

December 1990

# BEEF INDUSTRY

## Packer Market Concentration and Cattle Prices



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**Resources, Community, and  
Economic Development Division**

B-241851

December 6, 1990

The Honorable Patrick J. Leahy  
Chairman, Committee on Agriculture, Nutrition,  
and Forestry  
United States Senate

The Honorable Max S. Baucus  
United States Senate

By letters dated December 19, 1989, and February 2, 1990, you expressed concern about the impact that recent mergers by beef packers might have on cattle producers. Such mergers during the 1980s resulted in the four largest packers accounting for about 70 percent of the slaughter in the U.S. beef-packing industry. Specifically, you were concerned that such concentration<sup>1</sup> may have allowed the largest packers to pay lower prices for cattle than if this concentration had not existed.

Structural changes in the overall beef industry during the last decade have added to the complexity of evaluating the impact of concentration in the beef-packing market on steer and heifer prices. For example, while the number of fed cattle marketed remained relatively stable during the 1980s, the number of cattle-feeding operations in the top 13 cattle-feeding states that supply steers and heifers to the packing industry declined almost 40 percent. Additionally, beef packers have gained more control over the feeding sectors of the industry either through direct ownership or special agreements, and this situation could have an effect on steer and heifer prices.

Although many factors affect these prices, you asked us to try to isolate how prices are affected by the market's beef-packer concentration. Since the amount of empirical research data relevant to beef-packer concentration in the 1980s is very limited, we also obtained the opinions of analysts of the beef industry and other knowledgeable individuals. As agreed with your office, this report summarizes existing research and expert opinion on structural changes in the beef industry and the impact of these changes on the prices that beef packers pay for cattle.

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<sup>1</sup>A common measure of concentration, or market dominance, is the 4-firm concentration ratio which equals the aggregate market share of the four largest firms in an industry. Economic theory suggests that the greater is concentration, the more likely it will be that large firms can influence the prices of goods they buy or sell. In our opinion, a concentration ratio of 70 percent would likely be considered a concentrated market.

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## Results in Brief

Economic theory suggests that, other things being equal, a high level of market concentration in the beef-packing industry could result in lower cattle prices than would prevail with less concentration. Some of the empirical evidence we reviewed is consistent with this theoretical expectation. However, we refrain from drawing firm conclusions based on the literature we reviewed because (1) the number of relevant studies is small, (2) many of the studies relate to the 1970s and may not be applicable to market conditions in the 1980s, and (3) most have certain methodological limitations.

Generally, the industry analysts and experts with whom we spoke do not believe that the recent increases in beef-packer concentration have lowered cattle prices in the 1980s. During the same period that concentration increased, packers invested in new, larger, and more efficient processing plants. This investment led to the development of excess capacity in the packing industry relative to available cattle supplies. Industry analysts argue that the combined circumstances of excess capacity and decreasing processing costs led packing firms to compete more vigorously with one another in purchasing cattle, and this competition led to upward pressure on prices.

Some feedlot operators and cattle producers with whom we spoke are concerned that beef packers may exert greater influence over cattle prices in the future. They believe that this influence would result from the combined effect of increased beef-packer concentration, a trend toward increased vertical integration of the industry, and an increase in cattle supplies relative to processing capacity.

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## Background

The beef industry can be divided into three principal stages according to the growth phase of the cattle: (1) cow-calf production, (2) cattle feeding, and (3) fed-cattle slaughter, or beef packing. Cow-calf "operators" breed cows for the production and sale of young steers and heifers. Cattle-feeding operators take over the primary feeding of the cattle for several months until they are ready for slaughter. Highly specialized commercial feedlots with capacities of more than a thousand head of cattle per year handle most of the cattle feeding. Feedlot operators may either purchase the cattle they feed or custom feed the cattle for others, such as cow-calf producers or beef-packing firms. Since the 1940s and 1950s, commercial cattle feeding rapidly evolved as producers sought to increase the output of their herds by increasing the weight of the cattle. At the end of the feeding stage, the cattle owners sell the "fed" steers and heifers either directly to a beef-packing firm or

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to an agent acting on behalf of the beef-packing firm. Most of the large beef-packing firms both slaughter the fed steers and heifers and fabricate the carcasses into boxed beef. Another type of packer purchases the carcasses and fabricates them into boxed beef. The third type of packer only slaughters the steers and heifers and sells the carcasses.

