Risk Shifting via Partial Vertical Integration
Beef Packers' Acquisition of Slaughter Cattle

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"It is only by explicitly analyzing the effect of uncertainty on market behavior that the incentives and consequences of vertical integration can be fully comprehended." Dennis Carlton[2]

Partial vertical integration of many food and agricultural industries, especially beef packers' acquisition of slaughter cattle, increasingly raises competition and fairness issues for the non-integrated residual market. While market foreclosure may be a central antitrust concern with full integration[3], partial integration does not completely foreclose markets, but may shift risks to the residual non-integrated market.[4] This short report presents empirical analysis of risk shifting in the partially integrated market for slaughter cattle.

Brief History of Cattle Markets

Competition and fairness issues have characterized cattle markets since cattle first moved up the Chisholm Trail in 1867. Beginning not long after, a Big Five beef packer (processor) cartel set price and apportioned the market, triggering a legal and political battle that culminated with Consent Decree in 1920. Divestiture was followed by the Packers and Stockyards Act of 1921 that made it unlawful for packers *"... to engage in or use any unfair, unjustly discriminatory, or deceptive practice or devise or engage in any course of business or ... any act for the purpose or with the effect of manipulating or controlling prices[5]."*

Revised DOJ/FTC merger guidelines in the 1980 reversed the 1920 divestiture and led to a sharp increase in beef packing concentration from a CR4 of about 20% in the late 1970s to over 80% in the 1980s. For the past few decades, competition and fairness issues raised by independent ranchers and cattle feeders have been not only about buyer power of the Big 4 packers but also with the dominant packers' partial integration backward into slaughter cattle acquisition with various contractual relationships, commonly referred to as captive supply, primarily with very large cattle feeders.

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[2] Carlton (1979), p. 208.
[3] See, for example, Carlton (1979); Salinger; Hart and Tirole; Levy, Spiegel, and Gilo; and Avenel.
[4] Carlton (1979); Levy, Spiegel, and Gilo.
[5] Taylor (2008) has additional discussion on the legal and political history of cattle markets. The PSA is available at https://www.ams.usda.gov/rules-regulations/packers-and-stockyards-act

Partial Vertical Integration Concerns

Carlton[6] theoretically established that under uncertainty, partially integrated markets "are not Pareto-efficient in the absence of insurance markets" for the non-integrated fringe. Unique characteristics of the market for slaughter cattle that have been institutionalized by the partially integrated, dominant beef packers prevent non-integrated cattle feeders from obtaining any such insurance premium. Therefore, risk transfer is a critical component of analysis of efficiency and desirability of the partially integrated structure of cattle markets.[7]

Academic analyses of potential risk transfer by partial vertical integration are often restricted to theoretical examination because of data inadequacies. However, empirical assessment of relative risk with different cattle acquisition methods is possible due to detailed weekly data reported by large buyers—packers—under Federal legislation called Livestock Mandatory Reporting (LMR).[8]

Unique Characteristics of the Market for Slaughter Cattle

The market for slaughter cattle has several important and unique characteristics that are critical to theoretical and empirical analysis of risk transfer with partial integration.

First, cattle ready for slaughter are a perishable commodity because there is only a week or two for optimal marketing; consequently, slaughter cattle acquisition is best viewed as a dynamic weekly process.

Second, upstream vertical integration by packers into cattle feeding is primarily through two types of marketing agreements with feeders, called formula and forward contracts. These are sometimes referred to as alternative marketing arrangements, and colloquially called captive supply. LMR reports two types of negotiated (non-captive, often called cash) transactions, one with quality premiums and discounts (called a grid), and one without an explicit grid.[9]

Third, formula contracts (accounting for 61% of slaughter)[10] have a base price tied to the residual market, while forward contracts (9%) are tied to the CME cattle futures market. Apparent[11]

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[6] Carlton (1979).

[7] See Taylor (2022) for additional concerns about market power and institutionalized and other arrangements that raise efficiency, antitrust, fairness, and PSA issues. Numerous academic and government analyses of captive supply have all used a deterministic framework, which may lead to incorrect conclusions. As Carlton (1979, p. 208) cautioned *"An analyst using a deterministic approach to this problem (vertical integration) would be led astray and would be unable to find any desirable or undesirable incentives or disincentives for vertical integration "*

[8] https://www.ams.usda.gov/rules-regulations/mmr/lmr/rulemaking

[9] Negotiated cattle sold without a grid still typically receive a quality premium or discount, as both buyers and sellers are generally very good at recognizing quality "on the hoof."

