CONCENTRATION-PRICE RELATIONS IN REGIONAL FED CATTLE MARKETS

by

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WP 104 (REV) October 1993

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Certain unpublished data used in this analysis was provided by the Packers and Stockyards Administration, USDA (P&SA). P&SA's cooperation in providing the information in no way implies either agreement nor disagreement with the methods, conclusions, or implications derived from this analysis.

Introduction

Between 1977 and 1987, the U.S. beef packing industry was restructured at a pace unprecedented in large American industries. Whereas in 1977, 32 percent of U.S. steers and heifers were slaughtered by the largest four beef packers, by 1987 that share had more than doubled to 68 percent.[1] This sharp run-up in industry concentration triggered widespread concern among farmers, policy makers, and academics concerning the effectiveness of competition in beef packing.[2] However, the sharp increase in concentration largely occurred during a period when the performance effects of industry concentration were being challenged in the academic community and when enforcement by antitrust agencies reflected a growing agnosticism toward concentration as a source of market power.

Since 1980, several studies have examined competition in the beef subsector. These efforts can be grouped by methodology into 1) traditional structure-conduct-performance

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[1] It has been estimated that slightly over half of this increase can be traced to mergers and acquisitions while the remainder was due to internal growth (Marion and Kim 1990).

[2] The following reports and/or investigations are indicative of this concern:
•Hearings on Mergers and Concentration: The Food Industries before the Subcommittee on Monopolies and Commercial Law of the House Committee on the Judiciary, May 1988.
•Publication of Meatpacking Competition and Pricing (Clement Ward) by VPI Research Institute on Livestock Pricing, July 1988.
•Hearings on Concentration in Meat Packing Industry before House Committee on Agriculture, Iowa State Legislature, December 1988.
•Report by National Cattlemen's association (NCA) Beef Industry Concentration/Investigation Task Force, October 1989.
•Report on Competitive Issues in the Beef Sector by team of economists commissioned by NCA (D. Gale Johnson, October 1989).
•Report on Competition and the Livestock Market by task force of Center for Rural Affairs, April 1990.

(SCP) studies and 2) conjectural variation (CV) studies. Notable among the first group are Ward (1981, 1992); Menkhaus, St. Clair and Ahmaddand; and Quail et al. In the main, these studies find evidence that fed cattle prices are positively related to the number of packer buyers or negatively related to the concentration of packer slaughter in a region or state. The results are generally interpreted as evidence of monopsony power. The results are consistent with the large number of concentration-price studies in other industries (summarized by Weiss 1989).

Conjectural variation studies of the beef subsector include Schroeter; Azzam and Pagoulatos; and Azzam and Schroeter. While these studies vary in the extent to which they find monopoly price distortions, all three find evidence of significant but relatively small monopsony price distortions.

In addition to the difference in the methodologies employed in the above studies, the geographic areas examined vary widely. In both of Ward's studies, data on individual sale lots of cattle were collected from feedlots during a one-month period (July 1979 and June 1989). Ward's "markets" were small, averaging roughly 20 counties. By focusing on explaining the prices for individual transactions, Ward gains some richness of detail but is less able to test market level hypotheses. For example, Ward's research design (3 subregions for one month in 1989) eliminates the possibility of econometrically testing the concentration-price hypothesis of traditional structure-conduct-performance paradigm. Instead, he tests the impact of the number of buyers bidding on each lot of cattle, and examines whether the largest packers pay more or less than smaller packers. While buyer numbers have clear theoretical roots in most oligopoly models, the basis for expecting price differences among

buyers is more opaque. Most homogeneous product oligopoly models assume that all firms pay (or receive) the same price. Prices in more concentrated buying markets are expected to be lower because of collusion among buyers or because of the presence of a dominant price leader. Smaller fringe firms are expected to share the monopoly (monopsony) benefit. Ward is not clear on why packer size is expected to affect the price paid. In his 1979 data, packer size was not significantly related to cattle prices; in the 1989 data, the "Big 3" packers paid significantly lower prices for the cattle purchased.

The models employed in the Menkhaus et al and Quail et al studies were similar to the present study. Menkhaus et al chose states as the geographic level of analysis and analyzed data for two years, 1972 and 1977. Quail et al examined cattle prices during 1971-78 in 13 regional markets that were somewhat larger than states and defined to reflect the location of feedlots and slaughter plants. The same regional markets are used in the present analysis.

The conjectural variation studies have generally been limited to national data at the industry level of analysis. However, cattle procurement markets are relatively small in size (most cattle are purchased within 100 miles of the packing plant (Ward 1988, p. 58)). Thus, one of the frequent criticisms of CV studies is that it is inappropriate to use national data to model markets that are local in nature. Azzam and Schroeter responded to this deficiency in their most recent study by using data for regional markets. Their simulated consequences of increased packer concentration was lower cattle prices, but the effect of concentration was less than in the above three SCP studies.

The current study is a SCP study that in time periods and in geographic territories is analogous to Azzam and Schroeter. Thus, it provides a direct comparison of the two methodologies--the SCP and the CV. The results suggest that disequilibrium and structural change had major impacts on the beef industry in the 1971 to 1986 period and need to be incorporated into any empirical model. Although the empirical model employed in this analysis is subject to some of the criticisms made of SCP empirical work (i.e., it is not explicitly derived from a formal profit maximizing model), because the study uses multiple markets within a single industry and uses prices to measure market power, not profits or price-cost margins, it avoids other common criticisms (e.g., the inability of most SCP and CV studies to distinguish between efficiency and market power as a source of inflated price-cost margins; the problem of using accounting profits as a proxy for economic profits; the inability of cross industry studies to capture the unique characteristics of individual industries).

Because there are several regional cattle procurement markets, a pooled cross sectional-time series analysis is possible with the reasonable assumption that the elasticity of demand is similar across regions (derived from a common national demand).

Geographic Markets for Fed Cattle

The nature of competition and the existence of market power can only be understood if the geographic and product nature of markets is accurately identified. In agriculture, most producer-first handler markets are local or regional in scope. Even grain, which is not perishable, is usually sold to local elevators within 50 to 100 miles of the farm (Marion 1986, p. 149). Ward (1981) found that two-thirds of fed cattle are slaughtered within 100 miles of the feedlot; 80% are slaughtered within 150 miles.

One method of defining geographic markets is based upon product flow. In a manner analogous to defining watersheds, geographic market boundaries are based upon the predominant movement of cattle. This was the approach used by the late Willard Williams in the study conducted for the House Small Business Committee (Williams, p. 154 and 192). As packing plants close or open, market boundaries may change. Our telephone interviews with *Market News* reporters indicated that Williams' regions were accurate descriptions of trade flows throughout the 1970s and through 1986, with the possible exception of Region 9 (E. Kansas and W. Missouri) and Region 1 (Washington, Oregon and Idaho). In the analysis reported here, we use 13 geographic markets defined by Williams (see Figure 1).

