Competition for Fed Cattle in Colorado vs. Other Markets: The Impact of the Decline in Packers and Ascent in Contracting

by

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In recent years, several state and national farm or commodity
...izations have expressed concern about the declining number of packers
...ting for their livestock, and the influence of packer forward contracting
...rm prices. In this paper, we outline some early results of our analysis
...ese overlapping issues in the fed cattle market, with emphasis on
...ado where the comparative decline in the number of large packers located
...e state has been more severe than in most major cattle feeding states
...1 to 3 large plants owned by 2 packers). Since we implicitly are making
...ptions about the appropriate relevant geographic market for fed cattle as
...oceed in the analysis of the effect of forward contract deliveries or the
...ging number of slaughter plants on reported prices in a state, we also
...rze the dynamics of the geographic market arbitrage process using
...lation and vector autoregression techniques.

Relevant Literature

In the last decade, there have been a few studies beginning to address
...nfluence of the number of competing buyers or procurement market
...ntration on prices paid to farmers in the beef or pork industries. The
...t of pork plants opening or closing was studied by Hayenga, Deiter, and
...ya, and either temporary or no local producer price impact was found in
..., Wisconsin, and Oklahoma case studies. Miller and Harris analyzed the
...t of state pork slaughter firm concentration on state price levels, and
...1 marginally significant lower prices associated with higher
...ntration. Quail, Marion, Geithman and Marquardt analyzed the beef packer
...ntration--fed cattle price relationship in 13 regional fed cattle markets
...e 1970s, and found statistically significant negative relationships. The
...nal markets used in their study had earlier been estimated by Willard
...ams for the House Small Business Committee based primarily on his
...sis of fed cattle movements during the 1970s.

Analysis of the relationships between market concentration indices and
...es can be critically influenced by the choice of the relevant market and
...esulting level of concentration. The theory and procedures applicable to
...ant product and geographic market determination have been discussed in
...industrial organization textbooks and in many antitrust cases which we
...not cite here. Recent contributions include Stigler and Sherwin, where
...conclude that comparisons of price movements (correlations of direct or
...erenced time series) are essentially equivalent to the commonly
...mended cross elasticities of demand and supply for relevant market
...sis, and should be used in geographic and product market determination.

They also argue that the physical shipment of good or its absence may not provide reliable proof that two areas are or are not in the same relevant market. Slade utilized univariate time series techniques and Granger-Sims causality tests to determine the economic links between markets for petroleum. She used pairwise tests of market linkages, and suggested that multivariate analysis might be more appropriate. Schultz used trade areas, univariate time series, factor analysis and cross elasticities to analyze the relevant market for fed cattle. She concluded that the Midwest-Texas market seemed to constitute a relevant market, with additional but weaker ties to coastal regions. Schroeder and Goodwin analyzed fed cattle geographic market price lead-lag relationships using Granger causality tests, and found significant 1-3 week lags among 11 markets, but the relevance of their results to relevant market determination was not considered.

Objectives and Data Sources

The primary objectives of this study are to: determine the impact of the sharp decline in the number of plants and packers in Colorado on relative fed cattle prices; analyze the appropriate geographic market for fed cattle; and determine whether packer contracting of fed cattle influences spot market price levels.

To analyze these related issues, USDA reported Choice 1100-1300 lb. steer prices were acquired for a number of geographically dispersed markets (weekly averages--1973-1989; daily--1984-1989). Arizona prices were for 900-1100 lb. steers due to insufficient price data on heavier cattle. In addition, Cattle-Fax estimates of weekly contract cattle deliveries to packers in 4 states (October 1988-89), USDA statistics on monthly state cattle slaughter for the same time period, and USDA statistics on the number of beef slaughter plants above 100,000 head capacity in each state, annually for 1973-1989, were collected.

In this paper, some early results of our ongoing analysis are reported which offer some preliminary answers and raise some interesting questions.

Colorado Prices and the Number of Competing Packing Plants

Has the decline in the number of large packing plants and the number of active beef slaughter firms located in the state led to lower prices paid for fed cattle? This has often been a matter of concern among livestock producers in many states when they lost packing plants in the last 20 years. However, such concerns may be increased inappropriately if producers view their state as the relevant market in which to consider the number of competitors when the appropriate geographic market may be much larger. One way to test that is to find an extreme situation and determine whether structural changes in the state impacted market performance. Since Colorado is a major cattle feeding state on the fringe of the primary cattle feeding region, and the number of resident packers are down to 2 with 3 large plants (versus 8 in the 1970s), the potential for changes in relative prices appeared more likely there than in most other states.

