

The Effects of Industry Structure on Price: a Case in the Beef Industry

Dale J. Menkhaus, James S. St. Clair
and A. Zahedi Ahmaddaud

This study estimates the influence of concentration and other structural variables on the price of slaughter cattle. Cross-sectional data were used to estimate a single equation model which included, in addition to traditional factor demand variables, packer concentration and a measure of market power exerted by feedlots. Results suggest that packer concentration has had a significant and increasing negative impact on fed cattle prices during the years of analysis, 1972 and 1977.

There has been continuing interest in the effects upon traditional agriculture and upon consumers of the structural changes which are taking place in the agribusiness sector, including growing concentration, vertical integration and conglomerate merger. John Connor describes the general nature of the perceived problem in a recent USDA compendium on *Structure Issues of American Agriculture*, p. 227. He says: "Economic theory suggests that an atomistically organized sector wedged between two oligopolistic ones will pay monopolistically inflated prices for its input and receive relatively lower, less flexible prices for its output." He goes on to state: "When there is a high level of buyer concentration in a given local market for agricultural produce, price-fixing, price leadership, price discrimination

and other forms of collusive pricing are likely to occur."

Although theory gives some clues as to the expected results, relatively few empirical studies have dealt directly with the effects of structural variables on the prices of agricultural commodities. Lack of data, rather than lack of interest, is probably the principal reason for this omission. Nevertheless, recent congressional interest in the competitive environment in the marketing of beef provides an impetus to quantify the effects of these structural variables on price at various levels of the beef industry.

The purpose of this paper is to estimate the influence of concentration and other structural variables on the price of slaughter cattle. This study differs from most previous analyses of the influence of concentration on economic outcomes [Marion, *et. al.* and Hall, *et. al.*] in that price rather than profits or margins is taken as the dependent variable, and that the primary focus is on the effects of buyer concentration (oligopsony) rather than seller concentration (oligopoly). The hypothesis is that price will be a more sensitive measure of the effects of concentration than profits or margins. Profits are affected by price behavior of firms in their buying *and* selling activities. The objective here is to specifically identify effects of concentration

Dale J. Menkhaus is Associate Professor, James S. St. Clair is Professor and A. Zahedi Ahmaddaud is former Graduate Assistant, all in the Division of Agricultural Economics at the University of Wyoming.

Wyoming Agricultural Experiment Station Journal Article Number 1159. This research was partially funded by Western Regional Cooperative Research Project W-145, Impacts of Relative Price Changes of Feed and Cattle on Marketing of U.S. Beef. The authors wish to acknowledge the constructive suggestions of *Journal* reviewers on earlier versions of this paper.

on price as related to buying behavior. Engelman [1975, p. 28] suggests that market concentration on the buying side of the livestock business at the state and regional levels is greater than many realize. Specific objectives include: a) specifying, estimating and evaluating price (fed cattle) endogenous models which include measures of concentration and other economic and structural parameters at the packer level; and b) assessing the effects of packer concentration on fed cattle prices.

The Problem Setting

The beef industry has undergone significant structural change in the last decade. Changes in the cattle feeding and slaughtering industries have included trends toward a) fewer, larger firms; and b) increased geographic and firm concentration [Ward, 1977]. In the four largest cattle feeding states (Texas, Nebraska, Kansas and Iowa) the proportion of total purchases accounted for by the four largest packers in the state averaged a little more than 50 percent in 1969. By 1979, this proportion had increased to about 65 percent [Engelman, 1980, p. 22].

Writers differ on the degree of concentration necessary to produce substantial oligopoly (oligopsony) effects. Scherer [p. 60] categorizes a market as an oligopoly if the largest four firms account for 40 percent of the total market. Bain [p. 139] suggests that when the largest four firms have 65 percent of the total market, the market is a highly concentrated oligopoly. Concentration ratios (percent of total steer and heifer slaughter) for the four largest slaughtering firms in the 23 leading cattle feeding states indicate that beef packing industries in 22 of the 23 states have oligopolistic structures, using the standard of 40 percent or above. Using the more rigorous standard of 65 percent or above, beef packing industries in 17 of the 23 states have highly concentrated oligopolistic structures [Ward, 1980]. Since procurement areas are usually smaller than a single state, concentration at the packer level may in fact be greater than indicated by the above state

concentration data [Engelman, 1980, pp. 19-23]. Thus, the markets for slaughter cattle may not be fully competitive and larger firms may be able to control prices.