The size of our geographic markets are larger than those used by Ward (1981, 1992), slightly larger and conceptually different than Menkhaus et al, who simply used state boundaries. Our markets are smaller than those suggested by Williamson et al and Schultz, both of whom concluded that the Texas-Oklahoma High Plains and Iowa-Nebraska are in the same geographic market.

The weight given the Williamson and Schultz conclusions depends upon the credence given their methodology. Both relied on tests of price interdependence. Schultz correlated cattle prices in 10 different areas and found all were statistically related.

Scheffman and Spiller argue that the price correlation approach may be useful in defining economic markets (which Marshall defined as an area where "prices of the same goods tend to equality with due allowance for transportation costs" (p. 324)), but will often fail to define antitrust markets. Antitrust markets are defined as geographic areas in which market power can be exercised--the "markets" proposed by the Justice Department Merger

Guidelines. Economic markets and antitrust markets are often not synonymous. In the case of live cattle, prices in different locations may be highly correlated because of common cost and demand factors or the use of a common national reference price (e.g., the Yellow Sheet), not because the areas are interdependent. We believe there is substantial evidence that the price correlation method is a hazardous procedure for defining antitrust markets.[3]

Structure of National and Regional Markets

National concentration of steer and heifer slaughter changed little from 1972 to 1978; the largest four packers accounted for 29 percent of total slaughter. Four-firm concentration (CR4) then rose sharply over the following nine years to 67 percent by 1987 (Packers and Stockyards Administration). By 1991, the largest four packers slaughtered 73 percent of the nation's steers and heifers (Figure 2).

The 13 regional procurement markets used in our analysis (Figure 1) accounted for roughly 87 percent of fed cattle marketed in the U.S. in 1988.[4] Concentration of fed steer and heifer slaughter in regional procurement markets is 20 to 25 points higher than national

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[3] We have tested the price correlation approach for defining geographic markets in food retailing, gasoline retailing, fed cattle and eggs. Our experience to-date is that the price correlation approach frequently gives false positive results (says two areas are in the same market when in fact they are not). The approach rarely seems to give false negative results (says two areas are not in the same market when in fact they are).

[4] Regional boundaries are reported in Quail et al, Appendix A (1986). Region 14 is not included on our analysis due to lack of data.

Figure 1. Geographic Boundaries of 14 Regional Fed Cattle Markets

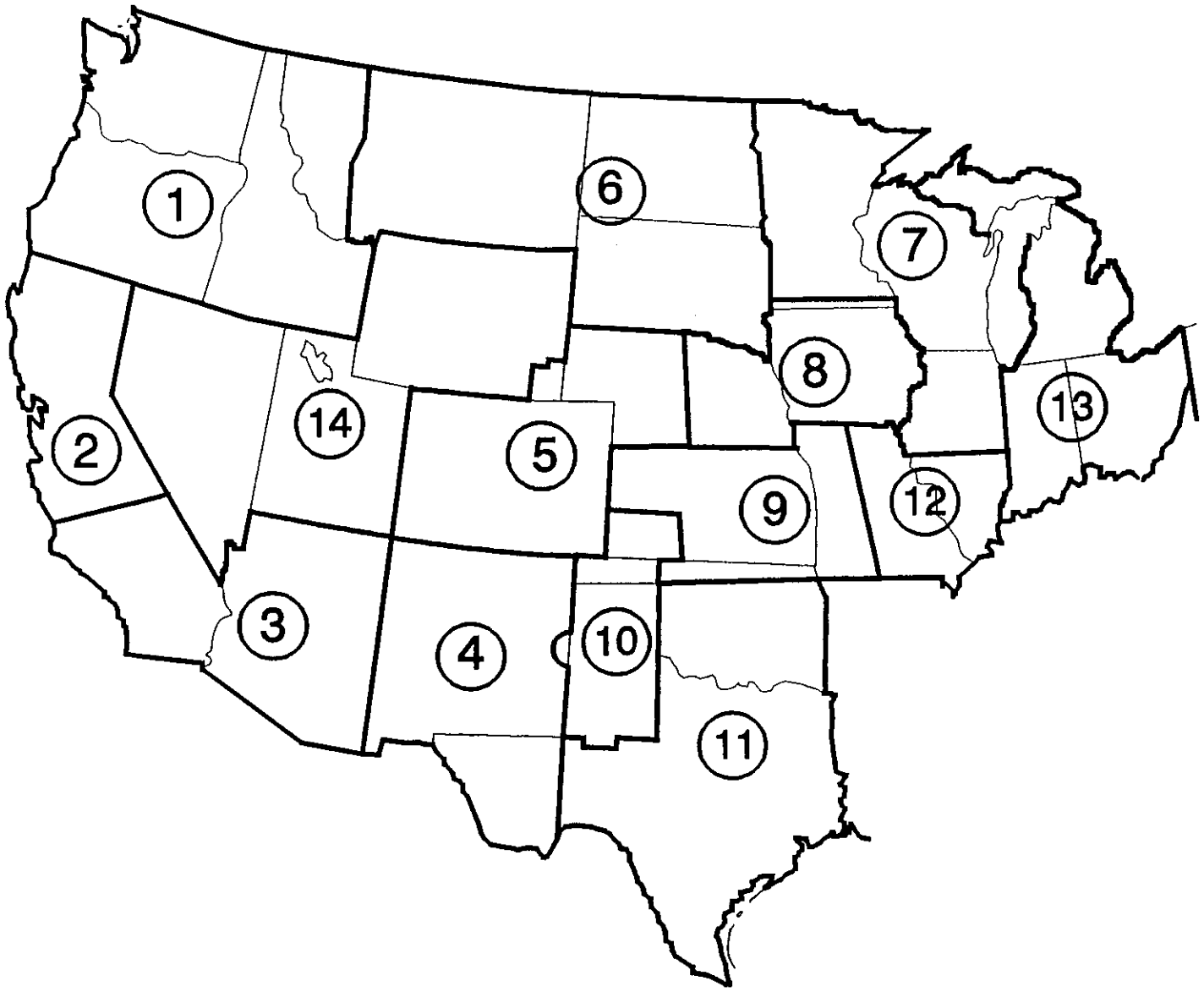
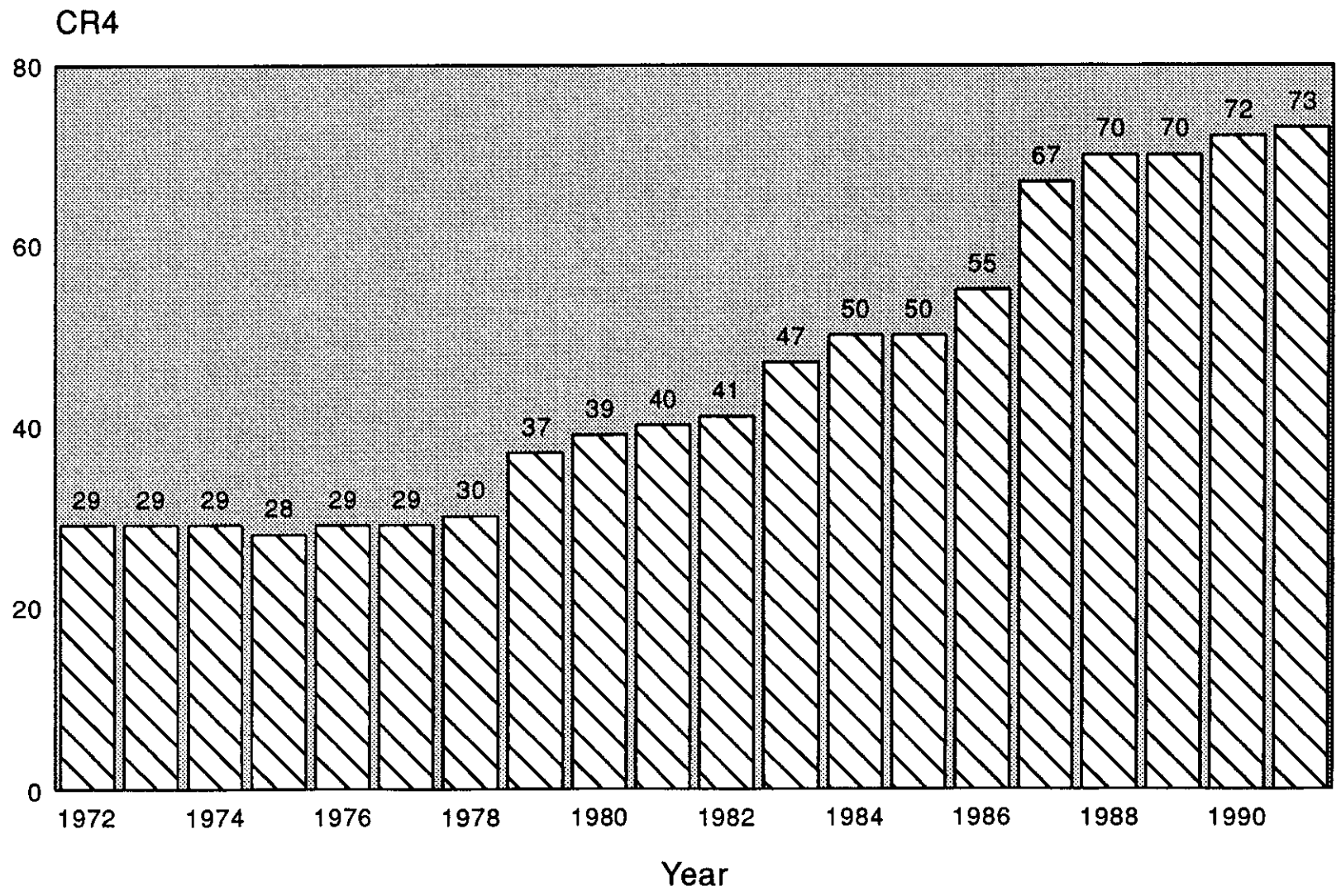