[10] Averaged over 10/2012 through 9/2022.

[11] Validity of LMR reporting of packer owned cattle is unclear. For example, JBS, one of the four largest beef packers, split ownership of Five Rivers feedlots (total capacity of about a million head), with JBS owning the feedlots and J&F Oklahoma Holdings owning the cattle One reason JBS gave for this split was to avoid *"existing and future potential 'Packer Ban' legislation at the state and federal level that place significant restrictions on packer ownership of livestock prior to slaughter."* JBS "Notice to the Market," https://sec.report/otc/financial-

direct packer ownership of cattle on feed is small (2%), with negotiated transactions (28%) accounting for the rest.

Captive supply (formula + forward + packer owned) trended upward since formula arrangements began in the late 1980s but appear to have stabilizing at about 71% nationally in recent years. The extent of captive supply varies by USDA/LMR report region, with TX-OK-NE (90% captive), NE (59%), KS (79%), and IA-MN (40%).[12] Captive supply fluctuates from week to week, from a national average low of 44% to a high of 90% in the last 10 years, at times with dramatic changes from week-to-week.

Fourth, captive arrangements typically guarantee the feeder a market, called shackle space, unlike non-integrated feeders who have no such market guarantee.

Fifth, it is critical to note that dominant packers have institutionalized the tie between captive and negotiated prices.[13] Consequently, potential risk transfer of partial vertical integration will not be manifested in relative price variability, but in terms of quantity, as packers move in or out of the residual non-integrated market depending on captive commitments and anticipated downstream demand for beef.

Sixth, because of the institutionalized tie between captive and negotiated prices, sellers in the residual negotiated market cannot obtain a risk premium. In fact, just the opposite is true, as some captive feeders receive a bonus not received by non-integrated feeders.

Finally, the beef packing industry is highly concentrated horizontally, with CR4 on the seller side (beef) of the market over 80%, yet concentration on the packer-buyer side of the market (slaughter cattle), is much higher in regional markets, often fluctuating considerable from week to week.[14]

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Empirical Assessment of Relative Risk

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Two empirical measures of risk are proposed: the coefficient of variation and the weekly percentage change in cattle acquisition.

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report/21482 Because JBS and various J&F entities are legally intertwined, this split was in their own words an effort to hide ownership of cattle. Whether this impacts LMR reporting is unclear.

[12] Data source: https://mpr.datamart.ams.usda.gov/menu.do?path=Products\Cattle\Weekly%20Cattle

[13] The base price in formula agreements in generally tied directly to an announced negotiated market price. Since CME cattle prices are strongly influenced by negotiated prices, forward contract base prices are indirectly related to the negotiated market.

[14] A buyer-side weekly HHI for slaughter cattle in regional markets fluctuates considerably, from somewhat below the DOJ/FTC threshold of 2500 to pure monopoly and at times even to no meaningful active buyers in the market. Consequently, annual seller-side HHI statistics are not indicative of buyer power in the market for slaughter cattle. See pp 23-24 in Taylor (2022).

The coefficient of variation[15] (CV) is a statistical metric widely accepted in finance to measure relative risk.[16] A CV Ratio—the CV of negotiated acquisitions divided by the CV of captive acquisitions—is an operational metric for assessing relative variability of weekly slaughter numbers. A ratio of one would indicate no risk differences, while a ratio greater than one indicate that the residual negotiated market is more risky than captive supply.

Table 1 shows CVs for prices paid for slaughter cattle acquired under captive arrangements and in the residual (negotiated) negotiated market. The price CVs are essentially the same, as expected because of the direct link between the base price in captive arrangements and the residual negotiated market price.[17] Because this pricing arrangement that has been institutionalized by the dominant, partially integrated packers, any risk transfer would be manifested in number of head acquired as packers move in or out of the residual non-integrated market.

Table 1. Coefficient of Variation for Price Paid for Cattle Acquired Under Different Arrangements, 10/2012 through 9/2022	
Captive	**Negotiated**
0.125	**0.130**

CVs based on LMR weekly head slaughtered acquired with alternative arrangements, as reported by the dominant packers, are summarized in Table 2. As can be seen, the non-captive market was considerably riskier than captive supply. The negotiated market was about 3 times riskier in the TX-OK-NM and KS regions, which has the highest average captive supplies, and somewhat higher in AI-MN that has the lowest average captive supplies.