Concurrent with, and perhaps as a result of increased concentration in the beef packing industry there has been an increase in concentration in the feedlot sector. Associated with the increased concentration among feedlots and packers is a change in procurement methods in the form of increased direct purchases by packers [Gee, *et. al.* p. 24 and Ward, 1977, pp. 25-30]. The trend toward increased direct purchases may also be attributed to the decentralization of the livestock industry. While most cattle are produced and marketed through independent firms, there are some notable exceptions. These exceptions include vertically integrated arrangements between packers and feedlots and ownership of national packers by industrial conglomerates. These arrangements may result in administered prices or other pricing practices inconsistent with the competitive model.

The Economic Model

Single equation models were specified to determine the impact of packer concentration on fed cattle prices for two years, 1972 and 1977. Since the effects of concentration tend to be more pronounced at a state or regional level, equations were specified on a state rather than a national basis. In accordance with factor demand theory, the price of the intermediate product (fed cattle) is made a function of relative plant capacity, input prices and output prices in a cross-sectional analysis.¹ To measure the extent of the oligopsony effect, a measure of packer concentration in each state is included as an explanatory variable. Further, a variable to represent the extent of bargaining power ex-

¹It was felt that the underlying economic structure would be more accurately depicted by means of a cross-sectional analysis rather than an analysis of a time series of cross sections, particularly when the primary focus is to isolate the effects of concentration.

erted by feedlots is included. The latter two variables are included in the model to measure the significance and magnitude of the effects of market structure on price. Packer concentration is a measure of oligopsony power, while the measure of bargaining power exerted by feedlots is an attempt to identify the effects of oligopoly power. Specifically, the price of fed cattle was hypothesized to be a function of the capacity of slaughter plants in the state relative to fed marketings (surplus-deficit measure), price of labor in the meatpacking industry, price of wholesale beef, average size of feedlot, and a measure of packer concentration at the state level.

The average size of feedlot variable is a proxy for feedlot concentration, which was not readily available for the years of analysis. This variable is measured by total marketings from feedlots with capacities of 1000 head and over divided by the corresponding number of feedlots. Such a measure is intended to reflect the dominance of large firms within a state and their influence on the price of fed cattle. It is assumed that lots of 1000 head capacity and smaller are too small to exert an oligopolistic effect on price. The price of by-products, which was judged to be an important explanatory variable for fed cattle price, could not be used in the cross-sectional analysis because these data are not available on a state basis.

The Statistical Model

The statistical model for the above economic model follows:

$$PSC_{it} = B_0 + B_1 SCSD_{it} + B_2 PLP_{it} + B_3 PWB_{it} + B_4 ASF_{it} + B_5 PC_{it} + e_{it}$$

Where:

PSC_{it} = deflated average price of choice slaughter (fed) steers 900-1100 pounds at specific state markets² — \$/cwt. [*LS-214 and Livestock and Meat Statistics*];

$SCSD_{it}$ = slaughter cattle surplus and deficit by state as measured by the

annual quantity of steer and heifer slaughter by packers in a specific state relative to the annual fed cattle marketings in the state — percent [*Committee on Small Business*];

PLP_{it} = deflated annual average wage rate of production workers in meat-packing plants in specific states — \$/hour [*Census of Manufacturers*];

PWB_{it} = deflated annual average price of choice steer beef 600-700 pounds carlot basis at selected regional markets³ — \$/cwt [*Livestock and Meat Statistics*];

ASF_{it} = average size of feedlot as calculated by total marketings from feedlots with capacities of 1000 head and over divided by the corresponding number of feedlots — 1000 head [*Livestock and Meat Statistics*];

PC_{it} = concentration of meat-packing plants in selected states as measured by the percent of total cattle slaughtered by the top four meat-packing plants in the state — percent [*Committee on Small Business*];

²Specific state markets include: Phoenix, Arizona; El Centro, California; Portland, Oregon; Moses Lake, Washington; Sioux Falls, South Dakota; Sioux City, Iowa; Omaha, Nebraska; South St. Paul, Minnesota; Kansas City, Missouri; Colorado Feedlot Sales, Colorado; Dodge City, Kansas; Amarillo, Texas; Springfield, Illinois; Billings, Montana; Indianapolis, Indiana; Columbus, Ohio; Michigan Auctions, Michigan; Salt Lake City, Utah. The use of these markets in the data series varied between 1972 and 1977, as explained later.