Figure 2. National Four-firm Concentration Ratio of Steer and Heifer Slaughter, 1972-91



Source: Packers and Stockyards Administration

concentration. The four leading packers in each region, on average, slaughtered 53 percent of the region's steers and heifers in 1971, 58 percent in 1978 and 85 percent in 1986.[5]

Fed cattle are slaughtered by two types of plants: 1) plants that slaughter only and sell carcass beef; and 2) integrated slaughtering-fabricating plants that both slaughter and process carcasses into boxed beef. Integrated plants are largely owned by the top 20 beef packing companies. In 1990, 96% of the boxed beef production came from the top 20 firms.

Boxed beef has been one of the major developments in beef packing in the last 20 years. Whereas in the 1960s, nearly all beef left the packer as forequarters or hindquarters, boxed beef now dominates. Boxed beef accounted for 31 percent of fed steers and heifers slaughtered in 1972, 51 percent in 1980 and 86 percent in 1990 (Packers and Stockyards Admin.)

Economies of scale exist in both beef slaughtering and processing. Until recently it was thought that a specialized slaughtering plant that killed 250,000 head per year using two shifts would realize most scale economies available (about 1 percent of the U.S. fed cattle slaughter). Economies of scale appear to be greater in boxed beef processing (Cothern et al.). A recent study by Sersland (see Ward 1988) suggests that scale economies may exist well beyond the 250,000 head per year capacity identified by Cothern et al. Most new

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[5] At the end of 1986, Region 8 had a CR4 of 77 percent. Only three other small regions had lower CR4s in 1986 (Regions 3, 11, and 13). Region 8 is dominated by IBP, Inc. with four of their smaller plants located there. The new IBP plant in Lexington, Nebraska (opened in 1990) suggests that a realignment of regions will be necessary in future studies. Lexington, Nebraska sits just west of our region 8 boundary in Dawson County. Dawson County is a major fed cattle producing county in Nebraska.

combination beef slaughtering-processing plants have a slaughtering capacity of 500,000 to 1 million head per year.

Entry barriers into beef packing are relatively high because of the capital cost of a new integrated plant, the difficulty of penetrating the boxed beef market, and the displacement effect in procurement markets of a minimum efficient scale (MES) plant. By 1986, a 250,000 head per year plant would require at least 25 percent of the total supply in eight of 13 regions studied. If an MES plant requires 500,000 head, only six regions could facilitate two or more MES plants.

Feedlot-packer negotiations nearly always occur at the feedlot. Whereas 39 percent of cattle were sold directly by feedlots to packers in 1960, this had increased to 80.2 percent by 1987; 94 percent of steers and heifers were sold direct in 1990 (Packers and Stockyards). Cattle feeders are dependent on packer buyers coming to the feedlot, inspecting their cattle, and making an offer.

Disequilibrium During Late 1970s and 1980s

Most theories of oligopoly deal with conditions of equilibrium and short-run profit maximization. But markets are not always in equilibrium and firms may not try to maximize profits in the short-run. For example, a firm may elect to build market share by aggressive pricing or mergers in order to reap the future benefits of greater market power. When this is the case, the hypothesized relationship between market structure and prices or profit may not hold. Similarly, a sudden shift in supply or demand may throw the industry into disequilibrium. Ziemer and White found modest support for the hypothesis of significant disequilibrium in the market for fed beef.