Table 2. Coefficient of Variation of Quantity Acquired for Different Arrangements, 10/2012 through 9/2022				
LMR Region	Captive	Negotiated	**CV Ratio (Negotiated /Captive)**	**Average % Captive**
TX-OK-NM	0.15	0.48	**3.16**	90%
NE	0.16	0.26	**1.67**	59%
KS	0.16	0.42	**2.66**	79%
IA-MN	0.27	0.30	**1.11**	40%
Total U.S.	**0.10**	**0.24**	2.44	**72%**
Packer Owned	0.47			2%

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[15] The CV is a widely accepted statistical measure of relative variability, defined as the standard deviation of a variable divided by its mean.
[16] See, for example,
https://www.investopedia.com/terms/c/coefficientofvariation.asp#:~:text=In%20finance%2C%20the%20coefficient%20of,risk%2Dreturn%20trade%2Doff.
[17] CVs for more detailed categories, such as live or dressed weight, and negotiated grid, are like the averages shown in Table 1.

Market Dynamics

Weekly cattle markets are highly dynamic. A dynamic way of empirically assessing relative risk is to use a moving average of the ratio of CV for captive supply divided by the CV for the residual market.

How long of a moving average to use is a moot issue. Since slaughter cattle are a perishable commodity, a moving average CV for only a few weeks is appealing, but may be too short from a statistical standpoint, while a moving average over several years would not be very enlightening about the dynamics of risk in cattle markets. Two extremes are considered here: 52-week and 4-week moving averages.

