This process removed 1,690 transactions or 0.85% of the data.[10]

[8] This process is consistent with AMS's data validation process. Following submission, information received from packers is automatically screened by the LMR electronic reporting program. Based on established criteria, certain transactions are flagged automatically by the program to be excluded during the generation of market reports.

[9] Miller, J. 1991. Reaction time analysis with outlier exclusion: Bias varies with sample size. *The Quarterly Journal of Experimental Psychology* 43(4): 907-912. https://www.tandfonline.com/doi/pdf/10.1080/14640749108400962?needAccess=true

[10] An alternative approach was also considered. We performed various influential diagnostic tests (e.g., studentized residuals, DFFITS statistics, and DFBETA statistics) and highlighted specific results that may be impacted by outlier data. This process identified 10,750 transactions or 5.43% of the data. If a transaction was

Table 6 reports summary statistics for weighted-average dressed prices by region and alignment, and t-tests of mean differences in prices. Paired t-tests are used because the price comparisons by alignment are not independent, a natural pairing of the price series exist as the base region is always contained in the alternative alignment. The paired t-test is more appropriate than a simple test of means because it takes correlation into account. Using this correlation results in higher power to detect existing differences between the means.

Findings for price differentials across alignments within regions are mixed, as some alternative alignments have higher values and others have lower values, while some show no statistical differences compared to the base alignment. For example, within Region 1 there is no statistical difference in mean price for IA/MN and IA/MN/SD/IL. However, between IA/MN and IA/MN/IL/IN/OH the difference is $0.14/cwt with the IA/MN/IL/IN/OH alignment having lower prices than IA/MN on average over the five-year period.

For Region 2, combining CO and WY with NE increases the price mean by $0.06/cwt, while adding SD, CO/WY/SD, or SD/WY to NE decreases the mean price by $0.15/cwt, $0.09/cwt, and $0.12/cwt, respectively. When TX/OK/NM is added to KS in Region 3 the mean price is $0.23/cwt lower. The addition of CO and WY to KS increases the mean price by $0.28/cwt. The one possible realignment to Region 4 is adding CO to TX/OK/NM and leads to a $1.04/cwt higher mean price. Adding WY and SD to CO in Region 5, decreases the mean price by $0.78/cwt. However, when just WY is added to CO the mean price increases by $0.19/cwt.

Mean differences in prices, and paired t-tests, between the base alignment and the 5-Area and the National composites are also shown to provide perspective on how further aggregation impacts price means. For example, both 5-Area and National mean prices are higher than those in IA/MN by $0.70/cwt and $0.60/cwt, respectively. On the other hand, 5-Area and National prices are lower than those in NE by $0.61/cwt and $0.71/cwt, respectively. Both the 5-Area and National mean price is not statistically different than the KS mean price. TX/OK/NM has a lower mean price than the 5-Area and National composites, while CO has a higher mean price with price differences in both TX/OK/NM and CO compared to the 5-Area and National composites greater than $1/cwt (in absolute value). In general, alternative alignments have less impact on mean price levels than aggregation to a 5-Area or National level. Table 6 also shows Pearson correlation coefficients between each alternative alignment and the base alignment in each region. All correlations are statistically significant at the 99% level of confidence. In fact, nearly perfectly positively correlated (values almost equal to 1). Since each base alignment in each region represents the bulk of the negotiated trade, this level of correlation was expected.

A measure of spread, or dispersion, was used to describe the variability in prices by alignment within a region. We use this in conjunction with a measure of central tendency, the mean, to provide a description of this variability. The measure of spread gives us an idea of how well the

removed, using the criterion of three standard deviations away from the mean as opposed to influential diagnostic tests, it was more likely an outlier than a valid observation.

mean represents the data. If the spread is large, the mean is not as representative as if the spread of data is small. This is because a large spread indicates that there are probably large differences between individual transaction prices. Additionally, it is often seen as positive if there is little variation in each price series as it indicates that they are similar.

Lower and upper percentiles provide a robust estimator of spread. A percentile range between the 15^{th} percentile and the 85^{th} percentile for each base and alternative alignment price series is used. Using this spread we know that price $p < P_{15}$ 15% of the time, and, $p < P_{85}$ 85% of the time. That is price p is within the range of $\{P_{15} - P_{85}\}$ 70% of the time. This range is then divided by the weighted average price for each price series and multiplied by 100 to convert it to a percentage.

Table 7 reports the price spreads by region and alignment, and paired t-tests of mean differences in spreads. For Regions 1, 3, and 4 results reveal statistically larger spreads for alternative alignments relative to the base alignment in each region. The one exception is in Region 3 where this is no statistical difference between the spread of KS and KS/TX/OK/NM. For Region 2 there is no statistical difference between the NE and NE/SD/WY spread, while the NE/CO/WY and NE/CO/WY/SD spreads are higher and the NE/SD spread is lower compared to the NE spread. For Region 5, all of the alternative alignment spreads are lower than the base alignment CO spread. However, the difference in the spread between CO/WY and CO is not statistically different than zero.

Table 8 illustrates the percentage change in mean prices of alternative alignments compared to the base alignment in each region. For example, in Region 1 a change in mean price is calculated as: ((IA/MN/SD/IL weighted average dressed price − IA/MN weighted average dressed price) ÷ IA/MN weighted average dressed price) × 100. The table also illustrates the percentage of weeks the mean price change falls in the intervals less than -1.0%, -0.51% to -1.0%, -0.01% to -0.50%, 0.0% to 0.49%, 0.50% to 0.99%, 1.0% to 1.49%, 1.50% to 1.99%, and greater than 2.0%.

Comparing alternative alignment IA/MN/SD/IL to base alignment IA/MN shows that 99.2% of the time during the 2014-2018 period the percentage change in mean price was in the interval -0.50% to 0.49%. This means that 258 out of 260 weeks the percentage change in mean price was within this range. The comparison of IA/MN/IL/IN/OH and IA/MN was similar at 98.5% or 256 out of 260 weeks. For all alternative alignments compared to the base NE alignment in Region 2, over 99% of the percentage change in mean price was within -0.50% to 0.49%, or 258 or 259 weeks. For Region 3, 98.5% and 92.7% of the percentage change in mean price was within -0.50% to 0.49%, respectively, for the KS/TX/OK/NM to KS and KS/CO/WY to KS comparisons.

For alternative alignments compared to the base alignment in Regions 4 and 5 are where percentage changes in mean prices become much larger. For Region 4, only 53.9% of the time, or 139 out of 258 weeks was the percentage change in mean price from TX/OK/NM to TX/OK/NM/CO in the -0.50% to 0.49% range. For Region 5, 51.2% and 86.6% of the percentage

change in mean price was within -0.50% to 0.49%, respectively, for the CO/WY/SD to CO and CO/WY to CO comparisons. Similar to what is shown in Table 6, potential alternative alignments have less impact on the percentage change in mean price than aggregation to a 5-Area or National level.

Table 9 is an extension of Table 7 and reports the percentage of weeks the $\{P_{15} - P_{85}\}/P_{\text{Mean}}$ spread falls in the range 0.0% to greater than 7.0% by 1.0% intervals. We consider the percentage of weeks that the price spread, as a percent of the mean, for each base alignment is between 0% and 2.99%. This shows that for IA/MN, 90.8% of the variation in prices is within 2.99% of the mean. This is 236 out of 260 weeks. This same measurement for NE, KS, TX/OK/NM, and CO is 88.1%, 95.8%, 93.0%, and 76.8%, respectively. As expected, in general variability in prices increases (a lower percentage is within 2.99% of the mean) as additional states are added to make up potential alternative alignments. However, there are a few exceptions. If SD is added to NE, 89.2% (compared to 88.1%) of the variation in prices is within 2.99% of the mean. When WY and SD are combined with CO or when just WY is combined with CO, 81.5% (compared to 76.8%) or 79.6% (compared to 76.8%) of the variation in prices is within 2.99% of the mean.

Considering all alternative market regional alignments, relative specifically to price means and variability, several generalizations surface. Combining SD and IL with IA/MN did not change the mean price level and only had a small impact on price variability. While combining WY and SD with CO did lead to a lower mean price and combining WY with CO led to a higher mean price, in both cases price variability was decreased. Similarly, adding SD to NE or SD and WY to NE decreased the mean price but also decreased price variability. Further detailed statistical analyses of the transaction prices and cattle quality information is completed in an Appendix to this report.

Table 6. Summary Statistics for Weighted Average Dressed Price by Region and Alignment, 2014-2018

Alignment	State(s)	N	Mean	Std Dev	Min	Max	Mean Difference[1]	Pr > |t|	Correlation Coefficient	Pr > |t|
Region 1										
1	IA/MN	260	208.441	30.32	152.78	269.70				
2	IA/MN/SD/IL	260	208.435	30.31	153.10	269.64	-0.0055	0.7210	0.99997	<0.0001
3 thru 10	IA/MN/IL/IN/OH	260	208.297	30.26	153.03	269.46	-0.1440	<0.0001	0.99995	<0.0001
11	5 Area	260	209.143	30.24	154.48	270.87	0.7023	<0.0001	0.99911	<0.0001
12	National	260	209.044	30.23	154.46	270.65	0.6037	<0.0001	0.99922	<0.0001
Region 2										
1, 3, 5	NE	260	209.751	30.42	155.59	270.96				
2	NE/CO/WY	260	209.810	30.43	155.48	271.58	0.0591	<0.0001	0.99997	<0.0001
4, 6, 8	NE/SD	260	209.598	30.45	155.35	270.90	-0.1530	<0.0001	0.99998	<0.0001
7, 10	NE/CO/WY/SD	260	209.663	30.45	155.27	271.32	-0.0880	<0.0001	0.99997	<0.0001
9	NE/SD/WY	260	209.634	30.45	155.35	270.97	-0.1174	<0.0001	0.99998	<0.0001
11	5 Area	260	209.143	30.24	154.48	270.87	-0.6085	<0.0001	0.99977	<0.0001
12	National	260	209.044	30.23	154.46	270.65	-0.7071	<0.0001	0.99977	<0.0001
Region 3										
1, 3, 4, 7, 9	KS	260	209.134	30.06	154.50	273.20				
2, 5, 6, 10	KS/TX/OK/NM	260	208.908	30.07	154.38	272.93	-0.2265	<0.0001	0.99996	<0.0001
8	KS/CO/WY	260	209.412	30.17	154.48	274.03	0.2778	<0.0001	0.99986	<0.0001
11	5 Area	260	209.143	30.24	154.48	270.87	0.0084	0.9411	0.99816	<0.0001
12	National	260	209.044	30.23	154.46	270.65	-0.0902	0.4475	0.99801	<0.0001
Region 4										
1 thru 8, 10	TX/OK/NM	258	207.774	29.83	154.02	272.12				
9	TX/OK/NM/CO	260	209.018	30.34	154.10	275.66	1.0411	<0.0001	0.99915	<0.0001
11	5 Area	260	209.143	30.24	154.48	270.87	1.1856	<0.0001	0.99759	<0.0001
12	National	260	209.044	30.23	154.46	270.65	1.0870	<0.0001	0.99744	<0.0001
Region 5										
1, 2, 7 thru 10	CO	254	210.739	30.83	154.24	275.93				
3, 5	CO/WY/SD	260	209.404	30.60	154.16	272.80	-0.7787	<0.0001	0.99836	<0.0001
4, 6	CO/WY	260	210.388	30.71	154.40	276.15	0.1898	<0.0001	0.99973	<0.0001
11	5 Area	260	209.143	30.24	154.48	270.87	-1.0585	<0.0001	0.99788	<0.0001
12	National	260	209.044	30.23	154.46	270.65	-1.1553	<0.0001	0.99779	<0.0001

[1] The paired t-test only use cases that have non-missing values for both variables. As such the mean differences for Regions 4 and 5 are different than would be calculated using the summary statistic means.

Table 7. Summary Statistics for Price Spreads as Percent of Mean Price by Region and Alignment, 2014-2018

Alignment	State(s)	N	Mean	Std Dev	Min	Max	Mean Difference[1]	Pr > |t|
Region 1								
1	IA/MN	260	1.966	0.85	0.78	6.92		
2	IA/MN/SD/IL	260	2.090	0.85	0.80	6.93	0.1241	<0.0001
3 thru 10	IA/MN/IL/IN/OH	260	2.281	0.88	0.94	6.92	0.3154	<0.0001
11	5 Area	260	2.358	0.86	1.00	6.62	0.3929	<0.0001
12	National	260	2.485	0.85	1.10	6.31	0.5195	<0.0001
Region 2								
1, 3, 5	NE	260	1.906	0.90	0.00	5.34		
2	NE/CO/WY	260	2.059	0.91	0.47	5.49	0.1533	<0.0001
4, 6, 8	NE/SD	260	1.855	0.87	0.32	5.34	-0.0506	0.0003
7, 10	NE/CO/WY/SD	260	1.996	0.89	0.50	5.33	0.0899	<0.0001
9	NE/SD/WY	260	1.887	0.88	0.47	5.34	-0.0185	0.1786
11	5 Area	260	2.358	0.86	1.00	6.62	0.4525	<0.0001
12	National	260	2.485	0.85	1.10	6.31	0.5792	<0.0001
Region 3								
1, 3, 4, 7, 9	KS	260	1.936	0.71	0.79	6.13		
2, 5, 6, 10	KS/TX/OK/NM	260	1.951	0.59	0.93	4.74	0.0153	0.4641
8	KS/CO/WY	260	2.137	0.69	1.10	6.57	0.2006	<0.0001
11	5 Area	260	2.358	0.86	1.00	6.62	0.4224	<0.0001
12	National	260	2.485	0.85	1.10	6.31	0.5491	<0.0001
Region 4								
1 thru 8, 10	TX/OK/NM	258	1.740	0.77	0.00	4.81		
9	TX/OK/NM/CO	260	2.452	0.97	0.32	6.70	0.7137	<0.0001
11	5 Area	260	2.358	0.86	1.00	6.62	0.6172	<0.0001
12	National	260	2.485	0.85	1.10	6.31	0.7460	<0.0001
Region 5								
1, 2, 7 thru 10	CO	254	2.508	1.37	0.06	9.11		
3, 5	CO/WY/SD	260	2.219	1.02	0.42	8.03	-0.2796	0.0004
4, 6	CO/WY	260	2.451	1.16	0.00	8.01	-0.0148	0.7596
11	5 Area	260	2.358	0.86	1.00	6.62	-0.1489	0.0936
12	National	260	2.485	0.85	1.10	6.31	-0.0250	0.7789

[1] The paired t-test only use cases that have non-missing values for both variables. As such the mean differences for Regions 4 and 5 are different than would be calculated using the summary statistic means.