Past research has shown that market power may have less (or no) effect during disequilibrium periods, such as during periods of rapid inflation (Weiss 1974). Rapid inflation was only one of the disequilibrating forces affecting the beef packing industry during 1971-1986, the period examined in this study. The rapid inflation of the 1970s had a particularly strong impact on older beef packers because most of these firms were on the "master contract" with the union. The master contract not only called for higher wage rates than those paid by "new breed" packers, but also contained a COLA (cost of living adjustment) clause that escalated wages during inflationary periods. By the latter half of the 1970s, older beef packers found themselves more and more out of line with the wages paid by IBP. Many older packers either withdrew from beef packing, re-negotiated labor contracts, or changed plant ownership. During 1976-80, there was a considerable scramble to "get competitive" with new breed packers.

A structural change in demand may also have occurred around 1979-80 (Buse). While evidence on this is mixed, a shift in demand to become more elastic may have stimulated price rivalry between packers and reduced packer market power.

The entrenchment of boxed beef also occurred during the late 1970s and early 1980s. As this occurred, packers without boxing facilities increasingly faced a withering market for beef carcasses. Packers with boxed beef plants were able to pick up market share.

Figure 2 indicates the change in national CR_4 in the slaughter of fed steers and heifers during 1972-1991. While most of the concentration increase during 1986 and 1987 was due to mergers, much of the increase during 1978-1984 was from internal growth. This was a period of substantial restructuring of the beef packing industry.

Figure 3 portrays live cattle and wholesale beef prices between 1971 and 1986. The shift in price levels that occurred during 1978 and 1979 is particularly apparent. This analysis stops with 1986 because comparable price data for three of our seven regions became unavailable for 1987 and later years.[6]

Economic Analysis

In many respects, Figures 2 and 3 capture the dynamics of the beef industry during 1971-1986: rapid increases in concentration and volatile prices. Disequilibrium in meat packing during the late 1970s and early 1980s poses a problem for empirical analysis of concentration-price relationships. Our initial analysis of monopsony power focused on 1971-1978. Pooled time-series cross section analysis revealed a significant negative relationship between regional buying concentration and live cattle prices (Quail et al).

In this article, the earlier analysis by Quail et al is extended through 1986. Although most of our analysis uses cattle prices as the dependent variable, several regressions examine packer margins by region, using cattle price as a percent of the wholesale price. Finally, an effort is made to determine whether a critical concentration level exists in the markets examined.

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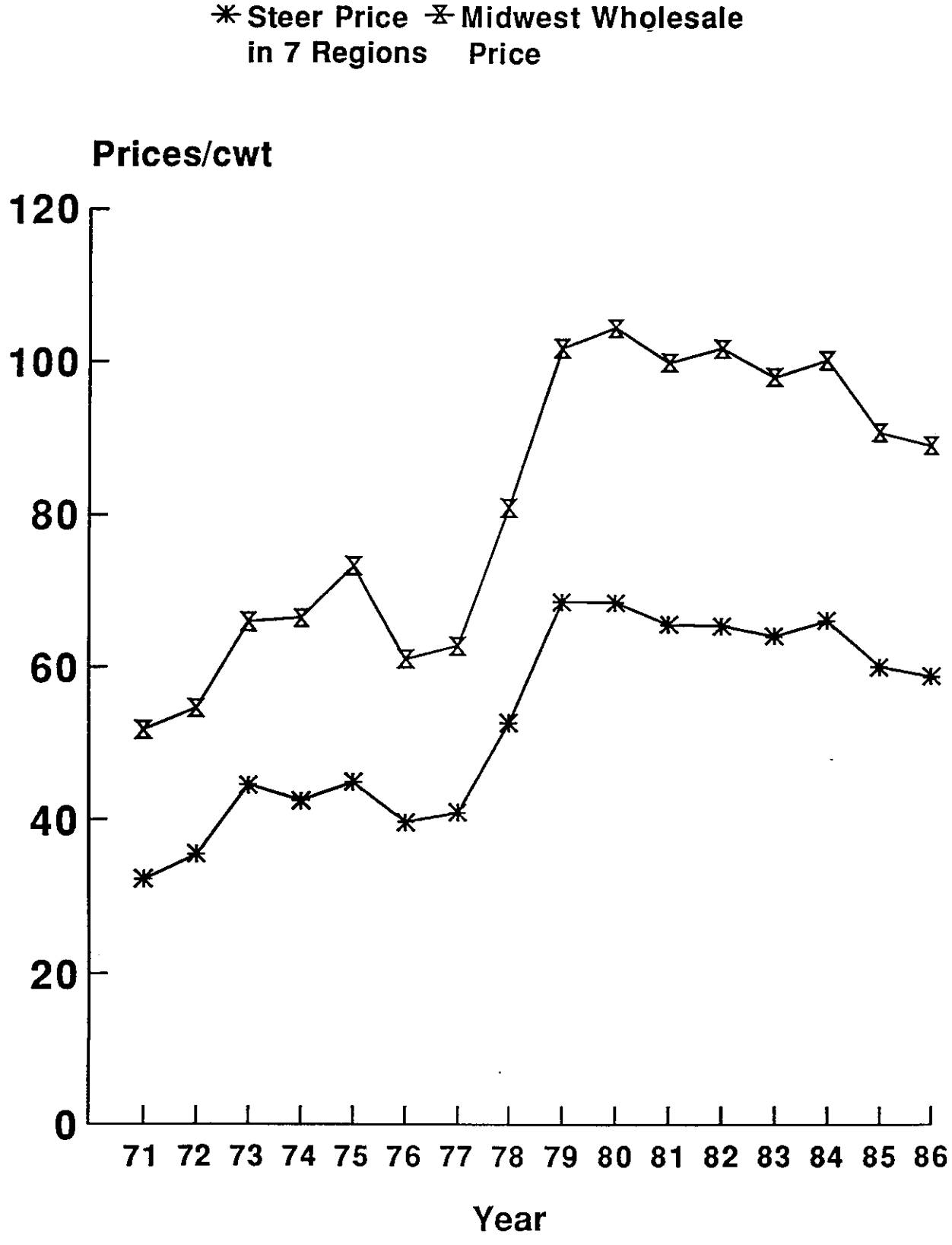
[6] Region 1 was dropped as an observation in 1984 because Market News shifted to reporting prices for heavier cattle (1100-1300 lb. steers). In 1987, Market News discontinued reporting separate prices for Eastern Kansas (the price base for Region 9) and Western Kansas (part of Region 10). Rather, unweighted prices for all of Kansas were reported. Thus, in 1987 we lost the ability to calculate comparable regional prices for Regions 9 and 10.

Figure 3. Annual Live Cattle Prices and Midwest Wholesale Prices for Choice Steer Carcasses, 1971-86



Empirical Results

The basic empirical model was: P = f(CR,FS,PC,T,NSD).[7] Variable definitions and expected signs are presented in Table 1.