Chart 1 shows the scatter plot of the 52-week moving average of the CV Ratio, and the moving average of the percentage captive supply from October 2012 through September 2022 for each of the LMR reporting regions. One strong visual implication of this scatter plot, which is consistent with results in Table 1, is that increasing captive supply makes the residual market considerably riskier, with risk increasing exponentially with captive supply. A similar chart with data going back to 2008 is not appreciably different.
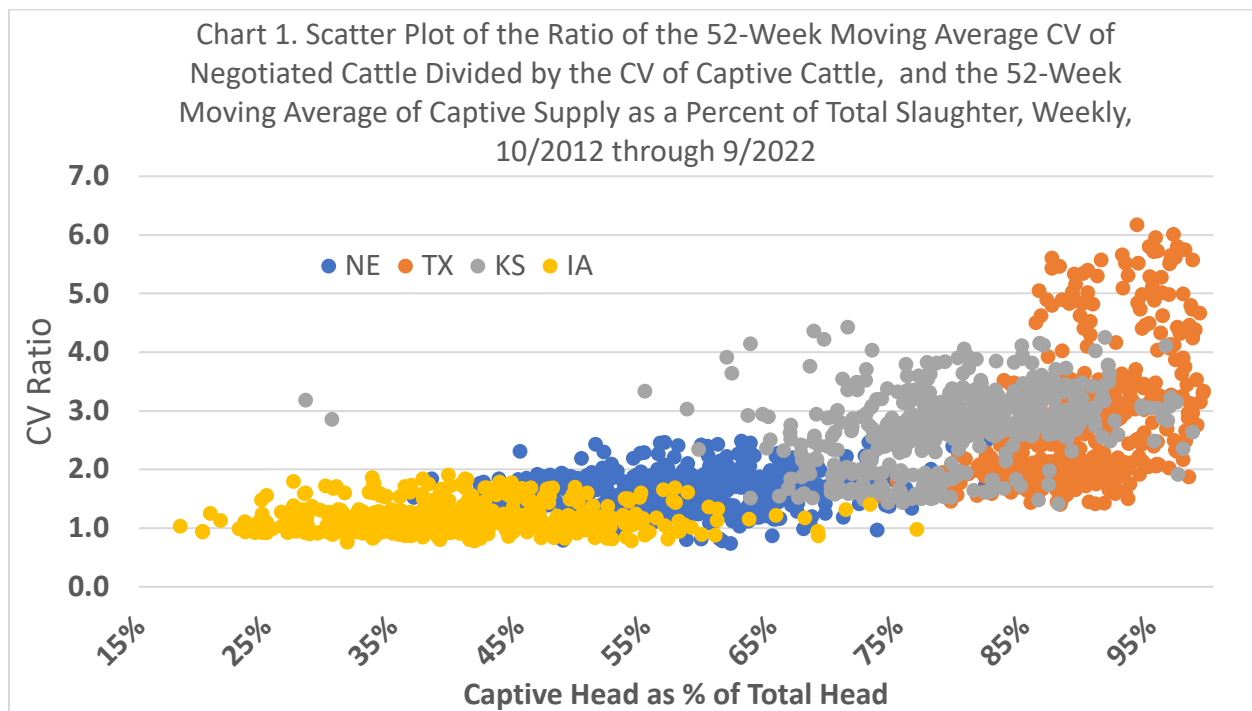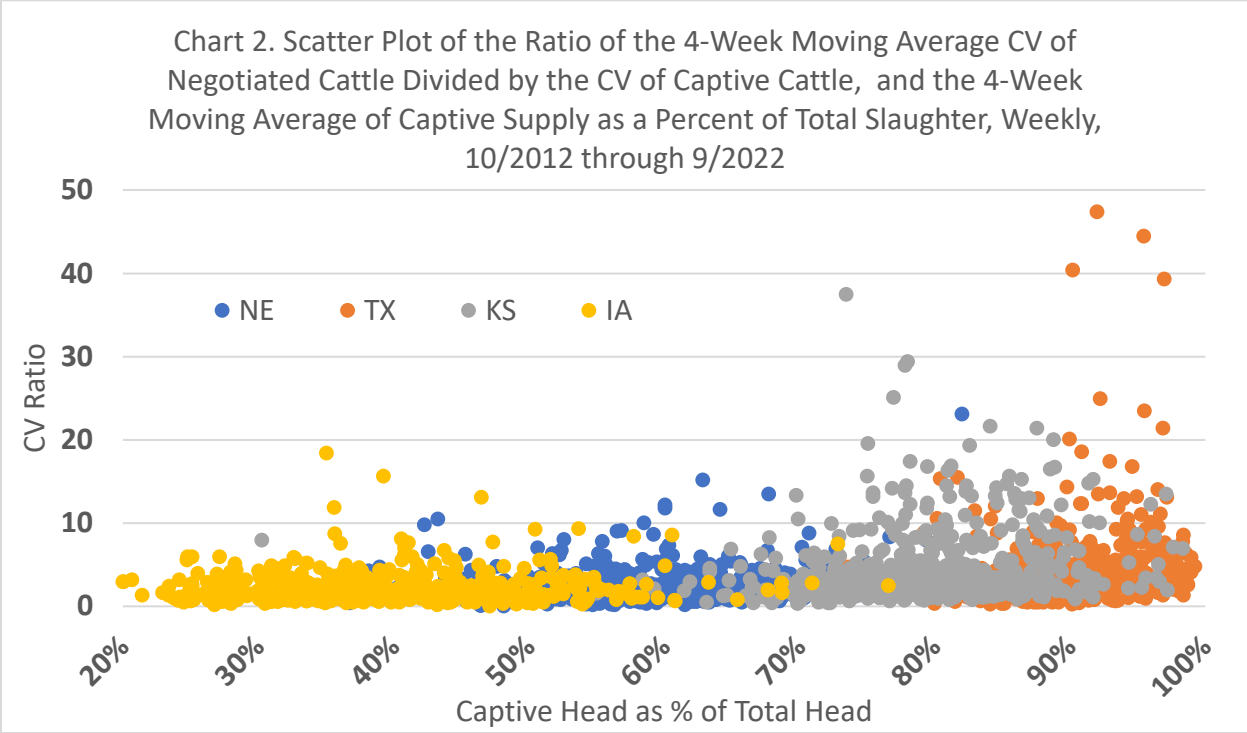

Chart 2 shows the scatter plot of the 4-week moving average of the CV Ratio, and the moving average of the percentage captive supply from January 2016 through September 2022. Implications are like Chart 1 with the 52-week moving averages, but the 4-week moving average reveals wide variability at higher captive supply levels, with a several data points having a ratio well above 10. (Note differences in the vertical scales of Charts 1 & 2).