³Due to the limited reporting of wholesale beef prices, states were aggregated as follows: Arizona, California, Oregon and Washington — Los Angeles market; South Dakota, Iowa, Nebraska, Minnesota, Missouri, Illinois, Ohio and Michigan — Midwest market; Colorado — Colorado market; and Texas — Amarillo market. For 1972, the Chicago market was used for Minnesota, Illinois, Indiana and Michigan.

- e_{it} = random disturbance;
 B's = structural parameters;
 i = states⁴
 t = years — 1972 and 1977.

In order to facilitate comparisons of the magnitudes of the coefficients between 1972 and 1977, price data were deflated using the Bureau of Labor Statistics Consumer Price index for all items, 1967 = 100.

Data and Statistical Considerations

Before interpreting the results of the statistical analysis, data limitations must be discussed. Even though an effort was made to conduct the analysis at a local level in order to more adequately measure the influences of oligopsony power, both the size and number of areas to be studied were dictated to some extent by the availability of data. It could be argued that the true effects of concentration cannot be measured even at the state level because prices may reflect conditions in procurement areas which do not correspond to state boundaries. Thus, the effects of the structural variables may be obscured by too much or too little aggregation of the data or by the failure of market or procurement areas to conform to state boundaries.

One data constraint was imposed by the availability of wage rates in the meat-packing industry. Reasonably complete state series are available for the variable in the census years (1972 and 1977). Even during these years, wage data are not reported for all states because of the disclosure policy of the Department of Commerce. The prices of fed cattle were not available for all states from the LS-214, perhaps because of the lack of organized fed cattle markets in some states. When the above problems are combined, degrees of freedom in the statistical analysis may be a factor to consider. Further, as

noted in footnote 4, the states used in the analysis were different in the two years of the study, limiting somewhat the comparability of the results between 1972 and 1977.⁵

There may be some problems inherent in using the price of carcass beef (PWB) as the product price in the fed cattle equation, both because of the extent to which it is formula priced, and the increasing importance of boxed beef. Formula pricing has been criticized both because of alleged shortcomings in the private price reports (Yellow Sheet) on which it is based, and the rigidities introduced by the formula itself (differentials for freight, quality, trim, etc.) [NCFM, pp. 57-58]. Carcass beef now accounts for only 50 percent of total sales while boxed beef accounts for 40 percent or more and is increasing. Approximately 70 percent of the sales of carcass beef are formula priced, compared to 10-20 percent of boxed beef. Some comfort is taken in the fact that formula prices are not much used in Pacific markets because retailers there believe that the midwest "Yellow Sheet" prices are not representative of their market conditions. The percentage of use is much higher in the eastern two-thirds of the U.S. than in the west. Also, formula prices are not much used by the largest retailers, who rely on either direct negotiations or offer and acceptance pricing procedures [Hayenga, 1978, 1979].

From a practical standpoint, the prices used were the only ones available for the included states. Since carcass beef prices are quoted for only five regional markets nationwide, these data are duplicated for several states. While this variable may effectively sort out a regional market, e.g., the west coast market, it has limited powers to explain state-to-state variation in the dependent variable.

⁴States for 1972 included: California, Arizona, Montana, Iowa, Nebraska, Minnesota, Missouri, Colorado, Texas, Illinois, Indiana and Michigan. States for 1977 included: California, Arizona, Oregon, Washington, South Dakota, Iowa, Nebraska, Minnesota, Missouri, Colorado, Kansas, Texas, Illinois, Ohio and Michigan.

⁵Another analysis was conducted in which ten identical states were considered for 1972 and 1977. The results of this analysis were consistent with those reported with regard to the market structure variables (ASF and PC) in terms of signs, significance and relative magnitudes of regression coefficients.

It would have been preferable to use feedlot concentration ratios rather than the average size of feedlot variable. However, such a measure was not available for the years included in this study.

Cross-sectional data were deemed more appropriate than time series data, given the variation in packer concentration across states as compared to over a time series. Statistical considerations revolve around the use of cross-sectional data. Heteroscedasticity is the common statistical problem encountered with this type of data [Murphy and Kmenta]. Unfortunately, in this analysis as in most analyses conducted by economists, the method of adjusting for heteroscedasticity suggested by Murphy and Kmenta is difficult to apply. Data are not replicated and thus estimates of the proportionality constants from the sample data are not obtainable.