Because transaction costs at terminal markets are higher than for direct sales, terminal prices are expected to be lower than direct sale prices. However, the volume sold through terminal markets also dropped sharply over the period examined, resulting in greater concern about the increasing "thinness" of these markets. Whereas 1.24 million head of cattle were sold at the Omaha terminal in 1971, this had dropped to 230,000 by 1988. Cattle sales at National Stockyards in St. Louis dropped from 349,000 to 107,000 during that period.[8]

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[7] Other variables were included in some equations that are not shown here.
1) Rivalry or market turbulence was measured in two ways:
- Relative share instability was the sum of the absolute change in the market shares of individual firms ranked in the top four. In all cases, it was not significant.
- Percentage change in packer CR4 from one year to the next. This has a significant positive sign in the equation in Table 5, in which it is included.

2) Regional surplus-deficit, measured by:

$$\frac{M_{ij}-S_{ij}}{M_{ij}}$$

where:
M_{ij} = fed cattle marketed from farms in region i in year j.
S_{ij} = number of steers and heifers slaughtered in plants in region i in year j. This variable was consistently insignificant.

[8] National stockyard prices were used for Region 12 up through 1980, after which that region was dropped from the sample.

Table 1. Variables Used in Econometric Analysis

Variable	Definition	Expected Sign
P (Price)	Annual average price for USDA choice steers (900-1100 lbs.) in each region as reported by USDA Market News. An alternate measure, regional steer price as percentage of national wholesale carcass price, is used in Table 5.	
CR (Buyer Concentration)	Concentration of steer and heifer slaughter in each region for each year, measured by CR4, 1/CR4 and Herfindahl Index.	−
FS (Feedlot Size)	Percent of fed cattle marketed in region that came from feedlots with capacity of 1000 head or more.	+
PC (Packer Costs)	Three variables measured variations in packer costs across regions	
	1. Labor: Wages for production employees in SIC 2011 in each state for 1971-78.	−
	2. Plant size: A zero-one binary identified regions in which one or more plants slaughtered 250,000 head per year or more.	+
	3. Distance: Distance of each region from either New York City or Los Angeles	−
T (Terminal Market)	Dummy variable to identify four regions in which Market News prices were for terminal markets	−
NSD (National Supply-Demand)	Two variables were used to measure or control for national supply-demand forces.	
	• Annual average midwest carcass price for U.S. choice steers	−
	• Yearly dummy variables	?

Tomek demonstrated that a terminal's prices become unrepresentative of the general price level for cattle when the volume sold through that terminal becomes small. Our statistical analysis supports the concern that terminal markets became unrepresentative of the broader market during the 1970s and 1980s. When the four terminal market regions were analyzed separately, no relationship between fed cattle prices and packer concentration was found. Conversely, when the direct market regions were analyzed without the terminal regions, the relationship between packer concentration and cattle prices was negative and highly significant. Additionally, because terminal market regions were among the smaller volume regions, data on fed cattle marketings and feedlot size became unavailable in 1981.

As a result of the above problems, the four terminal market regions were excluded from the analysis for 1981 to 1986. For earlier periods, the analyses were run both with and without the terminal regions. Table 2 presents the regression results for 1971-78, the period we consider most normal. Equations 1-4 included all 13 regions; equations 5-8 exclude the four terminal regions and regions 4 and 11, which have missing or unreliable data for some years.

In equations 2 and 4, the Herfindahl Index is significantly negative although only marginally so in equation 4. The Herfindahl Index (HI) and inverse CR4 (not shown) are slightly stronger then CR_4. All measures of concentration are highly significant when annual dummies are included. Using the wholesale price for beef rather than annual dummy variables to control for national supply-demand conditions reduces substantially the t-value on the concentration variable.

Of the remaining variables in the models, feedlot size has a significant positive relationship to cattle prices, as hypothesized. None of the variables measuring packer costs perform as hypothesized. Labor costs are never significant. The plant economies variable generally has a negative sign rather than the positive sign hypothesized. The distance variable usually has the expected negative sign but is not significant.

The terminal market dummy has the hypothesized sign but is not significant. The terminal, distance and feedlot variables are highly collinear. When all three are included in the model, only the feedlot variable tends to be significant.

Table 2. Regression Results Explaining the Prices of Live Steers in Regional Markets, 1971-78

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept	3279.51 (33.63)**	3269.39 (37.69)**	163.53 (1.29)	136.50 (1.06)	3254.97 (64.83)**	3245.37 (74.57)**	21.37 (0.12)	41.42 (0.26)
Herfindahl		-334.20 (-2.65)**		-313.74 (-1.60)+		-725.62 (-5.11)**		-562.67 (-1.73)*
CR4	-91.19 (-1.30)+		-87.27 (-0.89)		-299.16 (-3.91)**		-223.93 (-1.42)+	
Labor	11.08 (0.80)	8.66 (0.69)	-2.19 (-0.16)	-4.67 (-0.35)				
Terminal	-32.02 (-0.80)	-32.33 (-0.91)	-16.02 (-0.30)	-6.82 (0.13)				
Distance	-0.041 (-0.78)	-0.039 (-0.95)	-0.063 (-0.91)	-0.056 (0.92)	.041 (0.84)	-0.016 (-0.46)	0.001 (0.01)	-0.025 (-0.32)
Feedlot	0.81 (1.40)+	0.89 (1.71)*	1.18 (1.41)+	1.32 (1.58)+	1.01 (2.97)**	1.22 (4.22)**	1.531 (1.68)*	1.39 (1.89)*
Plant Size	-47.25 (-1.93)	-45.54 (-2.10)						
Wholesale Beef Price			0.63 (32.03)**	0.63 (32.37)**			0.64 (30.88)**	0.64 (32.02)**
Annual Dummy	Yes	Yes	No	No	Yes	Yes	No	No
NOBS	98	98	100	100	56	56	56	56
Type	EGLS	EGLS	EGLS	EGLS	EGLS	EGLS	OLS	EGLS

Note: t-statistics are in parentheses. Except for equations 3 and 5, parameters were estimated using the Prais-Winston Procedure and corrected for heteroskedasticity.

** = significant at 1% level

* = significant at 5% level

In the remaining analyses, the terminal market regions are excluded, allowing the terminal dummy to be dropped. Because of the insignificance or unexplainable results on the labor cost and plant economies variables, these are also dropped from future models.

As we expand the period studied to include 1979-1986, the appropriate model and statistical procedure is more problematic. Figure 3 reveals a sharp break in prices between 1977 and 1979. One question is whether it is appropriate to pool data for 1971-77 with the data for 1979-86. If a shift in demand occurred in 1978-79, did the coefficients on our independent variables also change? Did the relationship between wholesale beef prices and steer prices change during this period?