An initial graphical analysis of the ratio of weekly average Colorado steer prices to the average price in 8 other states during the 1973-89 period

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(Figure 1) showed little apparent change in relative prices. No significant trend was found.

Figure 1. Colorado/Eight State Average Price Ratio
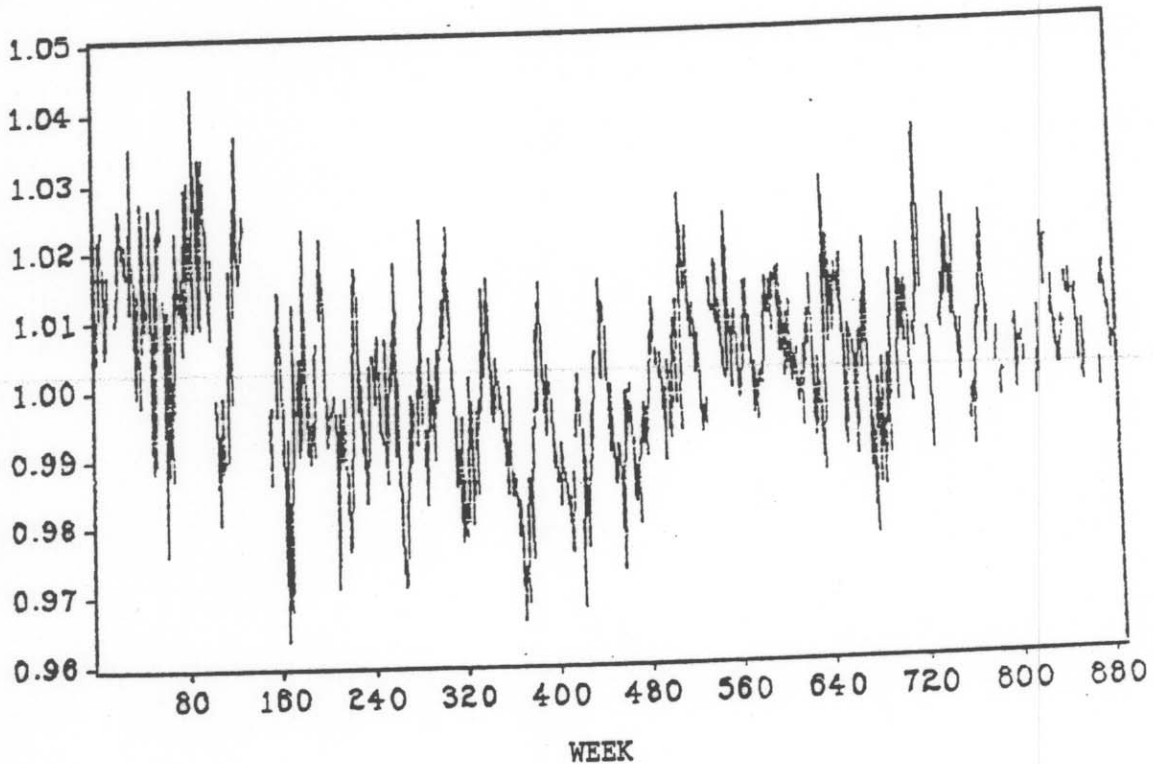
WEEK

Have changes in the number of beef slaughter plants in Colorado had an effect on Colorado fed cattle prices relative to other markets? The ratio of weekly Colorado fed cattle prices to the average market price of 8 other markets (COLPRRTO) was used as the dependent variable. The Colorado price ratio was regressed on: a) the ratio of the number of Colorado beef packing plants to the total number of beef packing plants in the 8 other states considered (COLPLRTO), b) the squared difference between COLPLRTO in a specific year and the average value of COLPLRTO from 1973 to 1989 (COLPLRT2) and c) a time trend (WKEND) to account for other factors that have changed over time. The results are summarized in Table 1.

Table 1. The Effect of the Relative Colorado Beef Packing Plant Numbers on Relative Colorado Fed Steer Prices

Dependent variable: COLPRRTO

Variable	Coefficient	T Value
CONSTANT	1.182	77.931**
COLPLRTO	-0.324	-13.839**
COLPLRT2	-1.537	-3.207**
WKEND	-1.630E-07	-10.636**

R-Squared = 0.202
Durbin-Watson statistic = 0.567
** indicates significance at the 1% level.
* indicates significance at the 5% level.