One source of heteroscedasticity is autocorrelation. In that case, not only may the variances not all be equal, but all the covariances will not be zero. If it is assumed, as it has been in this study, that heteroscedasticity arises from autocorrelation, the procedures applicable to autocorrelation problems should be utilized. The results reported here reflect the adjustment for autocorrelation through the use of the Cochrane-Orcutt iterative technique.

Results and Implications

A priori expectations concerning the signs of the variables included in the above model are suggested by factor demand theory, previous research and knowledge of the industry. In the previously specified equation, the price of labor (PLP) is *a priori* inversely related to the price of fed cattle. The surplus-deficit (SCSD) and the price of wholesale beef (PWB) are expected to be positively related to fed cattle price. The sign associated with the average size of feedlot variable is expected to be positive, both because of the increased bargaining power associated with size and the increased technical efficiencies resulting from the purchase of larger groups of cattle at one location.

The sign associated with the coefficient for the packer concentration measure is normally expected to be negative. That is, if concentration increases, there would be a negative effect on price. However, some writers speculate that the relation may be positive in the beef packing industry under certain conditions, in some areas, and during specified market periods. For example, Williams [Committee on Small Business, p. 37] indicates that a direct relationship might exist if the larger firms are attempting to drive out competition by bidding up price for slaughter cattle. This may be particularly evident, according to Williams, within selected procurement areas. Williams, however, does not provide any empirical analysis to support this hypothesis.

The results reported in Table 1 should be interpreted with caution because the states included in the analysis of 1972 and 1977, as previously mentioned, are different. Relative to expected signs, the results are mixed. For those variables which have coefficients significantly different from zero, relationships with the dependent variable are consistent with economic reasoning, with the exception of the price of labor in 1977. Possibly this inconsistency results from the differences in the states included in the two years, but the sign in 1977 is contrary to economic logic.

The significance, or lack thereof, of the surplus-deficit variable seems to follow the cattle cycle, being significant in 1972 when supplies were tight and there was real competition among packers for cattle, and not significant in 1977 when cattle numbers were greater. The significance, or lack thereof, of the price of wholesale beef is explained by the different mix of states included during the two years of analysis. Price of wholesale beef is a variable which has a strong geographical orientation. Beef and cattle prices are higher on the west coast and the inclusion of more west coast states in the second year increases the regression coefficient and the level of significance. The change in the sign and significance of the average size of feedlot variable is quite interesting. The number of

TABLE 1. Estimated Regression Coefficients and Summary Statistics Using the Cochrane-Orcutt Iterative Technique, 1972 and 1977, Real Prices.

Variable/Year	1972		1977	
	Regression Coefficients	t Statistics	Regression Coefficients	t Statistics
Constant	25.3142		22.6918	
SCSD	0.0089	2.6141	0.0002	0.0980
PLP	-0.2676	-1.4494	0.3100	2.2000
PWB	0.0960	0.9817	0.1260	2.6147
ASF	-0.0103	-0.7234	0.0582	3.9159
PC	-0.0145	-2.6077	-0.0220	-3.8271
R ²	0.7886		0.7945	
F Value	3.7297		6.1854	
Rho	-0.7897		-0.6172	

feedlots has decreased, and consequently the average size of feedlot has increased, allowing for perhaps an increased bargaining position. Although the magnitudes of the two coefficients are not directly comparable and the net effects on price remain indeterminate, there is a possible suggestion in the second period of a countervailing power structure. This would involve a bilateral oligopoly situation, consisting of large and powerful feedlots bargaining with equally large and powerful packers.

The results are consistent with respect to the concentration variable. This relationship is negative and significant for each of the two years. A comparison of the coefficients associated with packer concentration indicates that there has been a substantial increase in the negative impact of this variable on the real price of fed cattle between the years on the analysis. This result is supported by a supplementary analysis which included an identical ten states in each of the two years. (See footnote 5). Such results suggest that the concern over concentration in the beef packing industry by Congress is warranted and needs further investigation. Furthermore, the hypothesized positive relationship suggested by Williams (previously discussed) appears to be incorrect.