The issue of market concentration in the beef-packing industry is not a new one. In the early 1900s, five companies dominated the meat-packing industry. Their control over a significant portion of the market led to an investigation by the Federal Trade Commission. The investigative report concluded that the five companies had engaged in anticompetitive practices, which they ultimately agreed to discontinue.

The Packers and Stockyards Act of 1921 is intended to maintain effective competition and fair trade practices in the marketing of livestock, meat, and poultry for the protection of livestock and poultry producers. The act also protects consumers against unfair business practices in the marketing of meats and poultry and against restrictions of competition that could unduly affect meat and poultry prices. The Packers and Stockyards Administration within the U.S. Department of Agriculture (USDA) has the responsibility for administering the act's provisions.

Following the antitrust activity of the 1920s, market concentration by the larger beef-packing firms declined over the next 50 years. By 1975 the four largest firms slaughtered only 28 percent of the steer and heifer market. However, this situation reversed itself after 1975, culminating in mergers and acquisitions by two of the largest packers between 1986 and 1987. USDA reported that in 1988 the top four beef-packing firms slaughtered about 70 percent of steers and heifers, and they fabricated about 79 percent of the boxed beef on the market.

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## Structural Changes in the Beef Industry

Over the last decade, the beef industry has had an increasing concentration of fewer operators or firms at all levels, including the cow-calf, feeder, and packing sectors. Additionally, beef packers have exercised greater "vertical coordination," in that they have gained more control over the feeding and final packaging sectors of the industry.

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## Beef-Packing Concentration

In the mid-1980s, mergers and acquisitions allowed a handful of large beef-packing firms to gain a substantial market share of national steer and heifer slaughter and boxed-beef fabrication. USDA's Packers and Stockyards Administration measures concentration in the industry with

two concentration ratios. One is the percentage of the industry controlled by the four largest packers according to slaughter volume. As of 1980, this ratio for steer and heifer slaughter was 36 percent; however, by 1988 this figure had nearly doubled, reaching 70 percent. During the same period of time, the other ratio, which measures four-firm concentration for boxed-beef fabrication, increased from 53 percent to 79 percent. Concentration in the beef industry experienced its most dramatic increase in 1987, after a late 1986 Supreme Court ruling allowed a previously blocked acquisition of the third largest beef packer by the second largest beef-packing firm. As table 1 shows, between 1986 and 1987 the percentage of the beef-packing industry accounted for by the top four firms increased by 12 percentage points. While this table shows the available statistics on national concentration, it is generally agreed that markets for fed cattle are regional and not national, since cattle are not often transported more than 250 miles to slaughter plants.

**Table 1: Four-Firm Concentration Percentage for Steer and Heifer Slaughter and Boxed-Beef Production, 1980-89**

Year	Four-firm concentration	
	Steer & heifer slaughter	Boxed beef
1980	35.7	52.9
1981	39.6	57.1
1982	41.4	59.1
1983	46.6	60.2
1984	49.5	61.7
1985	50.2	61.5
1986	55.1	67.4
1987	67.1	79.5
1988	69.8	79.3
1989 <sup>a</sup>	70.4	N/A

<sup>a</sup>Preliminary estimate.

Source: USDA.

Market concentration in the beef-packing industry has been increasing over the last decade since the number of beef-packing firms has decreased every year since 1980. According to a Packers and Stockyards Administration annual report, between 1980 and 1988 the number of beef-packing plants slaughtering steers and heifers decreased by 40 percent, or from 626 to 374 plants. Most of the plants exiting the industry during this period were amongst the smallest in the industry. Simultaneously, the larger slaughter plants—500,000 or more head of annual slaughter—increased their share of the total commercial steer and heifer slaughter, while plants in the smaller-size categories decreased their share every year since 1980.