To further explore the appropriate statistical procedures, our base model was run for various time periods. Table 3 indicates the first order autoregression value (Rho), intercept term, CR4 coefficient, and wholesale price coefficient for our base model (Cattle price = f(CR4, Feedlot Size, Distance, Wholesale price) for time periods ending in 1986 but varying in starting years from 1971 to 1982. Table 4 provides a similar analysis for time periods starting in 1971 and ending in years ranging from 1975 to 1986. In both analyses, 1978-79 seemed to be a watershed period. Both the intercept term and the coefficient on WP (wholesale beef price) change sharply during that period. Between the 1978-86 and the 1979-86 models in Table 3, the coefficient on WP drops from .67 to .60 and the intercept term changes from a large negative to a large positive. These results suggest the inclusion of a dummy variable for 1971-78 when data are pooled for the entire 1971-86 period.

Four-firm concentration is negative and significant for most of the time periods examined in Table 3. However, for short periods either at the beginning (not shown) or end

Table 3. OLS Results for Base Model with Four-Firm Concentration Ratio, Time Periods with Different Beginning Years, Seven Regions

Years	Rho	Intercept	CR_4	WP	DFE
1971-86	.147 (1.51)*	-290.64 (-2.97)**	-144.13 (-1.72)*	0.68 (82.1)**	104
1972-86	.167 (1.66)*	-250.56 (-2.35)*	-140.72 (-1.63)*	0.67 (74.6)**	97
1973-86	0.100 (0.95)	-302.58 (-2.56)*	-150.04 (-1.65)*	0.68 (66.8)**	90
1974-86	0.107 (0.97)	-433.15 (-3.73)**	-146.92 (-1.70)*	0.69 (70.2)**	83
1975-86	0.071 (0.62)	-418.29 (-3.26)**	-134.09 (-1.451)*	0.69 (64.4)**	76
1976-86	0.155 (1.29)*	-271.40 (-2.61)**	-231.33 (-3.10)**	0.67 (80.3)**	69
1977-86	0.141 (1.12)	-272.22 (-2.14)*	-219.21 (-2.71)**	0.67 (63.0)**	62
1978-86	0.108 (0.80)	-254.05 (-1.26)	-220.36 (-2.47)**	0.67 (35.6)**	55
1979-86	0.237 (1.67)*	395.58 (1.20)	-357.61 (-3.30)**	0.60 (19.2)**	48
1980-86	0.162 (1.04)	445.56 (1.63)	-183.81 (-1.85)*	0.58 (22.4)**	41
1981-86	-0.097 (-0.56)	571.60 (1.93)*	-105.86 (-0.96)	0.57 (19.5)**	34
1982-86	-0.059 (-0.30)	605.47 (2.15)*	-16.46 (-0.14)	0.56 (20.1)**	27

Note: t-values in parentheses.

Table 4. OLS Results for Base Model with Four-Firm Concentration Ratio, Time Periods with Different Ending Years, Seven Regions

Years	Rho	Intercept	CR_4	WP	DFE
1971-75	.103 (.56)	167.76 (0.60)	-167.96 (-0.67)	0.61 (17.5)**	30
1971-76	-.007 (-.04)	204.31 (0.83)	-205.11 (-1.002)	0.61 (19.0)**	37
1971-77	.029 (.19)	214.14 (0.95)	-203.15 (-1.16)	0.61 (20.3)**	44
1971-78	.074 (.52)	21.37 (0.12)	-223.93 (-1.42)+	0.64 (30.9)**	51
1971-79	.070 (.53)	-318.99 (-2.22)*	-225.46 (-1.45)+	0.70 (53.3)**	58
1971-80	.026 (.21)	-250.87 (-1.98)*	-268.51 (-1.93)*	0.69 (65.4)**	65
1971-81	.052 (.44)	-246.59 (-2.12)*	-267.22 (-1.28)*	0.69 (71.1)**	72
1971-82	.050 (.44)	-216.32 (-1.92)+	-299.82 (-2.64)**	0.68 (73.0)**	79
1971-83	.065 (.60)	-259.56 (-2.40)*	-263.98 (-2.54)**	0.68 (75.4)**	86
1971-84	.081 (.77)	-281.79 (-2.69)**	-227.82 (-2.34)**	0.68 (78.0)**	92
1971-85	.118 (1.17)	-287.47 (-2.83)**	-176.81 (-1.96)*	0.68 (80.0)**	98
1971-86	.147 (1.51)+	-290.64 (-2.97)**	-144.13 (1.72)*	0.68 (82.1)**	104

Note: t-values in parentheses.

** = significant at 1% level.
* = significant at 5% level.
+ = significant at 10% level.

Note: t-values in parentheses.

of the time period studied, CR4 becomes insignificant. As more years are included in the sample, CR4 tends to become more significant. This is particularly important because the GAO report on Packer Market Concentration and Cattle Prices placed considerable emphasis on the lack of a statistically significant coefficient for CR4 in our 1981-1986 equation. Since our study was one of the few that provided evidence for the 1980s (the time period on which GAO focused), the GAO concluded:

> We found no convincing evidence in this literature that, in the 1980s, beef packers paid lower priced for fed cattle in more concentrated cattle-buying markets than in less concentrated markets. (p. 16)

Tables 3 and 4 indicate that although there was considerable instability and structural change in beef packing in the 1978-86 period, monopsony power was, if anything, slightly more evident than it was in the 1971-78 period.

Table 5 presents the regression results for several time periods, using CR4 and wholesale beef prices in all models. Equations 1 and 2 indicate a significant negative relationship of CR4 to cattle prices for the 1971-78 and 1979-86 periods. The coefficient and "t" values for CR4 are considerably higher for the latter period than for the earlier period. However, when the full period, 1971-86, is examined in equation 3, CR4 becomes insignificant.

In equations 4 and 5, a dummy variable for 1971-78 is included. The addition of the 1971-78 dummy increases sharply the intercept term, the negative CR4 coefficient and t-value, and drops the coefficient on wholesale beef price. CR4 is significant at the 5 percent level in both equations 4 and 5.

In equation 5, the percent change in regional CR4 from one year to the next is included as a short-term rivalry variable. Change in CR4 is positive and marginally significant, suggesting that in those regions and years in which the leading firms increased their market share the most, they did so in part by paying higher prices for cattle. This is not surprising. Firms may choose to sacrifice short-run profits in order to build market share and market power for the future. Our results suggest this was part of the dynamics of the beef packing industry during 1971-1986. Adding change in CR4 to the model also increased the coefficient and t-value on CR4.

Regression Examining Live Cattle to Wholesale Price Ratios

The ratio of steer prices to wholesale beef prices was also used as the dependent variable in an additional set of regressions (Table 6). Annual average steer prices ranged from 61.3 to 67.6 percent of the wholesale price. Equations 1-3 are for 1971-86, include a dummy variable for 1971-78, and are identical except for the measure of concentration used. CR4 and 1/CR4 are both significant at the 1% level with nearly identical t-values. The Herfindahl Index is negative but not significant.