Concluding Remarks

Large scale corporations have become a common feature of the agricultural input sector and the food processing and distribution sectors. Trends in the last decade have been toward still fewer and larger firms, often accomplished through merger and acquisition, and toward an increase in integrated arrangements. There has been growing concern about the effects of these structural changes upon competitive outcomes. Such concerns are validated by the results of this study. More attention needs to be given to identifying the effects of the changing structure in agriculture.

There may be some tendency for the presence of large feedlots in an area to counteract the oligopsony effect of large packers. However, it would be naive to expect that the outcome would approach the competitive ideal, given the prevailing extent of vertical integration and conglomerate merger. While the importance of these arrangements is recognized, the magnitude and perhaps even the direction of their effects are difficult to determine, in part because internal transactions are usually not reported.

From a policy perspective, consideration should be given to the question of what is the acceptable level of concentration, based on

chosen performance criteria. Furthermore, if regulatory action is contemplated, the control variables which influence the structural change process must be accurately identified in order for such programs to be effective. This latter issue is addressed by Reimund, *et al.* for broilers, fed cattle and processing vegetables.

References

- Bain, Joe S. *Industrial Organization*. 2nd ed. New York: John Wiley & Sons, 1968.
- Committee on Small Business. *Small Business Problems in the Marketing of Meat and Other Commodities (Part 4— Changing Structures of Beef Packing Industry)*. U.S. House of Representatives, June 1979.
- Connor, John M. "Manufacturing and Food Retailing" in *Structure Issues of American Agriculture*. USDA, ESCS, Ag. Econ. Report 438, November 1979.
- Engelman, Gerald. "Trends in Livestock Marketing Before and After the Consent Decree of 1920 and the Packers and Stockyards Act of 1921." Statement to the Subcommittee on SBA-SBIC Legislation, House Small Business Committee, June 23, 1975.
- Engelman, Gerald. "Changes in Livestock Marketing in the United States and Prospects for the Future." 1980 Annual Outlook Conference, Agriculture, Canada, Ottawa, Ontario, December 8, 1980.
- Hall, Lana, Andrew Schmitz and James Cothorn. "Beef Wholesale-Retail Marketing Margins and Concentration," *Economica* 46 (1979): 295-300.
- Hayenga, Marvin L. *Formula Pricing and Price Reporting. Problems in the Markets for Beef and Pork*. N.C. Project 117, WP-32, Univ. of Wisc., Madison, May 1979.
- Hayenga, Marvin L. *Vertical Coordination in the Beef Industry: Packer, Retailer and HRI Linkages*. N.C. Project 117, WP-22, Univ. of Wisc., Madison, Oct. 1978.
- Kmenta, J. *Elements of Econometrics*. New York: MacMillan Co., 1971.
- Marion, Bruce W., Willard F. Mueller, Ronald W. Cottewill, Frederick E. Geithman, and John R. Schmelzer. *The Profit and Price Performance of Leading Food Chains, 1970-74*. A Study Prepared for the Use of the Joint Economic Committee, Congress of the United States, April 12, 1977 (Revised May 6, 1977).
- Murphy, James L. *Introductory Econometrics*, Homewood, Illinois: Richard D. Irwin, Inc., 1973.
- National Commission on Food Marketing. *Organization and Competition in the Livestock and Meat Industry*. Tech. Study No. 1, June 1966.
- Riemund, Donn A., J. Rod Martin and Charles V. Moore. *Structural Change in Agriculture: The Experience for Broilers, Fed Cattle, and Processing Vegetables*. USDA, ESS, Tech. Bull. No. 1648, April 1981.
- Scherer, F. M. *Industrial Market Structure and Economic Performance*. Chicago: Rand McNally & Co., 1970.
- U.S. Dept. of Ag. Form LS-214, selected years.
- U.S. Dept. of Ag. *Livestock and Meat Statistics*. ESCS, Stat. Bull. No. 522, selected years.
- U.S. Dept. of Commerce. *Census of Manufacturers*. Industry Series, Meat Products, selected years (1972 and 1977).
- Ward, Clement E. *Vertical Coordination of Cattle Feeding and Slaughtering in the Cattle and Beef Subsector*. N.C. Project 117 Working Paper Series, WP-14, December 1977.
- Ward, Clement E. *Structural Changes and Market Power in Cattle Feeding and Meatpacking*. Dept. of Ag. Econ. Paper AE 8007, Oklahoma State University, February 1980.