In these least squares regression results, the relative number of slaughter plants in Colorado is inversely related to the relative fed cattle prices in Colorado. As the relative number of beef packing plants in Colorado decreased, the relative price in the Colorado fed cattle market has increased.

This issue was also examined using vector autoregression (VAR) analysis. The VAR dependent variable was Colorado weekly average prices (COLWK). COLWK was regressed on: a) one and two week earlier lagged values of itself (COLWK(-1) and COLWK(-2), respectively), b) one and two week lagged values of the average market price for 8 other markets considered in the study (AVMKT(-1) and AVMKT(-2)), and c) COLPLRTO and COLPLRT2 as defined above. The VAR results are given in Table 2.

Table 2. Effect of Lagged Colorado Weekly Average Prices, Eight Market Average Weekly Prices and Relative Colorado Beef Packing Plant Numbers on Colorado Weekly Average Steer Prices.

Vector Autoregression: Dependent variable is COLWK

Variable	Coefficient	T Value
COLWK(-1)	0.171	1.617 **
COLWK(-2)	0.418	3.910 **
AVMKT(-1)	1.224	10.380 **
AVMKT(-2)	-0.832	-6.928 **
COLPLRTO	-712.585	-3.473 **
COLPLRT2	299.921	0.053
CONSTANT	220.521	4.343 **

R-Squared = 0.989
Durbin-Watson statistic = 2.053

The VAR results indicate that two week lagged values of the weekly Colorado fed steer price, one and two week lagged values of the all market average fed steer price, and the ratio of the number of beef packing plants in Colorado to the total number of plants in all 8 states considered each had a significant impact on the weekly average Colorado price. The plant ratio (COLPRTO) had a significant negative impact on the weekly Colorado price.

In both the regression and vector autoregression analysis, fewer plants relative to other areas are associated with higher relative prices in Colorado. This is inconsistent with what many economists or industry participants would expect, since usually fewer competitors are expected to lead to depressed farm prices. These results may be due to misspecification of the plant ratio variable, or due to the increased efficiency of the larger scale plants still remaining in Colorado, compensating for any potential loss in competition. Alternatively, it may be due to the inappropriate use of the state as the relevant market area for structural market analysis, which could

lead to spurious results. Our packer survey found that a few packers in other states regularly or occasionally purchase fed cattle from Colorado, so the procurement area for Colorado cattle extends beyond Colorado borders into three other states. And the arbitrage process in the fed cattle market may extend significant market interactions well beyond that procurement area.

Forward Contract Deliveries and Market Prices

To measure the effect of forward contracting on fed cattle prices, Cattle-Fax weekly state estimates of forward contract deliveries were transformed into percentages of state monthly slaughter for Colorado, Texas, Nebraska, and Kansas (____CONT). Near-VAR (VARX) models were used to determine the effects of one and two weeks of lagged prices for each state and weekly contract variables for each of the four states on each state's current weekly fed cattle prices. Correlation in weekly contract volumes between the four states was generally low. For example, the correlation between COLCONT and TEXCONT was .24, whereas correlation between KANCONT and NEBCONT was .56. Results for Colorado are reported in Table 3. (The results for other states were very similar.)

Table 3. Effect of Lagged Weekly Prices and Contracting as a Percent of Monthly Slaughter on Colorado Fed Cattle Prices.

Near-VAR Dependent Variable: COLORADO Prices

Variable	Lag	Coefficient	T Value
COLORADO	1	-0.593	-1.499
COLORADO	2	0.052	0.136
NEBRASKA	1	0.423	0.994
NEBRASKA	2	-0.606	-1.693
KANSAS	1	1.457	3.417**
KANSAS	2	0.543	1.454
TEXAS	1	-0.596	-0.012
TEXAS	2	-0.377	-1.093
COLCONT		-5.300	-0.976
KANCONT		59.078	2.744**
TEXCONT		-20.452	-2.545*
NEBCONT		-19.209	-0.880

R-Squared = .934

Kansas forward contracting had a significant (1%) positive effect on Colorado fed cattle prices, while Texas forward contracting had a significant (5%) negative effect. Colorado and Nebraska contract deliveries had no significant effects. In each other state equation (not shown), Kansas forward contracting was found to have the same significant positive effect on prices in Texas, Kansas and Nebraska. Texas contracting had a similar significant (5%) negative on Nebraska prices, and a more significant (1%) negative effect on Texas and Kansas prices. Colorado and Nebraska contract volumes had no significant effect. Since this preliminary analysis has conflicting results on the contract delivery impacts, further analysis will be necessary before any conclusions can be drawn.