Chart 2. Scatter Plot of the Ratio of the 4-Week Moving Average CV of Negotiated Cattle Divided by the CV of Captive Cattle, and the 4-Week Moving Average of Captive Supply as a Percent of Total Slaughter, Weekly, 10/2012 through 9/2022

While a moving average CV ratio would be expected to vary at times, risk neutrality would be characterized by a ratio that would be above (or below) 1.0 approximately 50% of the time. As shown in Table 3 this is not the case. In IA-MN, which has the lowest average captive supply, the CV Ratio is above one 77% of the time based on the 52-week moving average, and above one 75% of the time based on the 4-week moving average. Thus, the CV Ratio exceeds one with high probability, even in regions with relatively low captive supply.

Table 3. Fraction of Weeks in Which the Negotiated Market Was Riskier Than Captive Supply Based on the Ratio of Moving Averages of the Coefficient of Variation of Head Slaughtered (weeks in which the CV Ratio was > 1)			
LMR Region	**52 Week Moving Average**	**4 Week Moving Average**	Average Percent Captive
TX-OK-NM	**100%**	**68%**	90%
NE	**98%**	**65%**	59%
KS	**100%**	**72%**	79%
IA-MN	**77%**	**75%**	40%
Based on LMR data 10/2012 through 9/2022			

An alternative dynamic metric to the CV Ratio is the weekly percentage change in acquisitions by type. Charts 3-6 present histograms for the weekly change in head acquired under captive arrangements and negotiated sales for each of the four LMR reporting regions. As with the CV metric, the residual negotiated market is considerably riskier than captive supply.

Chart 3. Histogram of Weekly Percentage Change in Head Acquired by Acquisition Method, TX/OK/NM, 10/2012 through 9/2022
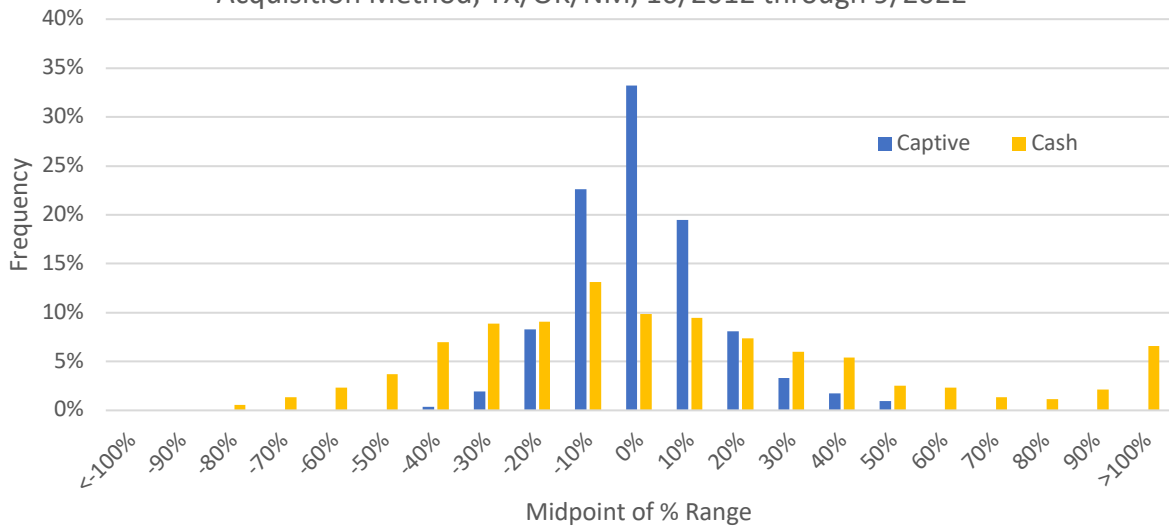