Table 8. Change in Mean Price as Percentage of Base Mean by Region and Alignment, 2014-2018

Alignment	State(s)	N	Mean	Std Dev	Min	Max	< -1.00	-0.51 to -1.00	-0.01 to -0.50	0.00 to 0.49	0.50 to 0.99	1.00 to 1.49	1.50 to 1.99	>= 2.00
Region 1 (Base = IA/MN vs. Alternative Alignment)														
2	IA/MN/SD/IL	260	-0.002	0.13	-0.61	0.66	0.0%	0.4%	50.4%	48.8%	0.4%	0.0%	0.0%	0.0%
3 thru 10	IA/MN/IL/IN/OH	260	-0.065	0.17	-0.52	1.65	0.0%	0.4%	80.4%	18.1%	0.4%	0.4%	0.4%	0.0%
11	5 Area	260	0.353	0.65	-1.38	2.45	1.9%	6.5%	20.4%	38.1%	15.8%	11.5%	5.0%	0.8%
12	National	260	0.306	0.61	-1.32	2.25	1.5%	5.8%	21.9%	41.2%	16.5%	8.8%	3.8%	0.4%
Region 2 (Base = NE vs. Alternative Alignment)														
2	NE/CO/WY	260	0.028	0.12	-0.65	0.55	0.0%	0.4%	39.6%	59.6%	0.4%	0.0%	0.0%	0.0%
4, 6, 8	NE/SD	260	-0.077	0.10	-0.55	0.11	0.0%	0.4%	80.4%	19.2%	0.0%	0.0%	0.0%	0.0%
7, 10	NE/CO/WY/SD	260	-0.045	0.12	-0.72	0.40	0.0%	0.4%	65.4%	34.2%	0.0%	0.0%	0.0%	0.0%
9	NE/SD/WY	260	-0.060	0.10	-0.51	0.16	0.0%	0.4%	74.2%	25.4%	0.0%	0.0%	0.0%	0.0%
11	5 Area	260	-0.284	0.32	-1.67	0.87	1.9%	20.8%	63.8%	12.7%	0.8%	0.0%	0.0%	0.0%
12	National	260	-0.331	0.32	-1.61	0.75	2.3%	23.8%	60.8%	12.3%	0.8%	0.0%	0.0%	0.0%
Region 3 (Base = KS vs. Alternative Alignment)														
2, 5, 6, 10	KS/TX/OK/NM	260	-0.111	0.13	-0.71	0.54	0.0%	1.2%	84.6%	13.8%	0.4%	0.0%	0.0%	0.0%
8	KS/CO/WY	260	0.128	0.24	-0.78	0.97	0.0%	1.5%	24.2%	68.5%	5.8%	0.0%	0.0%	0.0%
11	5 Area	260	-0.007	0.85	-2.87	2.87	11.9%	15.8%	19.6%	26.5%	16.5%	6.9%	1.5%	1.2%
12	National	260	-0.054	0.89	-3.07	2.76	15.4%	15.0%	17.3%	26.5%	16.5%	6.9%	1.2%	1.2%
Region 4 (Base = TX/OK/NM vs. Alternative Alignment)														
9	TX/OK/NM/CO	258	0.479	0.60	-1.25	2.53	1.6%	2.7%	11.2%	42.6%	25.6%	10.1%	4.7%	1.6%
11	5 Area	258	0.555	0.98	-2.20	3.55	5.4%	7.4%	14.0%	20.9%	20.2%	15.9%	10.1%	6.2%
12	National	258	0.508	1.01	-2.40	3.50	7.0%	9.7%	13.2%	19.4%	20.5%	14.0%	10.1%	6.2%
Region 5 (Base = CO vs. Alternative Alignment)														
3, 5	CO/WY/SD	254	-0.368	0.83	-3.46	1.59	18.9%	18.9%	28.0%	23.2%	7.9%	2.4%	0.8%	0.0%
4, 6	CO/WY	254	0.091	0.33	-1.02	1.61	0.4%	5.1%	24.0%	62.6%	6.3%	0.8%	0.8%	0.0%
11	5 Area	254	-0.479	0.95	-3.43	2.85	26.4%	21.3%	22.0%	17.7%	8.7%	1.6%	1.2%	1.2%
12	National	254	-0.525	0.97	-3.48	2.91	29.9%	21.7%	19.3%	16.9%	7.9%	2.0%	1.2%	1.2%

Table 9. Price Spreads as Percentage of Mean by Region and Alignment, 2014-2018

Alignment	State(s)	N	Mean	Std Dev	Min	Max	0.00 to 0.99	1.00 to 1.99	2.00 to 2.99	3.00 to 3.99	4.00 to 4.99	5.00 to 5.99	6.00 to 6.99	>= 7.00
Region 1														
1	IA/MN	260	1.966	0.85	0.78	6.92	3.8%	61.2%	25.8%	5.8%	2.3%	0.4%	0.8%	0.0%
2	IA/MN/SD/IL	260	2.090	0.85	0.80	6.93	0.4%	58.1%	31.5%	6.2%	2.7%	0.0%	1.2%	0.0%
3 thru 10	IA/MN/IL/IN/OH	260	2.281	0.88	0.94	6.92	0.4%	47.3%	36.2%	11.9%	2.7%	0.4%	1.2%	0.0%
11	5 Area	260	2.358	0.86	1.00	6.62	0.0%	40.4%	41.9%	12.7%	3.5%	1.2%	0.4%	0.0%
12	National	260	2.485	0.85	1.10	6.31	0.0%	32.3%	46.2%	15.0%	5.0%	1.2%	0.4%	0.0%
Region 2														
1	NE	260	1.906	0.90	0.00	5.34	10.4%	52.7%	25.0%	7.7%	3.5%	0.8%	0.0%	0.0%
2	NE/CO/WY	260	2.059	0.91	0.47	5.49	5.4%	50.4%	30.0%	9.2%	3.5%	1.5%	0.0%	0.0%
4, 6, 8	NE/SD	260	1.855	0.87	0.32	5.34	11.5%	53.5%	24.2%	7.3%	3.1%	0.4%	0.0%	0.0%
7, 10	NE/CO/WY/SD	260	1.996	0.89	0.50	5.33	6.2%	55.0%	26.2%	8.1%	3.5%	1.2%	0.0%	0.0%
9	NE/SD/WY	260	1.887	0.88	0.47	5.34	8.8%	55.4%	24.6%	7.3%	3.1%	0.8%	0.0%	0.0%
11	5 Area	260	2.358	0.86	1.00	6.62	0.0%	40.4%	41.9%	12.7%	3.5%	1.2%	0.4%	0.0%
12	National	260	2.485	0.85	1.10	6.31	0.0%	32.3%	46.2%	15.0%	5.0%	1.2%	0.4%	0.0%
Region 3														
1	KS	260	1.936	0.71	0.79	6.13	2.3%	61.9%	31.5%	2.3%	0.8%	0.8%	0.4%	0.0%
2, 5, 6, 10	KS/TX/OK/NM	260	1.951	0.59	0.93	4.74	1.5%	62.3%	31.2%	3.5%	1.5%	0.0%	0.0%	0.0%
8	KS/CO/WY	260	2.137	0.69	1.10	6.57	0.0%	47.7%	45.8%	5.0%	0.4%	0.8%	0.4%	0.0%
11	5 Area	260	2.358	0.86	1.00	6.62	0.0%	40.4%	41.9%	12.7%	3.5%	1.2%	0.4%	0.0%
12	National	260	2.485	0.85	1.10	6.31	0.0%	32.3%	46.2%	15.0%	5.0%	1.2%	0.4%	0.0%
Region 4														
1	TX/OK/NN	258	1.740	0.77	0.00	4.81	14.3%	58.9%	19.8%	4.3%	2.7%	0.0%	0.0%	0.0%
9	TX/OK/NM/CO	260	2.452	0.97	0.32	6.70	2.3%	33.1%	40.4%	16.9%	5.0%	1.5%	0.8%	0.0%
11	5 Area	260	2.358	0.86	1.00	6.62	0.0%	40.4%	41.9%	12.7%	3.5%	1.2%	0.4%	0.0%
12	National	260	2.485	0.85	1.10	6.31	0.0%	32.3%	46.2%	15.0%	5.0%	1.2%	0.4%	0.0%
Region 5														
1	CO	254	2.508	1.37	0.06	9.11	5.9%	31.5%	39.4%	12.6%	5.1%	1.6%	1.2%	2.8%
3, 5	CO/WY/SD	260	2.219	1.02	0.42	8.03	2.7%	47.3%	31.5%	13.1%	2.7%	1.9%	0.4%	0.4%
4, 6	CO/WY	260	2.451	1.16	0.00	8.01	5.0%	30.8%	43.8%	12.7%	3.5%	2.3%	1.2%	0.8%
11	5 Area	260	2.358	0.86	1.00	6.62	0.0%	40.4%	41.9%	12.7%	3.5%	1.2%	0.4%	0.0%
12	National	260	2.485	0.85	1.10	6.31	0.0%	32.3%	46.2%	15.0%	5.0%	1.2%	0.4%	0.0%

Hedonic Modeling

To further assess alternative alignments of various states in regional market information reporting, we estimated a hedonic model of transaction prices. The hedonic model serves several purposes. First, it enables us to assess differences in typical prices across candidate states to combine, after adjusting for other relevant transaction characteristics as available in LMR data. As such, the hedonic model provides an additional guide to selecting potential states to combine in regional price reporting. Second, the hedonic modeling provides information on how transaction characteristics typically influence price differentials across transactions which helps illustrate sensitivity of prices to transaction attributes. The more sensitive prices are to varying transaction attributes, the more market reports might want to assess disaggregating price reports by attributes. Or to put it another way, the less sensitive prices are to various transaction attributes, the more comfort there is in aggregating data across transactions to reduce confidentiality constraints. Third, not only does the hedonic model provide an aggregate test of statistical significance and interpretation of economic relevance of various price determinants, it also provides a direct assessment of how reliable or systematic each attribute is in impacting price differentials across transactions.

The hedonic model was formulated using each transaction price (live converted to dressed) as the dependent variable. Only negotiated transactions included in the 13 states considered in previous analysis in this study were included in the hedonic modeling. The individual transaction (*i*) prices across all days over the 2014-18 period in an unbalanced panel were regressed against the characteristics of the transacted set of cattle including:

Dependent Variable:

Price$_i$ the dressed price paid per hundred weight for each transaction *i.*

Independent Variables:

STATE$_i$ binary variables for the state of origin of the cattle (where *STATE=IA, MN, IL, IN, OH, CO, WY, SD, TX, NM, OK, KS, or NE*),

DRESSWT$_i$ and *DRESSWTSQ*$_i$ dressed weight (lbs. per head) and dress weight squared to allow for nonlinearity in price as weight changes,

STEER$_i$*, HEIFER*$_i$*, MIXED*$_i$ binary variables for purchase class,

DRESSED$_i$ binary variable for whether the transaction was purchased on a dressed basis as opposed to a live basis

DELIVERED$_i$ binary variable for whether the transaction was delivered to the plant as opposed to FOB,

0to14DAY$_i$ binary variable for whether the transaction was a 0-14 day delivery as opposed to 15-30 day,

0to14DAYyr$_i$ (where *yr = 2014, 2015, 2016, 2017, or 2018*) binary variables, to allow the 0-14 day delivery price differential to vary by year the 0-14 Day variable was interacted with a set of binary year variables,

HEAD$_i$ and *HEADSQ*$_i$ number of head included in the transaction and number of head squared to allow for nonlinearity,

CHOICE$_i$ the estimated percent Choice quality grade cattle in the transaction,
DAY$_i$ daily dummy variables were included to account for aggregate change in market price over time.