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## Vertical Coordination

Since the 1970s most large beef packers have vertically coordinated with other sectors of the beef industry. Previously, the packers sold carcasses to firms that specialized in the final processing and packaging of the beef for sale to wholesalers and retailers. However, the largest packers are now producing boxed beef themselves. In addition, beef packers have increasingly entered into forward contracts—contracts to purchase cattle at a future date—and special marketing agreements with feeders to ensure a steady supply of fed cattle for slaughter. For example, the largest beef packer has entered into an agreement with the nation's largest cattle feeder. Under this agreement the packer has agreed to purchase all of the steers and heifers offered to it by the feeder.

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## Changes in Cow-Calf and Feeder Sectors of the Industry

Like the number of beef packers, the number of operators in both the cow-calf and feeder sectors of the industry has also declined over the last decade. During the same period, steer and heifer production and marketing remained relatively stable. Data from the Department of Commerce's Census of Agriculture show that between 1978 and 1987 the number of cow-calf producers dropped by about 18.5 percent, from 1,032,952 to 841,778. Small farms with fewer than 50 cows accounted for over 90 percent of this reduction, while the number of farms with 500 head or more remained relatively stable.

Proportionately, the number of cattle-feeding operations decreased even more than cow-calf operations during the 1980s. Although the number of fed cattle marketed remained relatively stable throughout the 1980s, the number of cattle-feeding operations in the top 13 cattle-feeding states<sup>2</sup> declined almost 40 percent, or from 78,071 to 46,883 operations. Smaller farm-feeding operations accounted for almost all of this reduction.

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## Beef-Packing Industry Concentration's Impact on Cattle Prices

Given the high level of market concentration in the beef-packing industry, economic theory suggests that, other things being equal, cattle prices could be lower than in the absence of such concentration. However, our review of the empirical studies did not lead us to draw any definitive conclusions about the impact of beef-packer concentration on the prices packers paid for steers and heifers in the 1980s.

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<sup>2</sup>USDA compiles statistics on the number of fed cattle placed on feed and marketed for 13 selected states that represent close to 90 percent of all fed cattle marketed in the country.

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Generally, the industry representatives with whom we spoke believe that, to date, concentration in the 1980s has not been associated with decreases in cattle prices. However, we believe the potential exists for large packers to exert market power over the prices they pay for steers and heifers. Also, representatives of the cow-calf and feeder sectors that we talked to believe that the horizontal concentration, along with increased vertical coordination, on the part of the large packing companies will enhance market power that could enable the packers to influence cattle prices.

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## Empirical Study Results

We analyzed ten empirical studies on market concentration in the beef-packing industry. Seven of the studies expressly consider price as it relates to an indicator of market concentration. The other three studies assess market power as reflected by price. As is often the case with empirical work, the studies we reviewed have certain limitations relating to scope, underlying assumptions, and age of the data. Consequently, we do not draw any overall conclusions from this body of work regarding whether packer concentration has lowered steer and heifer prices.

For our analysis we identified 10 studies most of which pertain to the period of the 1970s. Two of the studies fell out of our results analysis because in one case the results are primarily intended to illustrate a particular methodology, and in the other case the study aggregates all meat packing. Of the remaining eight studies, five suggest that beef-packer concentration has resulted in decreases in the prices packers pay for cattle, and three do not find such a relationship between packers and cattle prices.

For several reasons, we chose not to draw conclusions from the above body of work. There are relatively few studies on the subject, and many of the studies may not be applicable because they relate to the 1970s, when industry conditions were much different from those in the 1980s. Further, we have concerns about the methodological limitations of some of these studies. For example, the geographic market is defined at a state level in one case and at a national level in several other cases. Most analysts believe that cattle markets are regional—typically larger than individual states. Additionally, some of the studies focus on measures of beef-packer concentration, but do not directly address the extent to which beef packers may or may not have influenced cattle prices. For a more detailed perspective on these studies, see appendix I.