Relevant Market

The relevant geographic market for industrial organization and antitrust analysis often is based on the trade areas of the firms dealing in closely related products, with some marginal attention to the potential competitors who might fairly easily move into those trade areas if prices moved up (or down, in the case of procurement markets) to make entry more attractive. Cross elasticity estimates are usually impractical due to data shortages, but often market prices from various firms or geographic markets can be obtained. Fairly simple correlation analysis often is relied on as one of the tools to characterize product, firm or geographic market interrelationships. However, simple analyses like that may mislead, especially in markets where many other common factors influencing general supply and demand conditions may be stronger influences on price behavior than the competitive arbitrage process within related geographic areas.

How can the relevant geographic market for livestock be characterized? Based on long observation, the individual procurement areas of livestock buyers can be viewed as an amoeba-shaped area, sometimes approaching a tear drop shape, around each slaughter plant. Each procurement area typically overlaps with others, with more significant influences from others as you approach the fringe of the amoeba. Further, the fringe of the procurement area ebbs and flows in response to changing geographic cattle supply patterns, product demands, slaughter capacity utilization, cutting margins, and competitive pressures. As a shock occurs in the system (e.g. a new plant opens), one competitor begins taking more cattle from the fringe of another's procurement area, who in turn does the same thing to an adjacent competitor on another fringe of his/her procurement area, and the domino or ripple effect is transmitted well beyond those packers actively involved in the initial trade area where the shock occurred. Thus, the trade area does not appear to be the appropriate focus of analysis. Rather, the area where the price reverberations from shocks to the system are sufficiently quick and strong would appear to be the best candidate as the relevant geographic market for subsequent structure--performance analysis.

Since it seems likely that different statistical analysis and data selection choices could potentially lead to different results when analyzing the speed and strength of geographic market price interactions, we explore a few alternative types of price data (weekly, daily, regular and differenced price series). In addition, we examine the degree of correlation among prices in geographically dispersed markets, as well as the strength of lagged price interrelationships among these markets, with emphasis on Colorado as a focus of inquiry.

Contemporaneous Price Correlations

In the following tables, the simple correlation matrices are reported for weekly average USDA direct market price reports from the states indicated during 1973-1989 (Table 4), the first differenced series of those same prices (Table 5), daily USDA price reports during 1984-89 (Table 6), and first differences of that series (Table 7). There were fewer states with frequent daily price reports for use in our analysis.

Table 4. Correlation Matrix of the Weekly Prices

	NE	TX	KS	CO	IA	IL	CA
NE	1.00	0.97	0.98	0.98	0.98	0.97	0.92
TX		1.00	0.98	0.98	0.97	0.96	0.89
KS			1.00	0.99	0.98	0.98	0.93
CO				1.00	0.98	0.97	0.95
IA					1.00	0.99	0.91
IL						1.00	0.91
CA							1.00

Table 5. Correlation Matrix of Weekly Price, First Differences

	NE	TX	KS	CO	IA	IL	CA
NE	1.00	0.80	0.89	0.81	0.89	0.89	0.77
TX		1.00	0.87	0.84	0.83	0.81	0.76
KS			1.00	0.92	0.91	0.90	0.87
CO				1.00	0.88	0.88	0.86
IA					1.00	0.93	0.85
IL						1.00	0.82
CA							1.00

Table 6. Daily Price Correlations, 1984–1989

	COL	KAN	TEX	IA	OMAHA	ARZ
COL	1.00	.991	.995	.988	.987	.969
KAN		1.00	.992	.982	.980	.966
TEX			1.00	.985	.984	.972
IA				1.00	.997	.956
OMAHA					1.00	.954
ARZ						1.00

Table 7. Daily Price Correlations, First Differences, 1984–1989

	COL	IA	KAN	OMAHA	TEX
COL	1.00	.518	.484	.548	.526
IA		1.00	.612	.531	.536
KAN			1.00	.609	.622
OMAHA				1.00	.632
TEX					1.00

The weekly average price correlation was quite high for all states included in the analysis, ranging from the West Coast to Illinois. However, part of that high correlation was associated with the strong upward trend in prices during 1973-89. First differenced weekly prices exhibited lower, but still fairly high correlations between all markets studied.