The full model is:

$$Price_i = \beta_0 + \sum_{s=1}^{S} \beta_s STATE_{si} + \beta_{S+1} DRESSWT_i + \beta_{S+2} DRESSWTSQ_i + \beta_{S+3} STEER_i$$
$$+ \beta_{S+4} HIEFER_i + \beta_{S+5} MIXED_i + \beta_{S+6} DRESSED_i + \beta_{S+7} DELIVERED_i$$
$$+ \beta_{S+8} 0to14DAY_i + \beta_{S+9} 0to14DAY2014_i + \beta_{S+10} 0to14DAY2015_i$$
$$+ \beta_{S+11} 0to14DAY2016_i + \beta_{S+12} 0to14DAY2017_i$$
$$+ \beta_{S+13} HEAD_i + \beta_{S+14} HEADSQ_i + \beta_{S+15} CHOICE_i + \sum_{d=1}^{D} \delta_d DAY_{di} + \mathcal{E}_i$$

In estimation, the state of *NE*, and *STEER* were the defaults and dropped to avoid perfect collinearity and the *0to14DAY2018* variable was dropped since it was embedded in the *0to14DAY* variable. The model was also estimated dropping the intercept term and not dropping a *DAY*. Three alternative models were estimated to illustrate potential model sensitivity to inclusion of specific independent variables. The percentage Choice grade variable had an unexpected negative sign in Model 1, so it was dropped in Model 2 to investigate its impact on other coefficients. The number of head and head squared were also dropped in Model 3 to assess how this variable impacted state price differences. The rationale was because some states tend to have smaller transaction sizes, the binary state variables could be associated with the number of head per transaction.

The estimates from the hedonic models are presented in Table 10. From a general perspective, key conclusions are the same for the main variables of interest across all three models. That is, dropping *HEAD*, *HEADSQ*, and *CHOICE* had no discernable economically or statistically important impact on the coefficient estimates for the rest of the variables in the models. As such, discussion here will focus on Model 1 that includes these variables since it is the most general model, results are essentially the same across the other model variants. With the large number of observations of nearly 200,000 transactions, nearly all variables are statistically significantly different from zero with at least a 99% level of confidence. Only two variables were not significant at these high levels. They included the *NM* price differential relative to the default of *NE* (but NM has very few transactions over the time period – only 27 (Table 2), so this is not a noteworthy result). The second variable not statistically significant at 99% confidence levels is the *0to14DAY2017* variable which simply measures whether the *0to14DAY* delivery in 2017 had a statistically different price impact than the default or base year of 2018. So, this result simply indicates 2017 and 2018 had similar price differentials associated with 1 to 14 relative to 15-30 day delivery transactions.

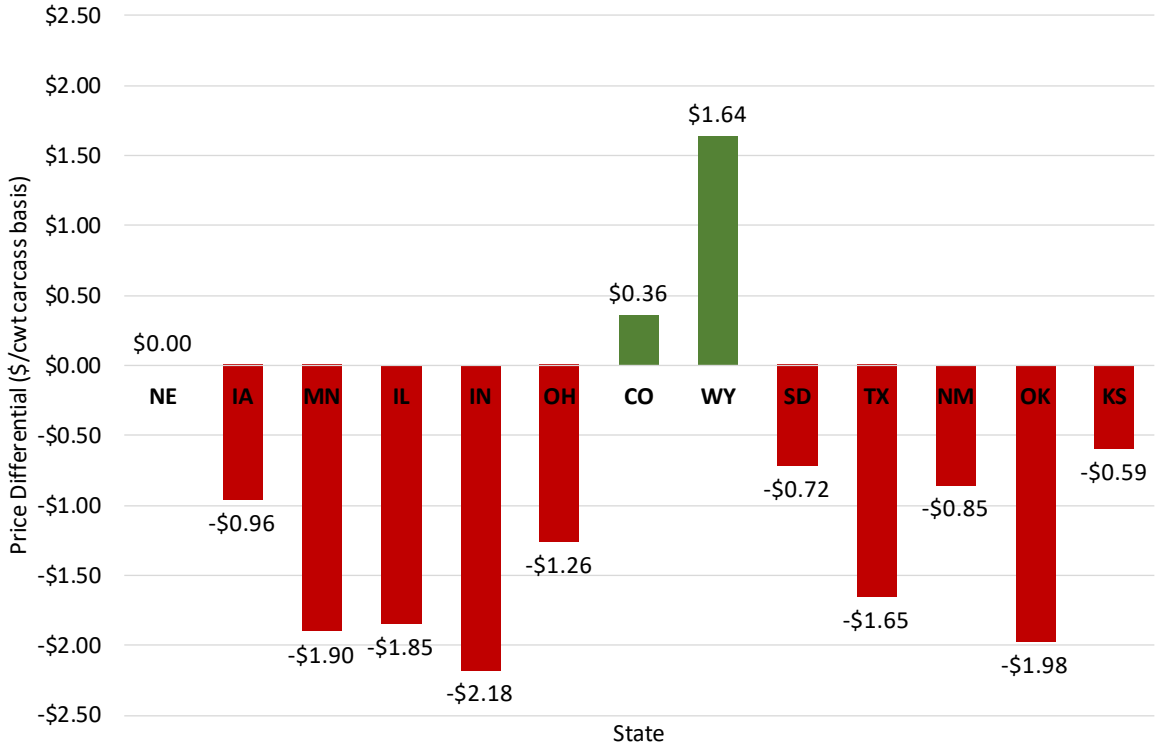
Table 10. Hedonic Model Parameter Estimates Using Transaction from 13 Select States

	Model 1			Model 2			Model 3		
Dependent Variable	Coefficient Estimate	Standard Error	P-Value	Coefficient Estimate	Standard Error	P-Value	Coefficient Estimate	Standard Error	P-Value
NE	base			base			base		
IA	-0.959	0.021	<.0001	-1.024	0.020	<.0001	-1.085	0.020	<.0001
MN	-1.899	0.040	<.0001	-1.966	0.039	<.0001	-1.986	0.039	<.0001
IL	-1.848	0.037	<.0001	-1.949	0.036	<.0001	-2.097	0.036	<.0001
IN	-2.177	0.071	<.0001	-2.305	0.070	<.0001	-2.476	0.070	<.0001
OH	-1.260	0.069	<.0001	-1.365	0.068	<.0001	-1.534	0.068	<.0001
CO	0.358	0.045	<.0001	0.423	0.045	<.0001	0.419	0.045	<.0001
WY	1.638	0.085	<.0001	1.639	0.085	<.0001	1.677	0.085	<.0001
SD	-0.719	0.030	<.0001	-0.760	0.030	<.0001	-0.782	0.030	<.0001
TX	-1.654	0.042	<.0001	-1.452	0.040	<.0001	-1.499	0.040	<.0001
NM	-0.855	0.629	0.1739	-0.773	0.629	0.2191	-0.888	0.630	0.1584
OK	-1.976	0.083	<.0001	-1.862	0.082	<.0001	-1.961	0.082	<.0001
KS	-0.593	0.026	<.0001	-0.481	0.025	<.0001	-0.540	0.025	<.0001
DRESSWT	0.088	0.002	<.0001	0.087	0.002	<.0001	0.085	0.002	<.0001
DRESSWTSQ	-0.000053	0.000001	<.0001	-0.000054	0.000001	<.0001	-0.000052	0.000001	<.0001
STEER	base			base			base		
HEIFER	-0.260	0.022	<.0001	-0.324	0.021	<.0001	-0.317	0.021	<.0001
MIXED	-0.443	0.020	<.0001	-0.469	0.020	<.0001	-0.505	0.020	<.0001
DRESSED	-0.181	0.028	<.0001	-0.168	0.028	<.0001	-0.201	0.028	<.0001
DELIVERED	0.915	0.028	<.0001	0.923	0.028	<.0001	0.886	0.028	<.0001
0to14DAY	1.258	0.043	<.0001	1.244	0.043	<.0001	1.219	0.043	<.0001
0to14DAY2014	-0.227	0.069	0.0009	-0.206	0.069	0.0026	-0.219	0.069	0.0015
0to14DAY2015	0.122	0.070	0.0808	0.151	0.070	0.0308	0.163	0.070	0.0201
0to14DAY2016	0.173	0.066	0.0088	0.178	0.066	0.0071	0.185	0.066	0.0053
0to14DAY2017	0.078	0.063	0.2126	0.074	0.063	0.2389	0.071	0.063	0.261
HEAD	0.0017	0.000	<.0001	0.0018	0.000	<.0001	-	-	-
HEADSQ	-0.00000045	0.000	<.0001	-0.00000047	0.000	<.0001	-	-	-
CHOICE	-0.012	0.001	<.0001	-	-	-	-	-	-
DAY	daily dummy variables too numerous to report								
R-Squared	0.9998			0.9998			0.9998		
RMSE	3.064			3.066			3.070		
Observations	190,351			190,351			190,351		

A few key takeaways from the hedonic model are important for this study. First, the *STATE* coefficient estimates provide a summary of how, after adjusting for other cofactors included in the model, state prices compare. To better illustrate these coefficients, they are graphed in Figure 9. Recall, *NE* is the base state, so all other coefficients represent price in that state relative to NE. For example, *IA* has a -0.96 coefficient which simply implies, all else held constant, *IA* had a $0.96/cwt dressed basis lower price than *NE*. We can also compare other states with each other in this chart. For example, *MN* has a coefficient estimate of -1.90 and *IA* of -0.96, this implies *MN* had a price that is on average $0.94 (-1.90 – -0.96) lower than *IA*. The chart suggests grouping for example *WY* (+1.64) with *OK* (-1.98) transactions would be combining markets with quite different price levels. This is not something we would necessarily recommend in regional price reporting as it would mask economically important regional price

differences. Similarly, the hedonic models suggest SD has price patterns more consistent with IA and NE than CO and particularly WY.

Figure 9. State of Origin Price Differentials Relative to NE Estimated using Hedonic Model 1



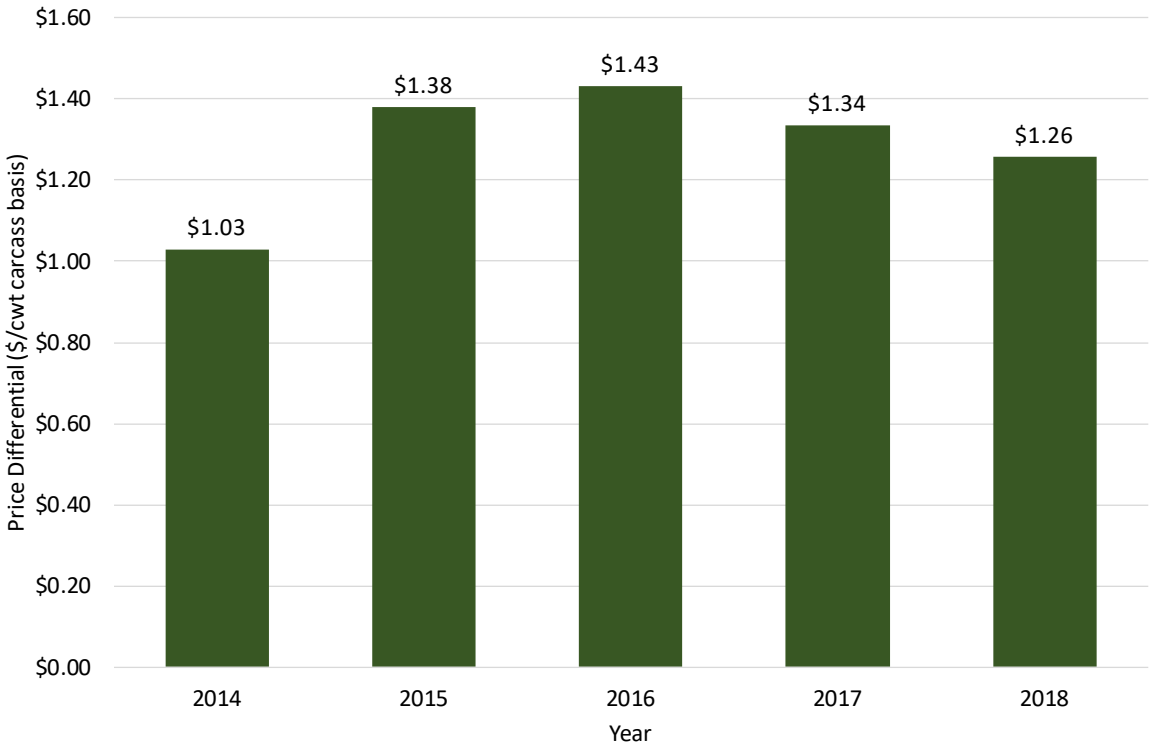
F-tests were conducted for each model on subsets of state coefficients that are of specific interest to compare since they are part of possible market alignments presented earlier. With such large numbers of observations present in the data set, we expect the F-tests to result in statistical differences being present across state variable estimated coefficients. We report the F-tests for comparing specific state coefficients in Table 11. As expected, essentially all of the F-tests suggest the individual state coefficients are not statistically equal to each other at high levels of statistical confidence. This means combining transactions from these markets results in calculated weighted-average prices that are blends of markets with statistically different price levels. More important than the statistical significance however are economic differences across specific state estimated coefficients. One can make the case from Figure 9 that MN, IN, IL, and OH could be combined perhaps with IA. One could also justify combining TX, OK, and NM from these results. What to do with SD requires more assessment combining this particular segment of the analysis with the other assessments in this study which we did earlier in this report.