## Views of Industry Analysts

Leading analysts of the beef-packing industry, including the Director of the Research Institute on Livestock Pricing,<sup>3</sup> have stated that concentration has been accompanied by improved efficiency in slaughter and meat processing, which has enabled beef packers to pay more for a limited supply of cattle than, as less efficient packers, they could have paid prior to achieving this efficiency. Since throughout the 1980s cattle supplies have not been sufficient to keep packers operating at full capacity, beef packers have competed vigorously for available cattle to keep their plants operating as close to capacity as possible. When plants operate below full capacity, it causes their per-unit costs to increase significantly.

For example, a 1985 statistical cost study demonstrates that larger plants have lower per-unit costs and that meat packers operating at or near full capacity have substantially lower costs than those operating at lower levels of production. As table 2 shows, slaughter costs ranged from as little as \$22.20 per head for a plant slaughtering 325 head per hour to more than \$40.00 per head for the smallest plants.

**Table 2: Estimated Average Cost for Steer and Heifer Slaughter by Plant Size, 1985**

Head per hour	Plant size by cattle head <sup>a</sup>	
	Head per year	Average cost per head
25	52,000	\$40.71
85	176,800	32.58
145	301,600	29.17
205	426,400	25.54
265	551,200	23.96
325	676,000	22.20

<sup>a</sup>Assumes one 8-hour shift per day, 5 days per week, at 100 percent of the hourly capacity—or 260 days per year.

Source: Claudia J. Sersland, "Cost Analysis of the Steer and Heifer Processing Industry and Implications on Long-Run Industry Structure," unpublished Ph.D. dissertation, Oklahoma State University, 1985.

Additionally, the cost of fabricating boxed beef was about \$10.00 per head lower for the larger slaughtering plants than for the smaller plants.

This same study shows, for example, that when a plant moves from operating at 100 percent of plant capacity to 80 percent of capacity, it experiences significantly higher per-unit costs for slaughtering and

<sup>3</sup>The Research Institute on Livestock Pricing was initiated in 1987 to contribute to the body of knowledge on livestock pricing issues. Sponsored initially by the Chicago Mercantile Exchange and the Department of Agricultural Economics, Virginia Tech, the Institute is conducting research at Virginia Tech and financing applied research at other Universities.

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fabricating boxed beef. Combined slaughtering and fabricating costs would go up \$7.93 per head—a 12.2 percent increase from the combined \$65.00 cost at full capacity.

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## Potential Market Power for Beef-Packing Industry

We discussed the concentration issue with four Montana feedlot operators as well as representatives from a cattle producer organization. While these individuals have strong concerns about the possible effects of concentration on cattle prices, they said that since the mergers of the middle to late 1980s, concentration in the beef-packing industry has not resulted in lower cattle prices. However, they are concerned about the combination of horizontal concentration—mergers and acquisitions amongst beef packers—and the vertical coordination that has and is taking place. Specifically, they believe that since the large beef packers have captive cattle supplies<sup>4</sup> of their own, they will be able to influence cattle price levels.

We also discussed the effects of beef-packer concentration with officials from two of the three largest beef-packing firms. They both stated that cattle prices are higher than they would be in the absence of the lower cost structures. Their arguments associating concentration with higher cattle prices mirror those of the industry analysts, who noted that concentration has enhanced access to greater efficiency, which in turn has enabled beef packers to pay more for a limited supply of cattle. Theory suggests that if beef packers are concentrated, they will have long-term market power that would lead them to pay lower prices to the cattle producers. However, current excess capacity along with lower beef-packer costs may have supported short-term cattle prices at levels higher than could be anticipated because of the concentration alone. Therefore, the current price may be between the high price that would result from the increased efficiency alone and the low price that would result from concentration alone.

Future changes in industry and market conditions could increase the likelihood that the beef-packing industry will lower the prices it pays for cattle. For example, if cattle supplies expand by several million head, as they have in the past, without a corresponding increase in consumer demand and processing capacity, the few controlling beef packers will have less of an incentive to compete aggressively for available

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<sup>4</sup>The term captive supply refers to livestock owned or controlled by a buyer in advance of slaughter. Typically, the three noncash-price forms of vertical coordination, i.e., forward contracting, packer feeding, and exclusive purchasing/marketing agreements, constitute captive supplies.