Daily price patterns exhibited more variability and lower correlations than the weekly prices, though even the differenced daily price correlations were above .5. Based on these comparisons, it seems clear that potentially different conclusions could arise from the choice of data in many case situations.

Lagged Price Relationships

However, immediate or same day price response measured by the correlation matrix may be an inappropriate test to apply. A strong response within a reasonably short time period to a shock in another area may be sufficient to consider those areas all part of the relevant market. Thus, the strength of same time period price linkages and the speed and strength of lagged price linkages need to be considered in making a judgement regarding the appropriate relevant market.

One statistical procedure which may be useful in evaluating lagged price interaction speed and strength among several geographic areas is vector autoregression. VAR models have been estimated for each of the weekly, daily, and differenced price series described earlier, though constraints due to computational capacity or gaps in the daily data have limited our progress. Due to space constraints, we will illustrate the results from one model focusing on Colorado as the selected endogenous price variable.

Vector autoregression analysis was used to determine the effect of lagged weekly and daily average fed steer prices in Colorado and other states on prices in Colorado during 1973-89. First differences effectively eliminated the upward trend in prices during this time period. In analysis of weekly price first differences shown in Table 8, Colorado weekly prices were significantly related to one and three week lagged values of Colorado prices, one week lagged values of Kansas, Nebraska, Arizona, Iowa and Illinois prices, and one and two week lagged values of Washington prices. Insignificant lags were omitted from the table. This analysis of significant effects is preliminary in nature since the determination of significant effects is based on T values instead of F tests.

Table 8. The Effect of Lagged Weekly First Differenced Fed Steer Prices for Various States on Fed Steer Prices in Colorado.

Dependent Variable: COLORADO Price
Lagged Independent Variables: COLORADO, KANSAS, NEBRASKA, TEXAS, ARIZONA, CALIFORNIA, WASHINGTON, IOWA, ILLINOIS

Variable	Lag	Coefficient	T Value
COLORADO	1	-0.830	-6.715**
COLORADO	3	-0.339	-2.757**
KANSAS	1	0.365	2.994**
NEBRASKA	1	0.671	6.649**
ARIZONA	1	-0.131	-2.056*
WASHINGTON	1	0.280	3.348**
WASHINGTON	2	0.209	2.423*
IOWA	1	0.258	1.954*
ILLINOIS	1	-0.450	-3.741**

R-Squared = 0.296
Durbin-Watson statistic = 1.948

Similar analysis was carried out for each state. Those lagged first differenced weekly prices which had a significance level of at least 5 percent are reported in Table 9.

Table 9. Significant Weekly Lags in Price Relationships in Weekly First Differenced VAR Analysis

Dependent Variables	Independent Variables								
	COL	KAN	NEB	TEX	ARZ	CAL	WASH	IOWA	ILL
COL	1,3	1	1		1		1,2	1	1
KAN	1		1	1	1		1,2	1	1
NEB	1	1	1				1,2	1,2	1
TEX	1	1	1	2	1		1,2	1	1
ARZ	3		1		1	1	1		1
CAL	1		1				1,2	1	1
WASH	1		1	1				1	1
IOWA	1		1	1			1,2		1
ILL	1		1	1			2	1	

Summary and Conclusions

Our preliminary results suggest that fed cattle prices in Colorado have not declined relative to other cattle feeding states during 1973-89 when the number of resident large slaughter firms declined from 8 to 2. In addition, the impact of forward contracted cattle deliveries on weekly price levels in 4 states is not clear, due to inconsistent results in our preliminary analysis.

One potential reason for these results may be the use of state price indices when the state may not be the appropriate geographic relevant market.

The contemporaneous correlation among weekly and daily prices among the widely dispersed cattle feeding states was quite high, as was the correlation of the weekly first differenced price series. Only a daily first differenced price series led to correlations among the most distant states dropping to .5.

The vector autoregression analysis done to date suggests that many of these state prices are also significantly affected by price changes in other states within the last two weeks, especially. If further analysis confirms these initial findings, the relevant geographic market for structural and competitive analysis is much larger than any state, and is much larger than the trade areas of individual firms due to the indirect competitive effects on and through the behavior of "third-party" firms in the dynamic arbitrage process in commodity markets.

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