Table 11. F-Test Results Statistcally Comparing Sets of State Coefficients from Hedonic Models

Testing Statistical Equality	Model 1		Model 2		Model 3	
	F-Value	P-Value	F-Value	P-Value	F-Value	P-Value
IA MN	561	<.0001	514	<.0001		<.0001
IA MN IL IN OH	306	<.0001	356	<.0001	325	<.0001
CO WY	187	<.0001	180	<.0001	169	<.0001
TX NM OK	7.7	0.0005	14.6	<.0001	11.8	<.0001
TX NM OK KS	318	<.0001	283	<.0001	284	<.0001

Of additional interest for this study is how similar the 0-14 day delivery window transactions are compared to the 15-30 day. Figure 10 illustrates the price differentials associated with 0-14 day deliveries based on the hedonic model estimates. The price differentials were allowed to vary by year in the estimation of the model. The reason for allowing these to vary by year is because in a forward up trending market, we might expect 0-14 day prices to be lower than 15-30 and the reverse when forward prices are trending down. However, the 0-14 day transactions typically were purchased at a premium relative to the 15-30 day over the five-year time period after adjusting for differences in other attributes associated with the transactions. In 2014 the 0-14 day transactions were at about a $1/cwt premium, the premium was the highest in 2016 at $1.43/cwt and it was $1.26/cwt in 2018. Recalling aggregate 5-Area market price trends summarized in Figure 2 we might have expected 15-30 day to be at a premium to 0-14 day in 2014 since the market trended upward during most of that year. In contrast, the market trended downward quite rapidly in both 2015 and 2016 suggesting the largest premiums for 0-14 day deliveries during that time. The premium for 0-14 was indeed larger during 2015 and 2016 than other years, but 0-14 still had a premium in 2014, though it was the smallest of the five years.

Figure 10. Estimated Premium for 0 to 14 Day Delivery Relative to 15 to 30 Day Delivery by Year, Model 1



To help further assess how prices between 0-14 and 15-30 delivery trade compare, we graphed the national weekly weighted-average 0-14 and 15-30 day delivery prices (converted to a dressed basis) in Figure 11 (these are estimated from transaction data and not based on estimates from the hedonic model) and the 0-14 day minus the 15-30 day price in Figure 12. These graphs illustrate first, as we would expect, the 0-14 day and 15-30 day weighted average prices track each other closely over time (Figure 11). However, the difference between the prices on any given week vary noticeably (Figure 12) with the 0-14 price typically being higher by about $1 to $2/cwt, consistent with hedonic model parameter estimates (Figure 10). However, the premium for 0-14 varies from a low of about -$2.50/cwt during one week in 2016 to an extreme spike of nearly a $10/cwt premium during one week in 2017. Transaction prices of 0-14 relative to 15-30 day cattle certainly vary more week to week than what is revealed by the hedonic model.

Figure 11. National Weekly Weighted Average Calculated Dressed Price for 0 to 14 and 15 to 30 Day Delivery, 2014-2018

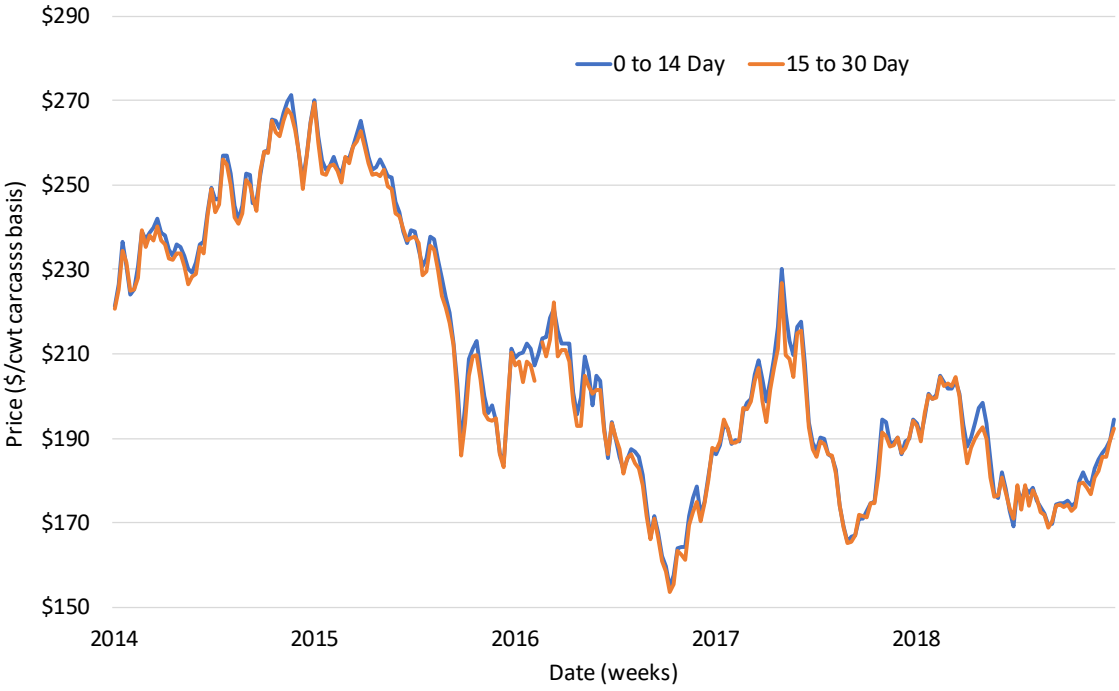
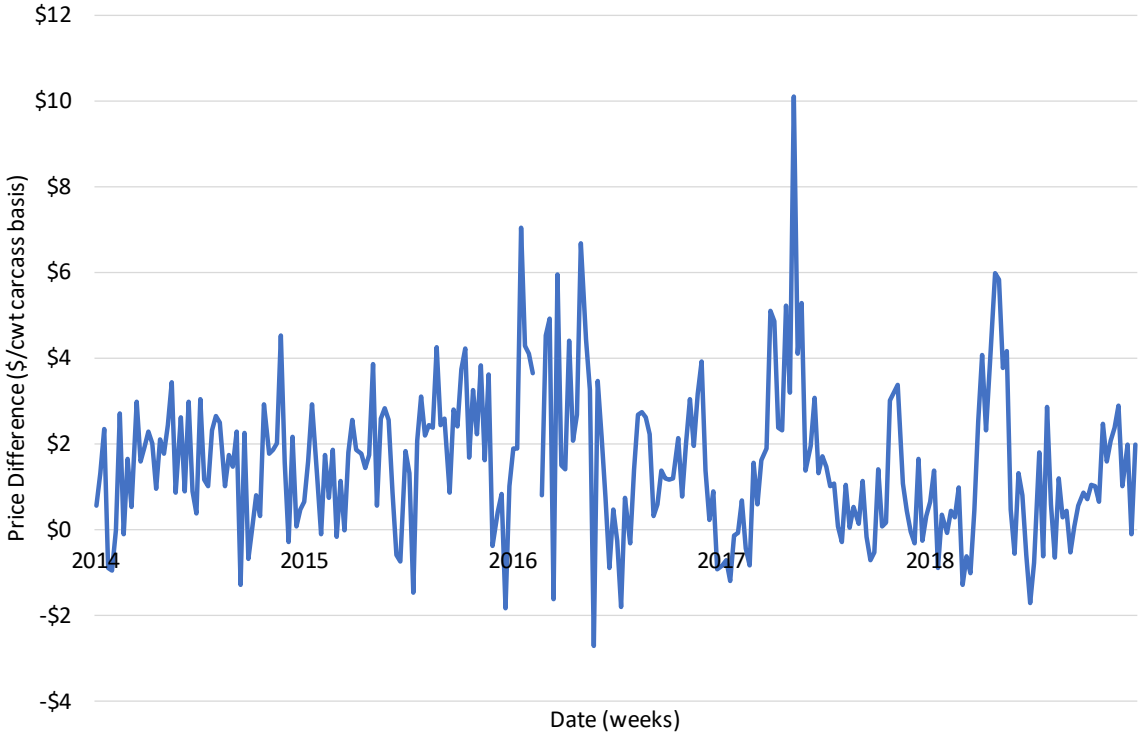


Figure 12. Weekly Calculated National Weighted Average Dressed 0 to 14 Day minus 15 to 30 Day Delivery Price, 2014-2018



Other information revealed from the hedonic model in Table 10 is that heifers received a $0.26/cwt lower price than steers and transactions with mixed steers and heifers brought about $0.44/cwt lower. Dressed transactions had about an $0.18/cwt lower price than live and delivered transactions received around $0.91/cwt more than FOB. The *CHOICE* variable had a negative and statistically significant coefficient. This would suggest a greater percentage of cattle grading Choice in the transaction resulted in a lower price. However, the coefficient was economically small as, for example, a 30 percentage point increase in Choice (e.g., 40% to 70%) reduced price by only $0.36/cwt. This suggests this coefficient, though statistically significant, is essentially economically irrelevant. We suspect this is because percentage Choice is an estimate that may suffer from biases across packers, and as such, may not be highly reliable or often used in establishing transaction prices. Since dropping the *CHOICE* variable in Models 2 and 3 had no important impact on other coefficient estimates, we did not spend more time on this variable.

The final set of coefficients that are reported in the hedonic model are the dressed weight and head in linear and quadratic terms. The easiest way to interpret the impacts of these variables on price is to graph predicted price as the variables range across relevant levels. Figure 13 shows how price varied with carcass weight. According to this model, the carcass weight with the highest price occurred at about 750 to 900 lb carcasses. For carcass weights below 700 lbs price dropped with a 600 lb carcass receiving about a $2/cwt lower price than an 800 lb. Similarly, as carcass weight increases above 950 lb price began to drop off with a 1050 lb carcass bringing about a $2/cwt lower price than an 800 lb. carcass. A similar graph was constructed varying the number of head per transaction (Figure 14). The number of head per transaction had a relatively small price impact with increasing head from about 15 to 500 head increasing price by about $1/cwt and increasing to 1500 head (from 15 head) about $2/cwt after which the price basically levels out beyond 1500 head.

Figure 13. Illustration of Price Differential Associated with Varying Carcass Weight, Model 1

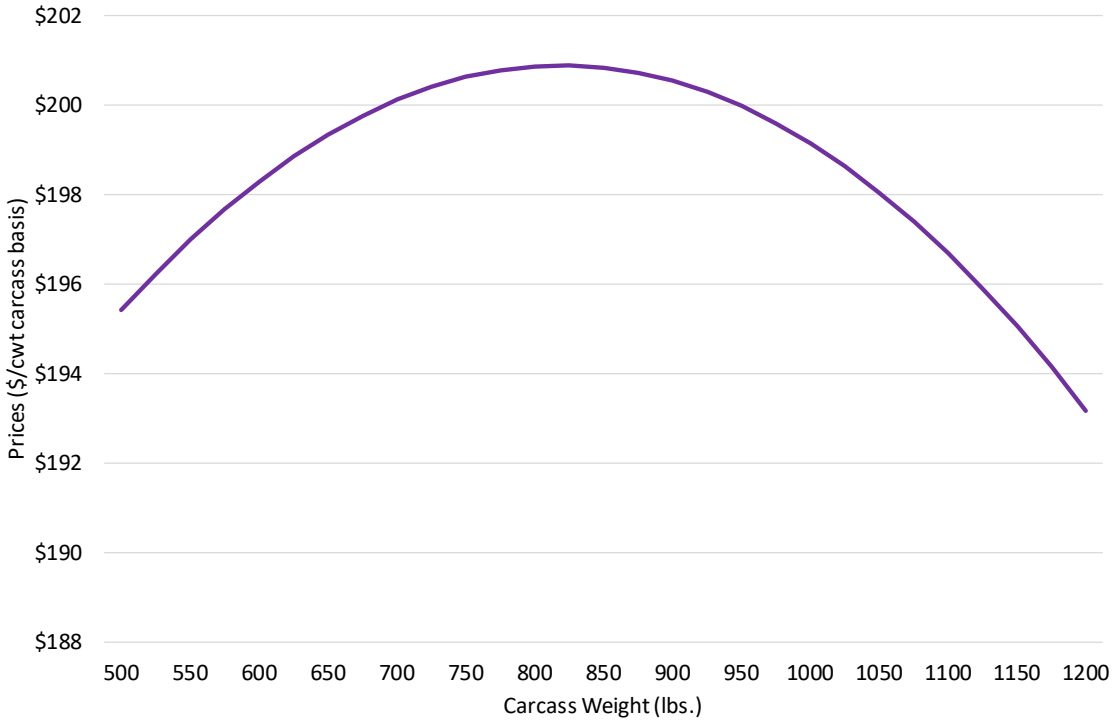
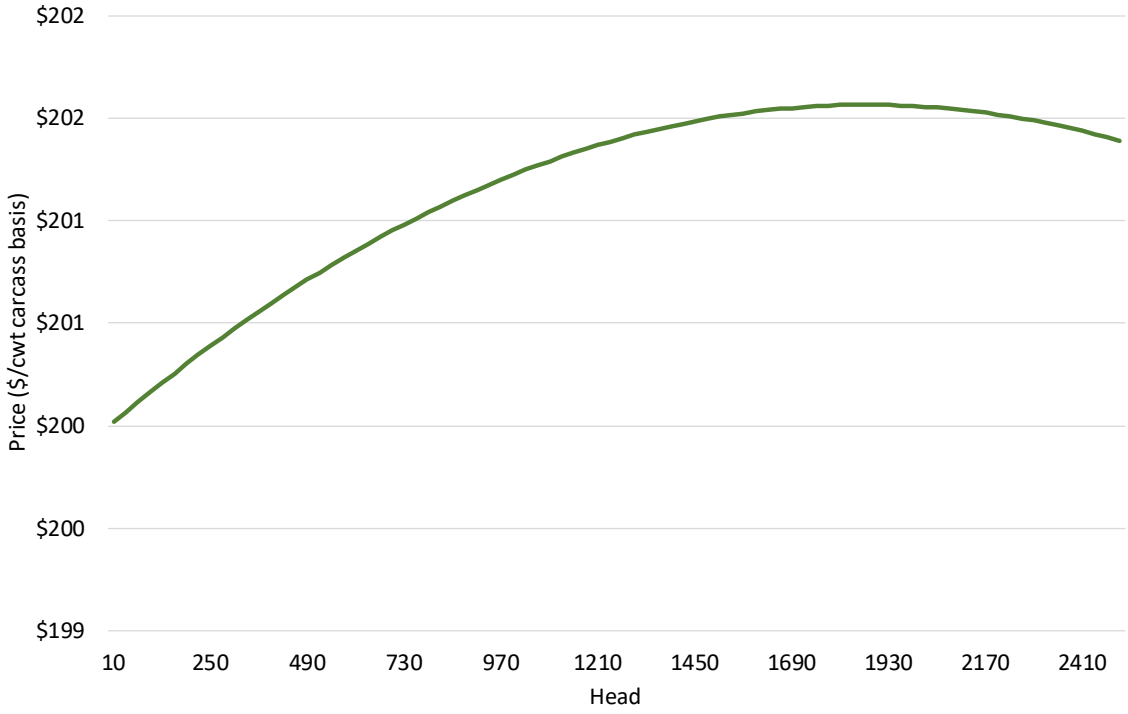