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cattle. Prices may then decrease more than if a greater number of firms had purchased the cattle.

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## Conclusions

According to economic theory, other things being equal, the high level of concentration in the beef-packing industry could result in lower cattle prices than would occur with less concentration. Nonetheless, our review of empirical studies did not lead us to draw any overall conclusions regarding the impact that market concentration in the beef-packing industry has on the prices packers paid for steers and heifers in the 1980s. Industry analysts and experts we spoke with said that recent packer concentration has not lowered steer and heifer prices in the 1980s. Some industry analysts believe that cattle prices may be higher because the increased efficiencies that accompanied increased concentration enabled beef packers to pay more for cattle when supplies were short relative to beef-packer capacity. Nevertheless, future changes in market and industry conditions could result in beef packers enhancing their market power.

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We performed our work between February 1990 and September 1990. We summarized existing and ongoing empirical studies related to the concentration issue. We also summarized the opinions of industry analysts, including our consultant who is an expert on the beef-packing issue—Dr. Wayne D. Purcell, Professor and Director, Research Institute on Livestock Pricing, Agricultural Economics, Virginia Polytechnic Institute and State University. At your request, we discussed the concentration issue in Montana with four feedlot operators, a cow-calf operator, and representatives of the Northern Plains Resource Council. This Council is part of a larger organization of resource councils, whose activities include calling for enforcement of antitrust laws in the meat industry. Additionally, we talked about the issue with representatives of two of the largest three beef-packing firms. We have not conducted an independent economic analysis of the effects of beef-packing concentration on cattle prices.

As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 7 days after the date of this letter. At that time we will send copies to the Director, Office of Management and Budget; the Secretary of Agriculture; the Administrator, Economic Research Service; the Administrator, Packers and Stockyards Administration; and other interested parties. If we can

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be of further assistance, please contact me at (202) 275-5138. Major contributors to this report are listed in appendix II.

A handwritten signature in black ink, appearing to read "John W. Harman". The signature is fluid and cursive, with a large initial "J" and "H".

John W. Harman  
Director, Food and  
Agriculture Issues



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## Abbreviations

GAO	General Accounting Office
IO	industrial organization
NEIO	new empirical industrial organization
OLS	ordinary least squares
USDA	U.S. Department of Agriculture



# Review of Empirical Studies

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In our review of the ways in which beef packers purchase cattle, we surveyed three types of empirical studies: structural, new empirical industrial organization (NEIO), and game theoretic empirical studies. We selected the studies for review on the basis of their relevance to this report, relevance which we determined by surveying the literature and seeking expert opinion of academic and industry analysts. We recognize that empirical studies alone can suggest only causal relationships.

We reviewed six “structural” studies, so called because they attempt to measure the degree of statistical association between a “structural” variable, in this case, an indicator of market concentration of fed-cattle purchasers, and a “performance” variable, such as price. Hence, the structural type of study could directly address the focus of our request, which was to examine whether increased beef-packer concentration has resulted in lower fed-cattle prices. A weakness of the structural approach is that it is not explicitly connected to market behavior at the firm level.

We also reviewed three NEIO studies because they are explicitly connected to market behavior at the firm level. Measures of the firm’s behavior in these studies include the level of competitiveness and the degree of market power exercised by beef packers in the fed-cattle market. A limitation of this approach is that the analyst must first specify an optimization problem in terms of one particular objective function to the exclusion of other objective functions.

Finally, we examined a game theoretic study. This study also focuses on the market behavior of firms. In this approach, the co-operative pricing behavior of individual meat packers is the behavioral indicator of interest. This study evaluates the effects of market power as reflected in the short-run dynamics of the pricing process in fed-cattle procurement.

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## Background

All three types of studies have emerged from a derivation of applied microeconomic theory called industrial organization (IO). An important tenet of the IO approach is that when a few firms represent a sizable proportion of the market, they can influence the price they charge for their output and/or influence the prices of inputs they use in producing the output. Concentration can be found both in selling and in purchasing markets.

In the IO tradition, market concentration permits individual firms to exercise market power, which is defined as the power to influence price.