Equations 4 and 5 examine the price ratio during 1971-78 (equation 4) and 1979-86 (equation 5). CR4 is negative and significant in both time periods. The price ratio is consistently higher in regions in which large feedlots are more important.

Equation 6 includes annual dummies for the period 1972-86. The results are similar to equation 1; however, the t-statistics are higher. It does not appear that the cattle cycle or other common annual effects have biased our results.

Table 5. Regression Results Explaining the Prices of Live Steers in Seven Regional Markets, Various Time Periods

	(1)	(2)	(3)	(4)	(5)
Period	1971-78	1979-86	1971-86	1971-86	1971-86
Constant	21.37 (0.12)	518.94 (1.61)+	-243.39 (-2.25)*	315.24 (1.68)+	491.05 (2.46)*
CR_4	-223.93 (-1.42)+	-318.27 (-2.55)**	-91.37 (-1.04)	-209.85 (-2.25)*	-249.89 (-2.58)**
Distance	0.001 (0.01)	0.100 (1.30)	-0.009 (0.94)	0.056 (0.94)	0.071 (1.13)
Feedlot	1.531 (1.68)*	2.862 (2.16)*	2.220 (2.83)**	2.103 (2.45)**	2.149 (2.44)**
Pct Change in CR4	- -	- -	- -	- -	2.135 (1.584)+
Wholesale Price	0.640 (30.88)**	0.589 (20.56)**	0.668 (74.58)**	0.614 (37.91)**	0.595 (34.54)**
1971-78 Dummy	-	-	-	-266.09 (-4.23)**	-307.94 (-4.77)**
NOBS	56	53	109	109	102
Type	OLS[a]	EGLS[b]	EGLS[b]	EGLS[b]	EGLS[b]

[a]No statistical evidence of autoregression or heteroskedasticity was found.
[b]Corrections were made for first order autoregression and heteroskedasticity following procedures outlined in Judge et al, pp. 180-183 and Kmenta pp. 512-515.
** = significant at 1% level
* = significant at 5% level
+ = significant at 10% level

Table 6. Regression Results Explaining the Ratio of Live Cattle to Wholesale Prices in Seven Regional Markets, Various Time Periods

Years	1971-86 (1)	1971-86 (2)	1971-86 (3)	1971-78 (4)	1979-86 (5)	1971-86 (6)
Constant	64.61 (56.31)**	63.60 (49.52)**	61.17 (45.62)**	64.33 (35.16)**	63.92 (45.80)**	61.17 (72.73)**
Herfindahl (HHI)		-1.002 (-0.99)				
CR_4	-2.578 (-2.51)**			-3.418 (-1.48)+	-2.408 (-1.97)*	-2.817 (-3.07)**
$1/CR_4$			1.084 (2.76)**			
Distance	0.000 (0.69)	-0.000 (-0.12)	0.001 (1.00)	0.000 (0.01)	0.001 (0.86)	0.000 (0.78)
Feedlot Size	0.027 (2.98)**	0.027 (2.42)**	0.023 (2.51)**	0.024 (1.77)*	0.030 (2.29)*	0.027 (4.13)**
1971-78 Dummy	-1.750 (-4.55)**	-1.431 (-2.42)**	-1.750 (-4.70)**			
Annual Dummies	No	No	No	No	No	Yes
NOBS	109	109	109	56	53	109
Type	EGLS	EGLS	EGLS	OLS	EGLS	EGLS

Critical Concentration Level

A critical concentration ratio, if one exists, has important implications for antitrust policy. Geithman, Marvel and Weiss comment:

> The critical concentration ratio can take two forms. The most common notion is that at some level of concentration industries become effectively collusive so that profit rates, price-cost margins, or prices rise to monopolistic levels. An alternative is that at some level concentration begins to affect performance. Below that level there is no relationship between concentration and performance, but above that level profits, margins, and/or prices rise with concentration. (p. 346)

The analysis summarized in Table 7 should reveal either type of critical concentration. Dummy variables were used for various levels of regional packer concentration. In equation 1, only two concentration levels show significantly lower prices at the 10% level. In equation 2 in which the 1971-78 dummy is added, four out of five concentration levels above CR_4 = 60 have significantly lower prices. There is no evidence of increasing coefficients as one goes from CR_4 of 60 to 65 to CR_4 of 80 or more. None of the cells for concentration levels less than 60 are even close to significance. The abrupt drop in prices at $CR_4 \geq 60$ suggests that as the critical CR_4. Prices in regions with a $CR_4 \geq 60$ averaged \$1.04 per cwt. less than prices in the remaining regions (equation #3).

Conclusions

The results in this article support the hypothesis that packer monopsony power had a significant negative effect on cattle prices during the 1971-86 period. This is so even though

Table 7. Regression Equations Testing for Critical Level of CR_4, 1971-86, Seven Regions

EQ NO.	(1)[1]	(2)[1]	(3)[2]
Type[3]	EGLS	EGLS	EGLS
Intercept	-344.29	257.62	393.69
(13)	(-2.85)**	(1.40)	(2.54)*
$40 \leq CR_4 < .45$	-4.80	-58.92	
(5)	(-0.06)	(-0.77)	
$45 \leq CR_4 < .50$	33.53	27.56	
(8)	(0.47)	(0.40)	
$.50 \leq CR_4 < .55$	-9.42	-41.43	
(9)	(-0.14)	(-0.61)	
$.55 \leq CR_4 < .60$	1.81	-33.43	
(14)	(0.03)	(-.52)	
$.60 \leq CR_4 < .65$	-92.82	-170.50	
(6)	(-1.14)	(-2.15)*	
$.65 \leq CR_4 < .70$	-94.80	-144.10	
(9)	(-1.42)+	(-2.24)*	
$.70 \leq CR_4 < .75$	-21.39	-60.17	
(7)	(-0.29)	(-0.87)	
$.75 \leq CR_4 < .80$	-85.60	-107.63	
(8)	(-1.31)+	(-1.74)*	
$.80 \leq CR_4$	-68.39	-162.84	
(30)	(-1.15)	(-2.69)**	
$.60 \leq CR_4$	---	---	-104.43
(60)			(3.25)**
1971-78 Dummy	---	-274.64	-309.68
		(-4.17)**	(5.14)**
Distance	-0.013	0.043	0.017
	(-0.21)	(0.76)	(0.31)
Feedlot	2.206	2.000	1.788
	(2.53)**	(2.42)**	(2.36)*
WP	0.678	0.619	0.597
	(77.30)**	(38.45)**	(34.01)**
F-Value	17,315	20,076	34,604
NOBS	109	109	109

[1]No correction for AR1; t statistics are in parentheses
[2]Correction for AR1 and Heteroskedasticity; t-statistics are in parentheses
[3]Number of observations are in parentheses
** = significant at 1% level
* = significant at 5% level
+ = significant at 10% level

there is considerable evidence that the beef industry experienced substantial disequilibrium during this 17-year period. The rapid general inflation of the 1970s, the beef demand shift of the late 70s, and the dramatic restructuring of the beef packing industry from 1977 to 1986 were major disequilibrating forces. However, even so, the presence of monopsony power is evident in regional live cattle markets throughout the period and is slightly stronger in the latter half than in the first half of the period.