Figure 14. Illustration of Price Differential Associated with Number of Head per Transaction, Model 1



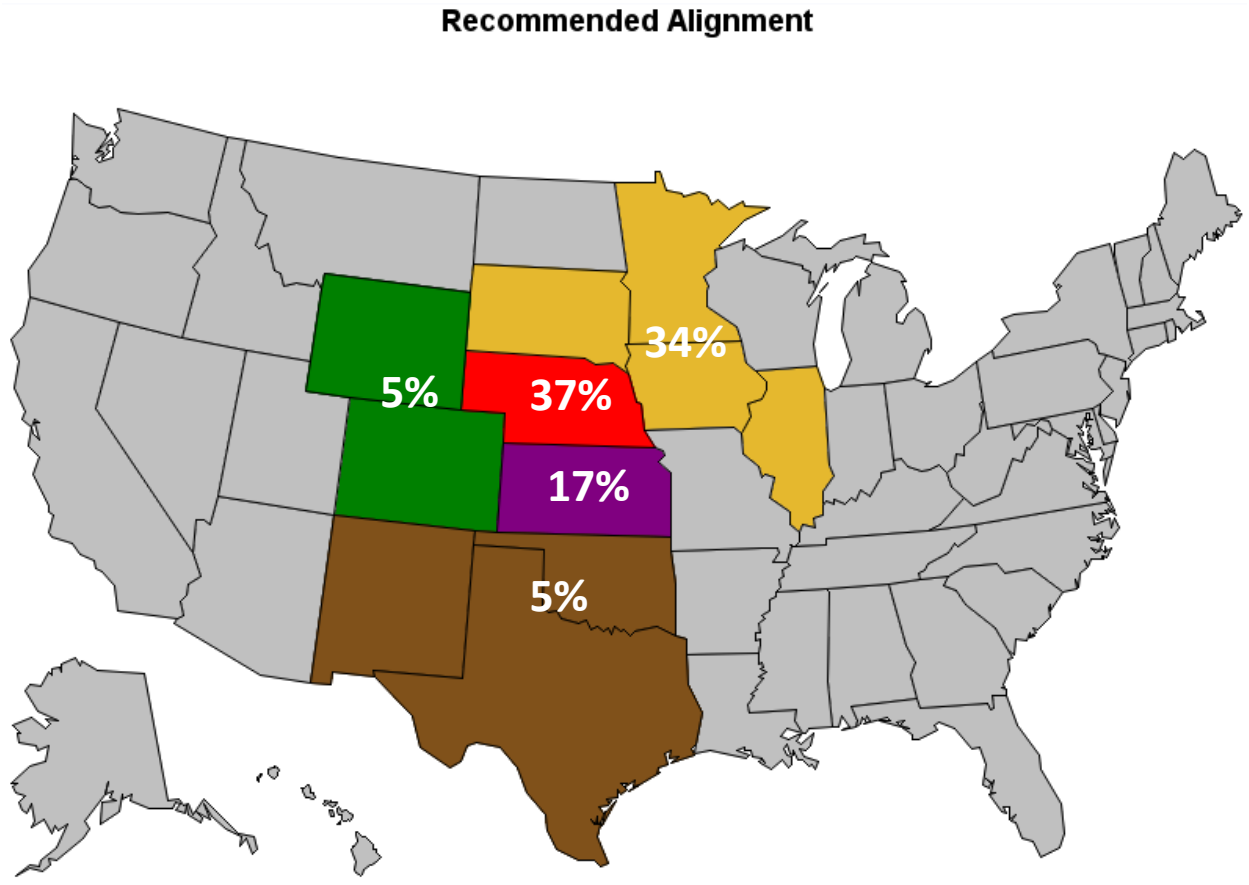
Recommended Market Alignment

Based on confidentiality constraints associated with the market alignments and the statistical analyses focused solely on negotiated trade, we propose an alternative preferred regional market alignment to the current alignment used by AMS in 5-Area market reports. The market alignment we recommend is presented in Table 12 and illustrated in Figure 15.

Table 12. Recommended Market Alignment for Regional Market Reporting

Region 1	Region 2	Region 3	Region 4	Region 5
IA/MN/SD/IL	NE	KS	TX/OK/NM	CO/WY

Figure 15. Recommended Alignment for Regional Market Reporting (Percentages Reported are National Negotiated Domestic Head Represented by Region, 2014-18)



Rationale for Recommended Regions

The regions were included in the recommended alignment based on the combined assessment of all analyses completed. First, supporting the recommended alignment of including transactions from SD, IL, and WY with current regional reporting is justified based on the volume of negotiated cash trade occurring in these regions. Over the 2014-2018 period, SD had the 4th largest negotiated volume at 6.7% (behind NE, IA, and KS), IL represented the 8th largest volume at 2%, and WY the 9th largest at 1%. Other possible candidate states to include are OH, IN, and WI which all had less than 0.5% of volume represented. With thinning negotiated cash trade, the more volume that can be included in market information reports the better as long as added volume contributes relevant information to improve the quality of market reporting. There is a tradeoff that simply adding states to regional reports is not recommended if the markets being combined are not well integrated based on statistical analyses.

Second, the ability of reporting of negotiated cash transactions subject to confidentiality analysis completed on the ten alternative alignments conducted reveals the proposed alignment is at least as good as any other we considered and allows marginally more frequent price reporting especially for the CO/WY region compared to the CO region by itself. Table 13 summarizes the confidentiality outcomes which were copied from various sections of Table 5 and provided here for convenience.

This alignment offers several improvements relative to current reporting regions in reducing, but not eliminating, confidentiality constraints to market information reporting. The key changes are in the IA/MN/SD/IL region where under this new alignment, over the entire 2014-2018 period, reportability of 0-30 and 0-14 day transactions remained at 100%. Reportability of 15-30 day increased from 46% of the weeks for IA/MN to 56% for the IA/MN/SD/IL alignment. In CO/WY, reportability increased for both 0-30 day and 0-14 day transactions relative to the CO only alignment by six percentage points (87% to 93%) for 0-30 day and by 11 percentage points (79% to 90%) for 0-14 day. In CO/WY, separate 15-30 day reporting is still completely constrained from being reportable. In general, even this recommended alignment does not relieve confidentiality constraints for 15-30 day negotiated cash transactions for most regions.

Further supporting the recommended alignment is the statistical price analysis. Combining SD and IL with current IA/MN slightly increased the price variation of price reporting, but by an economically very small amount compared to adding other candidate states of IN and OH to this alignment. Correlations of hedonic model prediction errors and hedonic price instability coefficient differences (discussed in the Appendix) were relatively high for IA, MN, SD, and IL supporting combining these states but relatively low for IA with OH and IN further suggesting OH and IN are not strong candidate markets to combine with IA/MN. Combining WY with CO is also supported by the statistical analysis as the CO/WY market combination demonstrates less price variation than present in CO alone and the CO and WY markets appear at least reasonably integrated.

Table 13. Recommended Market Alignment Confidentiality Reportable Trade, 2014-2018

Region / Delivery Window	2014	2015	2016	2017	2018	2014-18
	% of Weeks Trade Reportable					
IA/MN/SD/IL						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	73%	57%	0%	63%	90%	56%
NE						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	0%	0%	0%	36%	43%	18%
CO/WY						
0-30 Day	98%	90%	90%	100%	87%	93%
0-14 Day	83%	90%	90%	100%	87%	90%
15-30 Day	0%	0%	0%	0%	0%	0%
KS						
0-30 Day	100%	100%	100%	100%	100%	100%
0-14 Day	100%	100%	100%	100%	100%	100%
15-30 Day	0%	0%	0%	0%	0%	0%
TX/OK/NM						
0-30 Day	90%	47%	90%	100%	100%	85%
0-14 Day	85%	40%	90%	100%	100%	83%
15-30 Day	0%	0%	0%	0%	0%	0%

The challenges associated with negotiated cash price reporting for the TX/OK/NM market remain with the recommended alignment and largely also remain with the proposed CO/WY market region. We considered combining TX/OK/NM with several other alternative alignments including in particular CO and KS, the most logical candidates. The statistical price analysis did not support combining the CO market with the TX/OK/NM region in general. While the market integration assessment using the hedonic models provided some support for combining these states into one reporting region, assessment of price spreads and the hedonic modeling suggest CO prices differ from TX/OK/NM in economically important ways. As such, statistical analyses do not support combining these markets and this is further justified when CO and WY are combined. Combining TX/OK/NM with KS is not strongly recommended since this would have virtually no impact on price reporting confidentiality in KS. However, combining these markets

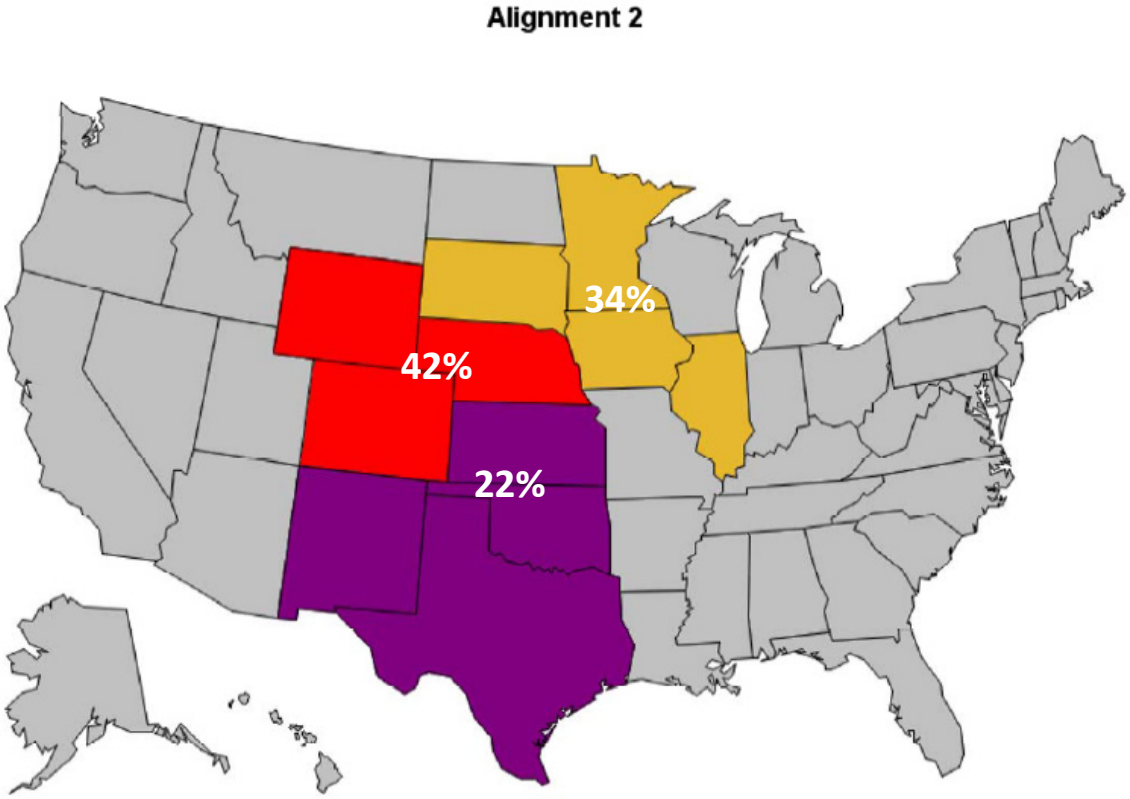
also appears that it would not substantially deteriorate the quality of price reporting in either market region as these markets appear to be integrated. However, TX and OK prices tend to be lower than KS which would mean combining them would reduce the combined price reported and as such, we elected not to recommend combining these markets at this time for price reporting.