Chart 4. Histogram of Weekly Percentage Change in Head Acquired by Acquisition Method, NE, 10/2012 through 9/2022
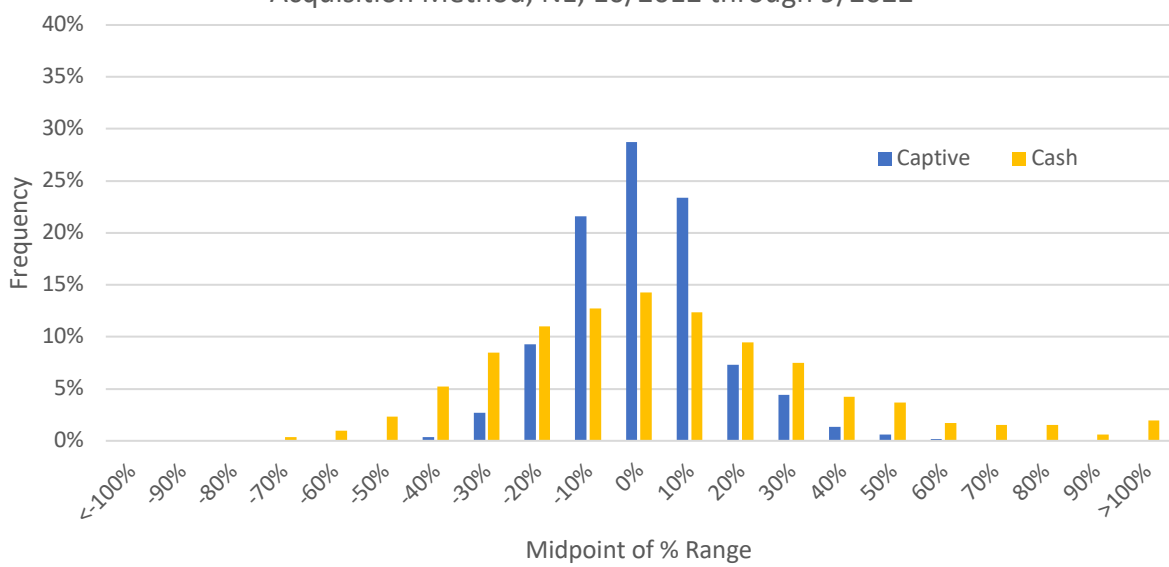
Chart 5. Histogram of Weekly Percentage Change in Head Acquired by Acquisition Method, KS, 10/2012 through 9/2022
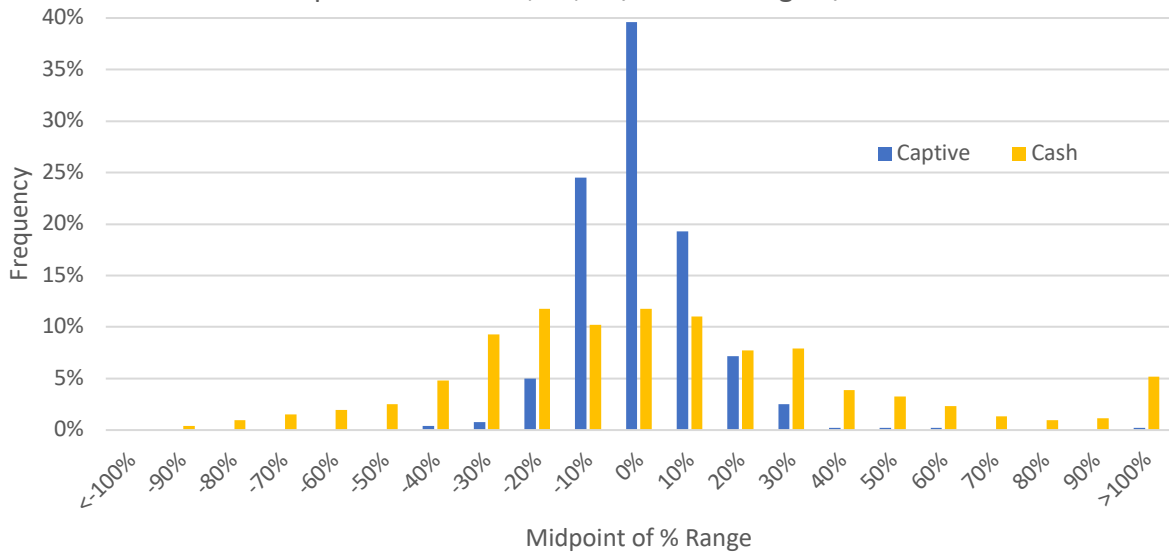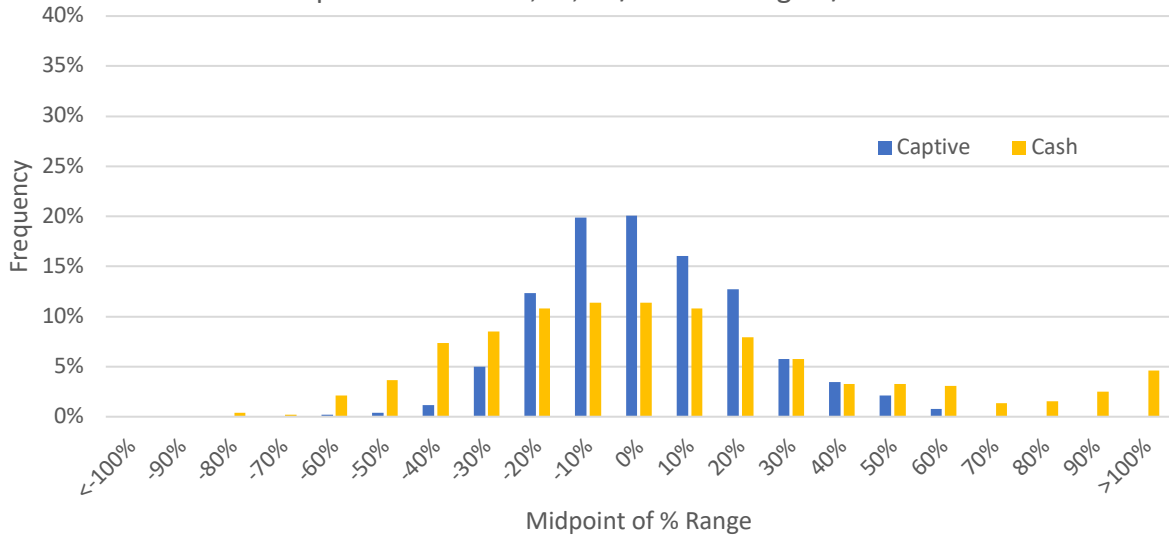