For the seven regions on which most of our analysis was done, cattle prices were estimated to be about 3 percent less in the most concentrated region/year compared to the least concentrated region/year. This is slightly larger than the price effects indicated by other SCP studies but more than triple the impact estimated by Azzam and Schroeter. Although the various studies have varied some in the magnitude of the effect, nearly all indicate that cattle prices are negatively affected by increased packer concentration.

We found some evidence of a critical concentration level in regional procurement markets. A four-firm concentration ratio of 60 or greater was associated with significantly lower prices paid for cattle. By 1988, the latest year for which data are available, all 13 regions in this study exceeded that level of concentration. The simple average regional CR_4 was 87.

For the seven regions on which much of our analysis was based, six had a CR4 over 90 in 1988. The lowest Herfindahl Index in 1988 was 1958. This exceeds the high concentration threshold (1800) identified in the Justice Department Merger Guidelines. And, in four of these regions, the Herfindahl indicates either a duopoly or monopoly.

Highly concentrated regional markets are particularly problematic when national concentration is also very high. IBP, ConAgra and Excel slaughter nearly 70 percent of the steers and heifers in the U.S. and also dominate most of the regional markets. IBP dominates Regions 1 and 9, Excel and ConAgra dominate Region 5 and all three dominate Regions 8 and 10. Only Regions 2 and 3, two of the smaller regions, are not dominated by one or more of the Big Three. Under these circumstances, mutual forbearance across markets--a live and let live arrangement--appears more likely than cross market policing or inter-market rivalry.

The beef packing industry has experienced a more rapid increase in concentration since 1977 than any industry we are aware of. Based upon the evidence in this and many other industries, the levels and trends of concentration warrant serious concern for future competition.

REFERENCES

Azzam, A.M. and E. Pagoulatos. "Testing Oligopolistic and Oligopsonistic Behavior: An Application to the U.S. Meat-Packing Industry." J. Ag Econ 41 (1990): 362-70.

Azzam, A.M. and J.R. Schroeter. "Implications of Increased Regional Concentration and Oligopsonistic Coordination in the Beef Packing Industry." W.J. Ag Econ 16 (1991) 374-381.

Buse, Reuben, ed. 1989. The Economics of Meat Demand. Conference Proceedings, Univ. of Wisconsin, Madison.

Cothern, James H., R. Mark Peard, and John L. Weeks. 1978. Economies of Scale in Beef Processing and Portion Control Operations: Northern California-1976. Division of Agricultural Sciences. University of California, Leaflet 21027.

Geithman, F.E., H.P. Marvel, and L.W. Weiss. 1981. "Concentration, Price, and Critical Concentration Ratios," Rev. of Econ. and Stat. 63/3 (August): 346-53.

Johnson, D. Gale, J. Connor, T. Josling, A. Schmitz and G.E. Schuh. 1989. Competitive Issues in the Beef Sector: Can Beef Compete in the 1990s? Humphrey Institute of Public Affairs, U. of Minn.

Marion, B.W. The Organization and Performance of the U.S. Food System. Lexington Books, 1986.

Marion, Bruce W. and Donghwan Kim. "Concentration Change in the Selected Food Manufacturing Industries: The Influence of Mergers vs/ Internal Growth." Agribusiness 7 (1991): 415-431.

Menkhaus, Dale J., James S. St. Clair and A. Zahedi Ahmaddaud. "The Effects of Industry Structure on Price: A Case in the Beef Industry." W. J. Agri. Econ. 6 (1981): 147-153.

Packers and Stockyards Administration, U.S. Dept. of Agriculture, "Packers and Stockyards Statistical Report," Nov 1992.

Quail, Gwen, Bruce Marion, Frederick Geithman, and Jeffrey Marquardt. "The Impact of Packer Buyer Concentration on Live Cattle Prices." Working Paper #89, University of Wisconsin-Madison, 1986.

Scheffman, D., and P. Spiller. "Geographic Market Definition Under the DOJ Merger Guidelines." FTC Working Paper 129, Washington, D.C. August, 1985.

Schroeter, John R. "Estimating the Degree of Market Power in the Beef Packing Industry." Rev. of Econ. and Stat. 70 (February 1988): 158-162.

Schultz, Margaret. "The Relevant Geographic Market Area for Fed Cattle and the Changing Structure of the Beef Packing Industry." Iowa State University, unpublished Ph.d. dissertation, 1988.

Tomek, William. 1980. "Price Behavior on a Declining Terminal Market. Amer. J. of Agr. Econ. 62(3): 434-444.

U.S. Department of Justice, "Merger Guidelines," 1984.

U.S. General Accounting Office. "Beef Industry: Packer Market Concentration and Cattle Prices." Dec 1990.

Ward, Clement. "Short-Period Pricing Models for Fed Cattle and Impacts of Wholesale Carcass Beef and Live Cattle Futures Market Prices." S. J. Agri. Econ. 13 (1981):125-132.

Ward, Clement. 1988. Meatpacking Competition and Pricing. Research Institute on Livestock Pricing, VPI.

Ward, Clement. "Inter-Firm Differences in Fed Cattle Prices in the Southern Plains," Amer. J. Agr. Econ. 74 (1992): 480-485.

Weiss, Leonard. "The Concentration-Profits Relationship and Antitrust," in Industrial Concentration: The New Learning, ed. H.J. Goldschmid, H.M. Maun and J.F. Weston, Little, Brown, 1974.

Weiss, Leonard, ed., Concentration and Price, The MIT Press, 1989.

Williams, Willard F. "The Changing Structure of the Beef Packing Industry," in Hearings Before the Committee on Small Business of the House of Representatives, "Small Business Problem in the Marketing of Meat and Other Commodities, Part 4," June 1979.

Williamson, J.C., R. Schneider, E. Stoddard and C. Swearington. "Geographic Markets and Prices for Fed Steers and Heifers." Packers and Stockyards Admin. Report 82-1, USDA, April 1982.

Ziemer, R.F. and F.C. White. "Disequilibrium Market Analysis: An Application to the U.S. Fed Beef Sector." Amer. J. Agri. Econ. 64 (1982): 56-62.