Another potential consideration could be to condense the recommended 5-Area regions we propose here into a smaller set of more aggregated alternatives. One could consider numerous alternatives here from one extreme of eliminating all regional reports and reporting simply a national market report to another extreme of considering adding even more areas. The tradeoffs we have emphasized throughout this report associated with aggregating markets and reducing information content relative to enabling more frequent reporting conditional on maintaining confidentiality must continually be considered. Moreover, it is important to note our analysis presumes that LMR data retains current structure such that whole states have to be assigned to a sole reporting region as previously noted.

One might consider for example, publishing Northern and Southern regional market reports as a compromise to what might ultimately be dropping the CO/WY and the TX/OK/NM market region reports. In such an alignment, the states north of KS and CO could be the Northern region and the states south of NE and WY the Southern region (of the states shaded in Figure 15). The tradeoff for this alignment is it would result in a loss in the content of market information across both regions due to the level of aggregation. Our analysis suggests this information loss is not justified for the Northern regions and our statistical analysis would not support combining KS with CO, TX/OK/NM markets for price reporting. Little is gained in terms of information reporting for such a Southern region for this combination. As such, at this time we do not recommend aggregating to Northern and Southern market reports.

Another alternative could be to consider a 3-Area market alignment, rather than a 5-Area, such as our previously assessed alignment 2 (see Figure 16 provided below for convenience). This alignment has some appeal because it increases the number of states relative to the current 5-Area report and each area has sufficient negotiated trade to be generally reportable at least for 0-14 day trade (though 15-30 day trade would still typically be unreportable in the southern most region). The main downside to this combination is, as we have discussed elsewhere, combining CO/WY with NE would dilute the information content in the current NE report alone and similarly for the KS market by combining it with the TX/OK/NM region. We consider this a potentially second-best option relative to our recommended option.

Figure 16. Alternative Alignment 2 for Regional Market Reporting (Percentages Reported are National Negotiated Domestic Head Represented by Region, 2014-18)



Appendix

The appendix was included to report results of additional detailed statistical data analysis that we conducted on the negotiated transactions. Comparing price instability coefficients between markets has been proposed as an alternative to price correlation coefficients or cointegration models for measuring market integration.[11] This approached is proposed as a step towards advancing spatial price analysis when price time series are relatively short, not uniform and missing data exist. The price instability coefficient for a given market expresses the average price deviation from the trend in percentage of the mean price, such that:

$$I(\%) = 100 * \left(\left(\sqrt{\sum\left(\ddot{Y}_i - Y_i\right)^2}\right)/(T * \bar{Y})\right) \qquad (A1)$$

where $\ddot{Y}_i$ is the predicted price on the trend line ($\ddot{Y}_i$ = a + *bt*), *t* is the time or market day number; Y_i is the actual price on market date *t*, and $\bar{Y}$ is the average price over *T* number of market days or periods (weeks in this study).[12] This provides a unit free measure of relative dispersion.

The price spread between two integrated markets is assumed to be approximately constant over time.[13] If the price spread is not constant, the price instability coefficient will be high and market integration would be low. In other words, the greater is the difference in price instability coefficients, the less likely will price movements be parallel and the less will the markets be integrated.[11]

Table A1 shows the price instability coefficients for the 13 states considered in the analysis completed and reported earlier. NM has the largest average deviation of prices from the trend. The value for NM is 2.52% meaning that the deviation from trend over the 260 weeks of this study is 2.52% of the mean price. Such a large value for NM in comparison to the 12 other states is expected as there were only 13 weeks of the 260 that had transactions for NM. OK, with 227 weekly transactions, has the next highest price instability coefficient at 0.60%. At 0.54%, Texas has the lowest price instability coefficient.

Table A2 shows differences in price instability coefficients between successive state pairs. The differences are sorted in ascending order for ease in interpretation. The lower the difference between the price instability coefficients of two states, the greater the integration among prices from these states. Low volume markets may not be integrated with higher volume markets because of problems associated with "thin" markets (Tomek, 1980).[14] This explains

[11] Honfoga, B.G., G. N'tandou-Bonzitou, R.S. Vodouhè, M.R. Bellon, and J.D. Hounhouigan. 2018. Assessing the Role of Market Integration in the Consumption of Traditional Foods in Benin: A Joint Price Instability Coefficient and Diet Composition Approach. *Agricultural and Food Economics* 6:2. DOI 10.1186/s40100-018-0097-1

[12] Heidingsfield, M.S. and A.B. Blankenship. 1974. Marketing. In: Harper and Row, Barnes and Noble Book Edition.

[13] Delgado, C.L. 1986. A Variance Components Approach to Food Grain Market Integration in Northern Nigeria. *American Journal of Agricultural Economics* 68(4): 970-979.

[14] Tomek, W.G. 1980. Price Behavior on a Declining Terminal Market. *American Journal of Agricultural Economics* 62(3): 434-444.

why market integration is the lowest for NM and OK. This measure of market integration, provides support for combining SD and IL with IA and MN to create an IA/MN/SD/IL regional market. For example when considering IL, SD, and MN price instability coefficients to that of IA, IL has the smallest difference (0.0001), SD the third smallest (0.0020), and MN the fourth smallest (0.0021). This conclusion is consistent when considering IL or MN as the base comparison as well. However, when the SD coefficient is compared to that of other states, SD is most integrated with CO as the difference in coefficients is 0.0007 compared to 0.0020 for SD and IA.

The average price deviation from the trend does show how stable a particular market is and comparing price instability coefficients across markets has been shown to be one approach for measuring market integration. However, by itself this measure may be inadequate as a proof of market integration; it can only serve as an indicator of likelihoods given many assumptions about market structure and conduct.

A better way to potentially measure market integration within the price instability coefficient methodology would be to account for heterogeneity in prices and then examine differences. Research suggests that empirical tests of market integration are best carried out using prices of primary homogeneous commodities.[15] In the framework of hedonic prices, it is not the commodities themselves that are valued but instead the utility bearing attributes of the commodities.[16] Negotiated fed cattle bearing different attributes, that is differentiated based on several cattle and transaction characteristics, should have different values and thus different prices. Market integration may be improperly rejected due to this heterogeneous price data.

From equation (A1) we redefine $\ddot{Y}_i$ as the predicted price from the hedonic model estimated earlier in this report. The model is estimated each week for the 260 weeks and weekly predicted prices calculated. Table A3 shows the price instability coefficients based on the hedonic regression method. Similar to the previous measure, NM and OK have the largest average deviation of prices. However, under this measure IA has the smallest price instability coefficient, i.e., the lowest coefficient of variation for all the individual transaction prices around the predicted hedonic price.

Table A4 shows differences in these alternative price instability coefficients. These findings help confirm the results in market integration that were observed using the previous approach. That is IA, MN, SD, and IL are all highly integrated. An interesting, but not entirely unexpected, result under this new approach is that NE is most integrated with IA and SD. This makes intuitive sense given these three states share at least one border. TX and CO are shown to have high market integration as is the case with KS and WY.

[15] Goodwin, B.K. and T.C. Schroeder. 1990. Testing Perfect Spatial Market Integration: An Application to Regional U.S. Cattle Markets. *North Central Journal of Agricultural Economics* 12(2): 173-186.
[16] Rosen, S. 1974. Hedonic Prices and Implicit Markets. *Journal of Political Economy* 82(1): 34-55.

A criticism of the approach so far may be that price deviations may not fully capture the structure of price linkages. That is, just because pairs of market prices have large or small variation (so their differences in variation are small) does not necessarily imply their variations from week to week are highly related to each other. To test for this, we calculated correlations of hedonic price prediction errors to observe how weekly weighted average prices and hedonic model predicted prices relay information about integration of prices. The idea here is that if hedonic price prediction errors across states are highly correlated, these markets are likely moving in similar directions relative to the hedonic model predictions and as such prices in these markets might be well-aligned with each other.

Table A5 shows the correlation coefficients. The correlations are sorted in descending order for ease in interpretation. A value of 0 shows no linear relationship, while ±0.30 is a weak relationship, ±0.50 a moderate relationship, ±0.70 a strong relationship, and exactly ±1 a perfect relationship. Again, this supports combining SD and IL with IA/MN. Combining WY with KS, NE, or CO would be supported based on the moderately strong correlation. TX and KS were found to have the highest correlation when comparing weekly weighted average prices and hedonic model predicted prices. Markets such as NE and TX; KS and IA; SD and TX; or CO and TX would not be viable candidates to combine, for example, based on this analysis since they have lower than 0.55 correlations. Combining markets that have divergent price patterns reduces market information content.

Table A1. Price Instability Coefficients Based on Trend Regressions

State	T	I(%)
CO	254	0.5474416009
IA	260	0.5501764130
IL	260	0.5502515908
IN	259	0.5443762653
KS	260	0.5409443488
MN	260	0.5522617962
NE	260	0.5446024014
NM	13	2.5158727107
OH	260	0.5503422825
OK	227	0.5974905674
SD	260	0.5481758363
TX	256	0.5380521065
WY	251	0.5605981463

Table A2. Differences in Price Instability Coefficients between State Pairs (Trend Regressions)

CO		IA		IL		IN		KS		MN		NE		NM		OH		OK		SD		TX		WY	
State	I diff	State	I diff	State	I diff	State	I diff	State	I diff	State	I diff	State	I diff	State	I diff	State	I diff	State	I diff	State	I diff	State	I diff	State	I diff
SD	0.0007	IL	0.0001	IA	0.00008	NE	0.0002	TX	0.0029	OH	0.0019	IN	0.0002	OK	1.9184	IL	0.0001	WY	0.0369	CO	0.0007	KS	0.0029	MN	0.0083
IA	0.0027	OH	0.0002	OH	0.00009	CO	0.0031	IN	0.0034	IL	0.0020	CO	0.0028	WY	1.9553	IA	0.0002	MN	0.0452	IA	0.0020	IN	0.0063	OH	0.0103
IL	0.0028	SD	0.0020	MN	0.0020	KS	0.0034	NE	0.0037	IA	0.0021	SD	0.0036	MN	1.9636	MN	0.0019	OH	0.0471	IL	0.0021	NE	0.0066	IL	0.0103
NE	0.0028	MN	0.0021	SD	0.0021	SD	0.0038	CO	0.0065	SD	0.0041	KS	0.0037	OH	1.9655	SD	0.0022	IL	0.0472	OH	0.0022	CO	0.0094	IA	0.0104
OH	0.0029	CO	0.0027	CO	0.0028	IA	0.0058	SD	0.0072	CO	0.0048	IA	0.0056	IL	1.9656	CO	0.0029	IA	0.0473	NE	0.0036	SD	0.0101	SD	0.0124
IN	0.0031	NE	0.0056	NE	0.0056	IL	0.0059	IA	0.0092	NE	0.0077	IL	0.0056	IA	1.9657	NE	0.0057	SD	0.0493	IN	0.0038	IA	0.0121	CO	0.0132
MN	0.0048	IN	0.0058	IN	0.0059	OH	0.0060	IL	0.0093	IN	0.0079	OH	0.0057	SD	1.9677	IN	0.0060	CO	0.0500	MN	0.0041	IL	0.0122	NE	0.0160
KS	0.0065	KS	0.0092	KS	0.0093	TX	0.0063	OH	0.0094	WY	0.0083	TX	0.0066	CO	1.9684	KS	0.0094	NE	0.0529	KS	0.0072	OH	0.0123	IN	0.0162
TX	0.0094	WY	0.0104	WY	0.0103	MN	0.0079	MN	0.0113	KS	0.0113	MN	0.0077	NE	1.9713	WY	0.0103	IN	0.0531	TX	0.0101	MN	0.0142	KS	0.0197
WY	0.0132	TX	0.0121	TX	0.0122	WY	0.0162	WY	0.0197	TX	0.0142	WY	0.0160	IN	1.9715	TX	0.0123	KS	0.0565	WY	0.0124	WY	0.0225	TX	0.0225
OK	0.0500	OK	0.0473	OK	0.0472	OK	0.0531	OK	0.0565	OK	0.0452	OK	0.0529	KS	1.9749	OK	0.0471	TX	0.0594	OK	0.0493	OK	0.0594	OK	0.0369
NM	1.9684	NM	1.9657	NM	1.9656	NM	1.9715	NM	1.9749	NM	1.9636	NM	1.9713	TX	1.9778	NM	1.9655	NM	1.9184	NM	1.9677	NM	1.9778	NM	1.9553

Table A3. Price Instability Coefficients Based on Hedonic Regressions

State	*T*	*I(%)*
CO	254	0.0603331371
IA	260	0.0409178932
IL	260	0.0531060976
IN	259	0.0683602170
KS	260	0.0555222522
MN	260	0.0504931363
NE	260	0.0416268575
NM	13	0.3725414839
OH	260	0.0678423265
OK	227	0.1050580562
SD	260	0.0432369846
TX	256	0.0626902568
WY	251	0.0546170248

Table A4. Differences in Price Instability Coefficients between State Pairs (Hedonic Regressions)