Chart 6. Histogram of Weekly Percentage Change in Head Acquired by Acquisition Method, IA, 10/2012 through 9/2022

Concluding Remarks

Carlton[18] theoretically established that markets under uncertainty are not Pareto-efficient in the absence of insurance markets for the non-integrated fringe. Unique characteristics of the market for slaughter cattle that have been institutionalized by the dominant, partially integrated, beef packers prevent non-integrated cattle feeders from obtaining any such insurance premium, thereby making the market inefficient.[19]

The CV Ratio and the weekly percentage change in cattle acquisition are two empirically operational metrics of relative risk of different cattle acquisition arrangements. The packers' own data, as reported under LMR, reveals that with either measure the residual negotiated market is considerably riskier than captive arrangements, and the relative risk increases exponentially with captive supply. Thus, available data clearly support the contention that captive arrangements have transferred risk to the residual negotiated market, making the residual market an insurance market for packers that have partially integrated upstream with captive supply arrangements.

Because packers have institutionalized the tie between the base price in formula contracts and the residual negotiated market price, cattle feeders without captive agreements are not compensated for bearing higher risks and in effect being an uncompensated insurance market for packers with large captive arrangements. Risk transfer, combined with the undeniable negative relationship between captive supply and residual market price[20], as well as other manifestations of buyer power, strongly support independent cattle feeders long-standing contention that captive supply arrangements are unfair and anticompetitive.

Partial vertical integration has not completely foreclosed the market for slaughter cattle, but it has transferred risk to the residual negotiated market.

Many other food and agricultural markets are partially integrated and horizontally concentrated. In recent years, food retailers have partially integrated upstream into processing and some even further upstream into raw material production. While public information and empirical data on these other industries is scanty, risk transfer in acquisition of slaughter cattle suggests that risk transfer as well as market power may be critical competition, fairness and efficiency issue in many food and agricultural markets.

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[18] Dennis W. Carlton (1979)

[19] See Taylor (2022) for additional concerns about market power and institutionalized arrangements that raise efficiency, antitrust, fairness and PSA issues.

[20] Additional competition and fairness concerns are that some, maybe all, captive feeders have sweetheart deals involving bonuses, risk sharing, and financing not offered to feeders selling on the residual negotiated market. For captive feeders, the sweetheart deals may offset the negative effects base price, but result in supply response that, along with potential market power excesses, lower price to independent feeders. Quality adjusted weekly prices reported under LMR for formula and negotiated transactions are essentially the same, as are regional prices for different acquisition methods. These reported prices do not appear to include some or any of the sweetheart deals.

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