CO		IA		IL		IN		KS		MN		NE		NM		OH		OK		SD		TX		WY	
State	I diff	State	I diff	State	I diff	State	I diff	State	I diff	State	I diff	State	I diff	State	I diff	State	I diff	State	I diff	State	I diff	State	I diff	State	I diff
TX	0.0024	NE	0.0007	WY	0.0015	OH	0.0005	WY	0.0009	IL	0.0026	IA	0.0007	OK	0.2675	IN	0.0005	IN	0.0367	NE	0.0016	CO	0.0024	KS	0.0009
KS	0.0048	SD	0.0023	KS	0.0024	TX	0.0057	IL	0.0024	WY	0.0041	SD	0.0016	IN	0.3042	TX	0.0052	OH	0.0372	IA	0.0023	OH	0.0052	IL	0.0015
WY	0.0057	MN	0.0096	MN	0.0026	CO	0.0080	CO	0.0048	KS	0.0050	MN	0.0089	OH	0.3047	CO	0.0075	TX	0.0424	MN	0.0073	IN	0.0057	MN	0.0041
IL	0.0072	IL	0.0122	CO	0.0072	KS	0.0128	MN	0.0050	SD	0.0073	IL	0.0115	TX	0.3099	KS	0.0123	CO	0.0447	IL	0.0099	KS	0.0072	CO	0.0057
OH	0.0075	WY	0.0137	TX	0.0096	WY	0.0137	TX	0.0072	NE	0.0089	WY	0.0130	CO	0.3122	WY	0.0132	KS	0.0495	WY	0.0114	WY	0.0081	TX	0.0081
IN	0.0080	KS	0.0146	SD	0.0099	IL	0.0153	SD	0.0123	IA	0.0096	KS	0.0139	KS	0.3170	IL	0.0147	WY	0.0504	KS	0.0123	IL	0.0096	SD	0.0114
MN	0.0098	CO	0.0194	NE	0.0115	MN	0.0179	OH	0.0123	CO	0.0098	CO	0.0187	WY	0.3179	MN	0.0173	IL	0.0520	CO	0.0171	MN	0.0122	NE	0.0130
SD	0.0171	TX	0.0218	IA	0.0122	SD	0.0251	IN	0.0128	TX	0.0122	TX	0.0211	IL	0.3194	SD	0.0246	MN	0.0546	TX	0.0195	SD	0.0195	OH	0.0132
NE	0.0187	OH	0.0269	OH	0.0147	NE	0.0267	NE	0.0139	OH	0.0173	OH	0.0262	MN	0.3220	NE	0.0262	SD	0.0618	OH	0.0246	NE	0.0211	IA	0.0137
IA	0.0194	IN	0.0274	IN	0.0153	IA	0.0274	IA	0.0146	IN	0.0179	IN	0.0267	SD	0.3293	IA	0.0269	NE	0.0634	IN	0.0251	IA	0.0218	IN	0.0137
OK	0.0447	OK	0.0641	OK	0.0520	OK	0.0367	OK	0.0495	OK	0.0546	OK	0.0634	NE	0.3309	OK	0.0372	IA	0.0641	OK	0.0618	OK	0.0424	OK	0.0504
NM	0.3122	NM	0.3316	NM	0.3194	NM	0.3042	NM	0.3170	NM	0.3220	NM	0.3309	IA	0.3316	NM	0.3047	NM	0.2675	NM	0.3293	NM	0.3099	NM	0.3179

Table A5. Correlations of Weekly Hedonic Price Prediction Errors

CO		IA		IL		IN		KS		MN		NE		NM		OH		OK		SD		TX		WY	
State	corr	State	corr	State	corr	State	corr	State	corr	State	corr	State	corr	State	corr	State	corr	State	corr	State	corr	State	corr	State	corr
NE	0.7441	SD	0.7513	IA	0.6636	IL	0.4091	TX	0.7705	IA	0.6194	CO	0.7441	OK	0.2608	IN	0.4061	WY	0.4075	IA	0.7513	KS	0.7705	KS	0.6004
KS	0.6358	NE	0.7193	SD	0.6039	OH	0.4061	NE	0.6715	NE	0.5906	IA	0.7193	CO	0.2081	IL	0.3337	KS	0.4039	IL	0.6039	NE	0.5366	NE	0.5056
MN	0.5101	IL	0.6636	NE	0.4530	IA	0.2917	CO	0.6358	CO	0.5101	KS	0.6715	TX	0.1933	IA	0.3053	TX	0.2804	NE	0.5724	CO	0.4912	CO	0.5024
WY	0.5024	MN	0.6194	MN	0.4255	MN	0.2850	WY	0.6004	SD	0.5062	MN	0.5906	WY	0.1779	SD	0.2689	CO	0.2752	MN	0.5062	WY	0.4768	TX	0.4768
TX	0.4912	KS	0.4788	IN	0.4091	CO	0.2675	IA	0.4788	IL	0.4255	SD	0.5724	KS	0.1133	MN	0.2540	NM	0.2608	CO	0.3941	IA	0.4328	OK	0.4075
IA	0.3978	TX	0.4328	KS	0.3809	NE	0.2419	OK	0.4039	TX	0.4232	TX	0.5366	NE	-0.0053	NE	0.1796	NE	0.1692	KS	0.3804	MN	0.4232	IA	0.3385
SD	0.3941	CO	0.3978	OH	0.3337	SD	0.2367	MN	0.4020	KS	0.4020	WY	0.5056	IA	-0.0645	KS	0.1278	IL	0.1661	TX	0.3588	SD	0.3588	MN	0.3067
IL	0.3201	WY	0.3385	TX	0.3303	KS	0.1941	IL	0.3809	WY	0.3067	IL	0.4530	MN	-0.0898	CO	0.1238	IN	0.1575	OH	0.2689	IL	0.3303	SD	0.2469
OK	0.2752	OH	0.3053	CO	0.3201	OK	0.1575	SD	0.3804	IN	0.2850	IN	0.2419	SD	-0.1294	TX	0.1175	SD	0.1173	WY	0.2469	OK	0.2804	IL	0.2126
IN	0.2675	IN	0.2917	WY	0.2126	WY	0.1507	IN	0.1941	OH	0.2540	OH	0.1796	IL	-0.1758	WY	0.0760	IA	0.1143	IN	0.2367	NM	0.1933	NM	0.1779
NM	0.2081	OK	0.1143	OK	0.1661	TX	0.1454	OH	0.1278	OK	0.0487	OK	0.1692	OH	-0.2687	OK	0.0008	MN	0.0487	OK	0.1173	IN	0.1454	IN	0.1507
OH	0.1238	NM	-0.0645	NM	-0.1758	NM	-0.4551	NM	0.1133	NM	-0.0898	NM	-0.0053	IN	-0.4551	NM	-0.2687	OH	0.0008	NM	-0.1294	OH	0.1175	OH	0.0760

To further determine how negotiated transaction information would be affected under alternative regional market alignment, we evaluated how percent Choice levels and variability was impacted by adding more states of cattle origin to the price reporting regions.

Table A6 reports summary statistics for weighted-average percent Choice levels by region and alignment, and t-tests of mean differences in prices. Findings for percent Choice differentials across alignments within regions are mixed, as some alternative alignments have higher values and others have lower values, compared to the base alignment. Within Region 1 there is no statistical difference in mean percent Choice for IA/MN and IA/MN/SD/IL. However, between IA/MN and IA/MN/IL/IN/OH the difference is 0.32 with the IA/MN/IL/IN/OH alignment having higher percent Choice levels than IA/MN on average over the five-year period. For Region 2, combining CO and WY with NE decreases the percent Choice level by 0.45, while adding SD, CO/WY/SD, or SD/WY to NE increases percent Choice by 0.65, 0.20, and 0.64, respectively. When TX/OK/NM is added to KS in Region 3 the mean percent Choice level is 1.66 lower. The addition of CO and WY to KS increases percent Choice by 1.22. The one possible realignment to Region 4 is adding CO to TX/OK/NM and leads to a 5.09 higher percent Choice. Adding WY and SD to CO in Region 5, increases the percent Choice level by 6.19. However, when just WY is added to CO percent Choice only increases by 1.42.

In general, alternative alignments have less impact on mean percent Choice levels than aggregation to a 5-Area or National level. Both 5-Area and National percent Choice levels are lower than those in IA/MN by 6.65 and 5.85, respectively. Five-Area and National percent Choice levels are lower than those in NE by 1.25 and 0.45, respectively. For Regions 3, 4, and 5, 5-Area and National percent Choice levels are higher than the base. For example, KS percent Choice levels are 8.20 to 9.00 lower than the 5-Area and National composites. TX/OK/NM has 15.49 to 16.30 lower and CO have 4.09 to 4.88 lower percent Choice levels than aggregation at the 5-Area and National level, respectively.

Table A7 reports percent Choice spreads by region and alignment, and paired t-tests of mean differences in spreads. A percentile range between the 15^{th} percentile and the 85^{th} percentile for each base and alternative alignment is used. For Regions 1, 2, 3, and 4 results reveal statistically larger spreads for alternative alignments relative to the base alignment in each region. The one exception is in Region 1 where this is no statistical difference between the spread of IA and IA/MN/IL/IN/OH. For Region 5, all of the alternative alignment spreads are lower than the base alignment CO spread. However, the difference in the spread between CO/WY and CO is not statistically different than zero.

Table A8 is an extension of Table A6 and reports the percentage of weeks the change in percent Choice level of alternative alignments compared to the base alignment in each region change falls in the intervals less than -5.00, -4.01 to -5.00, …, 4.00 to 4.99, and greater than 5.00. Comparing alternative alignment IA/MN/SD/IL to base alignment IA/MN shows that 99.2% of the time during the 2014-2018 period the change in percent Choice level was in the interval -2.00 to 1.99. This means that 258 out of 260 weeks the change in percent Choice was within this range. The comparison of IA/MN/IL/IN/OH and IA/MN was even higher at 100.0% or 260

out of 260 weeks. For all alternative alignments compared to the base NE alignment in Region 2, over 96% of the change in percent Choice level was within -2.00 to 1.99, or 252 weeks or greater. For Region 3, 64.2% and 73.8% of the change in percent Choice level was within -2.00 to 1.99, respectively, for the KS/TX/OK/NM to KS and KS/CO/WY to KS comparisons.

For alternative alignments compared to the base alignment in Regions 4 and 5 are where changes in mean percent Choice levels become much larger. For Region 4, only 18.6% of the time, or 48 out of 258 weeks was the change in percent Choice from TX/OK/NM to TX/OK/NM/CO in the -2.00 to 1.99 range. For Region 5, 15.0% and 68.9% of the change in percent Choice level was within -2.00 to 1.99, respectively, for the CO/WY/SD to CO and CO/WY to CO comparisons. Similar to what is shown in Table A6, potential alternative alignments have less impact on the change in percent Choice level than aggregation to a 5-Area or National level.

Table A9 is an extension of Table A7 and reports the percentage of weeks the $\{Ch_{15} - Ch_{85}\}$ percent Choice spread falls in the range 0.0 to greater than 30.0. We consider the percentage of weeks that the price spread, for each base alignment is between 0 and 19.99. This shows that for IA/MN, 90.8% of the variation in the percent Choice level is within 0 to 19.99. This is 236 out of 260 weeks. This same measurement for NE, KS, TX/OK/NM, and CO is 65.0%, 38.8%, 36.8%, and 37.8%, respectively. As expected, in general, variability in percent Choice level increases (a lower percentage is within the 0.0 to 19.99 range) as additional states are added to make up potential alternative alignments. However, there are two exceptions. When WY and SD are combined with CO or when just WY is combined with CO, 51.9% (compared to 37.8%) or 39.6% (compared to 37.8%) of the variation in percent Choice level is within the 0.0 to 19.99 range.

While this additional analysis is a valuable demonstration of variation in reported quality grade associated with alternative regional alignments, it remains important to recognize the quality grade field is an estimate and therefore is not confirmed. In the hedonic modeling analyses (Table 10) unexpected results regarding the marginal effect of percent Choice are an example of potential errors in estimated percentage Choice data field.

Table A6. Summary Statistics for Weighted Average Percent Choice Level by Region and Alignment, 2014-2018

Alignment	State(s)	N	Mean	Std Dev	Min	Max	Mean Difference[1]	Pr > |t|	Correlation Coefficient	Pr > |t|
Region 1										
1	IA/MN	260	82.576	3.34	75.22	90.40				
2	IA/MN/SD/IL	260	82.523	3.21	75.61	90.38	-0.0525	0.2012	0.98046	<0.0001
3 thru 10	IA/MN/IL/IN/OH	260	82.893	3.43	75.35	91.08	0.3174	<0.0001	0.98902	<0.0001
11	5 Area	260	75.926	3.25	66.75	84.63	-6.6496	<0.0001	0.80588	<0.0001
12	National	260	76.723	3.21	68.37	85.24	-5.8527	<0.0001	0.82191	<0.0001
Region 2										
1, 3, 5	NE	260	77.176	3.22	69.02	84.22				
2	NE/CO/WY	260	76.728	3.29	68.91	83.88	-0.4478	<0.0001	0.98103	<0.0001
4, 6, 8	NE/SD	260	77.824	3.10	70.37	84.76	0.6488	<0.0001	0.98482	<0.0001
7, 10	NE/CO/WY/SD	260	77.377	3.17	70.04	84.46	0.2011	<0.0001	0.96986	<0.0001
9	NE/SD/WY	260	77.815	3.11	70.40	84.76	0.6397	<0.0001	0.98432	<0.0001
11	5 Area	260	75.926	3.25	66.75	84.63	-1.2493	<0.0001	0.87056	<0.0001
12	National	260	76.723	3.21	68.37	85.24	-0.4524	<0.0001	0.87003	<0.0001
Region 3										
1, 3, 4, 7, 9	KS	260	67.723	6.36	52.91	81.07				
2, 5, 6, 10	KS/TX/OK/NM	260	66.063	5.89	52.24	81.07	-1.6600	<0.0001	0.98074	<0.0001
8	KS/CO/WY	260	68.940	5.76	55.66	79.71	1.2172	<0.0001	0.96530	<0.0001
11	5 Area	260	75.926	3.25	66.75	84.63	8.2033	<0.0001	0.73337	<0.0001
12	National	260	76.723	3.21	68.37	85.24	9.0002	<0.0001	0.73683	<0.0001
Region 4										
1 thru 8, 10	TX/OK/NM	258	60.406	6.09	35.00	76.40				
9	TX/OK/NM/CO	260	65.536	5.33	51.83	78.24	5.0873	<0.0001	0.71868	<0.0001
11	5 Area	260	75.926	3.25	66.75	84.63	15.4947	<0.0001	0.54974	<0.0001
12	National	260	76.723	3.21	68.37	85.24	16.2957	<0.0001	0.54783	<0.0001
Region 5										
1, 2, 7 thru 10	CO	254	71.736	6.73	53.85	86.32				
3, 5	CO/WY/SD	260	78.126	4.17	66.63	88.92	6.1906	<0.0001	0.72221	<0.0001
4, 6	CO/WY	260	73.431	6.35	56.49	97.00	1.4188	<0.0001	0.92714	<0.0001
11	5 Area	260	75.926	3.25	66.75	84.63	4.0937	<0.0001	0.51550	<0.0001
12	National	260	76.723	3.21	68.37	85.24	4.8818	<0.0001	0.52315	<0.0001

[1] The paired t-test only use cases that have non-missing values for both variables. As such the mean differences for Regions 4 and 5 are different than would be calculated using the summary statistic means.

Table A7. Summary Statistics for Percent Choice Spreads by Region and Alignment, 2014-2018

Alignment	State(s)	N	Mean	Std Dev	Min	Max	Mean Difference[1]	Pr > |t|
Region 1								
1	IA/MN	260	15.687	2.30	9.00	21.00		
2	IA/MN/SD/IL	260	16.138	2.25	10.00	23.00	0.4512	<0.0001
3 thru 10	IA/MN/IL/IN/OH	260	15.772	2.26	10.00	23.00	0.0854	0.3959
11	5 Area	260	23.194	3.34	15.00	35.00	7.5073	<0.0001
12	National	260	23.177	3.09	15.00	36.00	7.4900	<0.0001
Region 2								
1, 3, 5	NE	260	17.992	2.97	12.00	27.00		
2	NE/CO/WY	260	18.417	3.13	12.00	26.00	0.4250	<0.0001
4, 6, 8	NE/SD	260	18.208	3.00	13.00	28.00	0.2154	0.0222
7, 10	NE/CO/WY/SD	260	18.515	3.08	12.00	28.00	0.5231	<0.0001
9	NE/SD/WY	260	18.233	3.01	12.00	28.00	0.2404	0.0098
11	5 Area	260	23.194	3.34	15.00	35.00	5.2019	<0.0001
12	National	260	23.177	3.09	15.00	36.00	5.1846	<0.0001
Region 3								
1, 3, 4, 7, 9	KS	260	20.154	3.57	11.00	34.00		
2, 5, 6, 10	KS/TX/OK/NM	260	21.637	3.44	11.00	35.00	1.4827	<0.0001
8	KS/CO/WY	260	21.524	3.89	12.00	34.00	1.3700	<0.0001
11	5 Area	260	23.194	3.34	15.00	35.00	3.0404	<0.0001
12	National	260	23.177	3.09	15.00	36.00	3.0231	<0.0001
Region 4								
1 thru 8, 10	TX/OK/NM	258	20.597	7.01	0.00	48.00		
9	TX/OK/NM/CO	260	25.817	5.43	12.00	44.00	5.2225	<0.0001
11	5 Area	260	23.194	3.34	15.00	35.00	2.6260	<0.0001
12	National	260	23.177	3.09	15.00	36.00	2.6047	<0.0001
Region 5								
1, 2, 7 thru 10	CO	254	21.079	7.00	5.00	40.00		
3, 5	CO/WY/SD	260	19.363	5.17	10.00	40.00	-1.613	0.0002
4, 6	CO/WY	260	20.475	6.99	0.00	45.00	-0.2972	0.3327
11	5 Area	260	23.194	3.34	15.00	35.00	2.1516	<0.0001
12	National	260	23.177	3.09	15.00	36.00	2.1181	<0.0001

[1] The paired t-test only use cases that have non-missing values for both variables. As such the mean differences for Regions 4 and 5 are different than would be calculated using the summary statistic means.

Table A8. Change in Mean Percent Choice by Region and Alignment, 2014-2018

Alignment	State(s)	< -5.00	-4.01 to -5.00	-3.01 to -4.00	-2.01 to -3.00	-1.01 to -2.00	-0.01 to -1.00	0.00 to 0.99	1.00 to 1.99	2.00 to 2.99	3.00 to 3.99	4.00 to 4.99	>= 5.00
Region 1 (Base = IA/MN vs. Alternative Alignment)													
2	IA/MN/SD/IL	0.0%	0.0%	0.0%	0.8%	6.5%	43.5%	45.0%	4.2%	0.0%	0.0%	0.0%	0.0%
3 thru 10	IA/MN/IL/IN/OH	0.0%	0.0%	0.0%	0.0%	0.4%	28.1%	61.5%	10.0%	0.0%	0.0%	0.0%	0.0%
11	5 Area	78.1%	13.8%	6.5%	1.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
12	National	65.0%	17.7%	11.9%	4.6%	0.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Region 2 (Base = NE vs. Alternative Alignment)													
2	NE/CO/WY	0.0%	0.0%	0.8%	1.5%	11.9%	61.5%	24.2%	0.0%	0.0%	0.0%	0.0%	0.0%
4, 6, 8	NE/SD	0.0%	0.0%	0.0%	0.0%	0.0%	8.8%	67.7%	21.5%	1.5%	0.4%	0.0%	0.0%
7, 10	NE/CO/WY/SD	0.0%	0.0%	0.0%	0.8%	5.4%	33.5%	45.4%	12.7%	1.9%	0.4%	0.0%	0.0%
9	NE/SD/WY	0.0%	0.0%	0.0%	0.0%	0.0%	10.8%	65.0%	22.3%	1.5%	0.4%	0.0%	0.0%
11	5 Area	2.3%	2.3%	8.8%	16.9%	24.2%	26.2%	13.1%	3.8%	1.5%	0.4%	0.0%	0.4%
12	National	0.8%	1.2%	3.8%	10.8%	18.8%	24.2%	26.2%	7.7%	5.0%	0.8%	0.4%	0.4%
Region 3 (Base = KS vs. Alternative Alignment)													
2, 5, 6, 10	KS/TX/OK/NM	2.3%	2.7%	10.4%	20.4%	30.4%	26.5%	7.3%	0.0%	0.0%	0.0%	0.0%	0.0%
8	KS/CO/WY	0.8%	0.0%	0.0%	0.0%	3.5%	13.5%	29.6%	27.3%	12.7%	8.5%	3.1%	1.2%
11	5 Area	0.0%	0.0%	0.0%	0.4%	0.4%	0.0%	1.2%	3.8%	3.8%	7.7%	10.4%	72.3%
12	National	0.0%	0.0%	0.0%	0.4%	0.0%	0.4%	0.8%	1.9%	2.7%	5.0%	7.7%	81.2%
Region 4 (Base = TX/OK/NM vs. Alternative Alignment)													
9	TX/OK/NM/CO	1.2%	0.4%	0.4%	0.8%	1.2%	2.7%	7.0%	7.8%	10.9%	8.9%	11.2%	47.7%
11	5 Area	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.8%	0.4%	0.0%	0.0%	0.4%	98.4%
12	National	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.4%	0.4%	0.0%	0.0%	98.8%
Region 5 (Base = CO vs. Alternative Alignment)													
3, 5	CO/WY/SD	0.8%	0.0%	0.4%	0.4%	1.2%	1.2%	6.3%	6.3%	13.0%	7.9%	4.7%	57.9%
4, 6	CO/WY	1.2%	0.8%	0.0%	0.8%	3.1%	12.2%	35.0%	18.5%	13.0%	5.1%	3.1%	7.1%
11	5 Area	3.9%	2.0%	2.4%	7.1%	4.7%	6.7%	4.7%	7.1%	3.5%	9.1%	5.1%	43.7%
12	National	2.8%	1.6%	2.4%	3.5%	6.3%	4.3%	6.3%	5.1%	7.1%	5.1%	7.5%	48.0%

Table A9. Percent Choice Spreads by Region and Alignment, 2014-2018

Alignment	State(s)	0 to 9.99	10 to 11.99	12 to 13.99	14 to 15.99	16 to 17.99	18 to 19.99	20 to 21.99	22 to 23.99	24 to 25.99	26 to 27.99	28 to 29.99	>= 30.00
Region 1													
1	IA/MN	0.4%	2.7%	10.4%	45.8%	19.2%	12.3%	9.2%	0.0%	0.0%	0.0%	0.0%	0.0%
2	IA/MN/SD/IL	0.0%	2.3%	5.8%	43.8%	20.0%	16.9%	10.8%	0.4%	0.0%	0.0%	0.0%	0.0%
3 thru 10	IA/MN/IL/IN/OH	0.0%	3.1%	8.1%	47.3%	21.9%	10.4%	8.8%	0.4%	0.0%	0.0%	0.0%	0.0%
11	5 Area	0.0%	0.0%	0.0%	0.4%	1.9%	6.5%	26.5%	18.8%	29.6%	7.7%	3.1%	5.4%
12	National	0.0%	0.0%	0.0%	0.4%	2.3%	4.2%	23.5%	25.0%	28.5%	8.1%	4.2%	3.8%
Region 2													
1	NE	0.0%	0.0%	4.2%	23.5%	15.8%	21.5%	26.2%	3.5%	4.2%	1.2%	0.0%	0.0%
2	NE/CO/WY	0.0%	0.0%	3.5%	21.2%	13.8%	21.2%	25.8%	6.5%	7.3%	0.8%	0.0%	0.0%
4, 6, 8	NE/SD	0.0%	0.0%	1.9%	24.2%	14.2%	22.3%	26.5%	5.0%	3.8%	1.2%	0.8%	0.0%
7, 10	NE/CO/WY/SD	0.0%	0.0%	1.9%	21.2%	15.0%	20.8%	27.7%	5.4%	6.9%	0.8%	0.4%	0.0%
9	NE/SD/WY	0.0%	0.0%	2.3%	22.7%	15.4%	21.2%	28.5%	3.5%	4.6%	1.5%	0.4%	0.0%
11	5 Area	0.0%	0.0%	0.0%	0.4%	1.9%	6.5%	26.5%	18.8%	29.6%	7.7%	3.1%	5.4%
12	National	0.0%	0.0%	0.0%	0.4%	2.3%	4.2%	23.5%	25.0%	28.5%	8.1%	4.2%	3.8%
Region 3													
1	KS	0.0%	0.4%	2.7%	5.4%	13.1%	17.3%	30.4%	15.8%	8.1%	3.5%	2.3%	1.2%
2, 5, 6, 10	KS/TX/OK/NM	0.0%	0.4%	0.0%	3.5%	6.2%	7.7%	35.0%	22.7%	15.8%	3.1%	3.8%	1.9%
8	KS/CO/WY	0.0%	0.0%	1.5%	3.1%	10.0%	14.2%	25.4%	16.9%	15.4%	5.4%	2.7%	5.4%
11	5 Area	0.0%	0.0%	0.0%	0.4%	1.9%	6.5%	26.5%	18.8%	29.6%	7.7%	3.1%	5.4%
12	National	0.0%	0.0%	0.0%	0.4%	2.3%	4.2%	23.5%	25.0%	28.5%	8.1%	4.2%	3.8%
Region 4													
1	TX/OK/NN	3.9%	4.7%	3.1%	13.6%	5.0%	6.6%	21.7%	7.4%	15.1%	4.7%	4.3%	10.1%
9	TX/OK/NM/CO	0.0%	0.0%	0.4%	3.5%	1.2%	2.7%	15.0%	9.6%	23.8%	7.7%	8.8%	27.3%
11	5 Area	0.0%	0.0%	0.0%	0.4%	1.9%	6.5%	26.5%	18.8%	29.6%	7.7%	3.1%	5.4%
12	National	0.0%	0.0%	0.0%	0.4%	2.3%	4.2%	23.5%	25.0%	28.5%	8.1%	4.2%	3.8%
Region 5													
1	CO	2.8%	7.1%	4.3%	11.4%	7.1%	5.1%	17.7%	7.5%	16.1%	3.5%	2.0%	15.4%
3, 5	CO/WY/SD	0.0%	2.7%	6.5%	18.8%	14.6%	9.2%	21.9%	4.2%	11.5%	1.9%	3.5%	5.0%
4, 6	CO/WY	3.5%	4.2%	8.1%	11.5%	5.4%	6.9%	18.8%	8.8%	15.4%	2.7%	2.7%	11.9%
11	5 Area	0.0%	0.0%	0.0%	0.4%	1.9%	6.5%	26.5%	18.8%	29.6%	7.7%	3.1%	5.4%
12	National	0.0%	0.0%	0.0%	0.4%	2.3%	4.2%	23.5%	25.0%	28.5%	8.1%	4.2%	3.8%

END