In IO work, the exercise of market power has been detected empirically by examining the statistical relationship between market concentration and price and between concentration and profits. At the same time, the positive impact of market concentration on profits can reflect greater efficiency of large scale operation, not market power. This point is addressed in other work that has focused on a possible efficiency connection in the relationship between concentration and profits.<sup>1</sup>

Many industrial organization studies of market power are rooted in the microeconomic theory of the firm. Traditional microeconomic theory holds that, in a perfectly competitive market, prices are determined outside the firm, to such an extent that the firm is termed a “price taker” in the market for the output it sells and for the inputs it purchases. To conform with the competitive market model, no beef-packing firm would be able to influence the price it charges for meat or the price it pays for any of the inputs it employs in cattle slaughter and beef processing, including the fed-cattle input.

In microeconomic theory, if a market consists of a few firms that can influence prices paid for inputs, the market is called an oligopsony (in contrast to an oligopoly in which a few firms can influence prices charged for output). In this report, we are interested in whether empirical evidence indicates that the beef-packing industry exhibited oligopsonistic characteristics in its purchase of fed cattle for its slaughtering and processing operations during the 1980s.

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## Summary

Of the ten studies we reviewed, five suggested that beef-packer concentration has resulted in decreases in the prices packers pay for cattle—three structural, one NEIO, and one game theoretic—and three structural studies did not find such a relationship between packers and cattle prices. In reviewing two NEIO studies, we focused on their methodological approach as opposed to results because in one case the results were intended to provide an illustration of methodology, and in the second case the study results were broader than the beef-packing industry.

Three of the six structural studies found that indicators of beef-packer concentration were related to lower fed-cattle prices. Of the three, one study only was based on post-1979 data and an update to this study

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<sup>1</sup>H. Demsetz, “Two Systems of Belief about Monopoly,” *Industrial Concentration: The New Learning*, ed. Harvey J. Goldschmid et al. (Boston: 1974), pp. 184-233; H. Demsetz, “Industry Structure, Market Rivalry, and Public Policy,” *Journal of Law and Economics* Volume 16, No. 1, (1973), pp. 1-9.

found that concentration was not statistically related to lower cattle prices in the 1981-1986 period. One NEIO study indicated that beef packers exercised some market power on a national level in their purchases of fed cattle from 1951 through 1983, but preliminary results from a recent NEIO study indicate that the effect on regional markets observed in 1980 was negligible. The game theoretic study suggests evidence of increasing cooperative pricing power among beef packers for 1980 through 1982 and from 1984 through 1986, but declining exercise of the pricing power.

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## Structural Studies of Concentration and Cattle Prices

To determine whether prices paid for fed cattle have been lower due to market concentration of beef packers, we surveyed the industrial organization literature for "structural" studies that address the effect of concentration in the beef-packing industry on cattle prices.

We found no convincing evidence in this literature that, in the 1980s, beef packers paid lower prices for fed cattle in more concentrated cattle-buying markets than in less concentrated cattle markets. We examined six structural studies. All of them tested for lower prices by measuring the degree of statistical association between an indicator of market concentration of meat-packing firms and fed-cattle prices. In all cases, the authors hypothesized a negative relationship between the degree of market concentration and prices. Four of the six studies are based on data prior to 1980; statistical estimates in the fifth study are derived from relationships over the 1971-1980 period. The sixth study relates to the 1973-1989 period.

Three of the studies found a statistically significant negative relationship between the degree of market concentration and cattle prices. Of the remaining three studies, two did not find a statistically significant relationship between the two variables of interest, and one found a statistically significant positive relationship.

Only one of the structural studies that found a statistically significant negative relationship between an indicator of beef-packer concentration is not based entirely on pre-1980 data. This study found that lower fed-steer prices were associated with higher levels of beef-packer concentration during the 1971-80 period for all 13 regions studied, which covered 25 states. However, the principal author of this study told us that an update to this study did not find a statistically significant negative relationship between cattle prices in the 1981-1986 time period.

Menkhaus, Dale J. et al. "The Effects of Industry Structure on Price: A Case in the Beef Industry". Western Journal of Agricultural Economics, Vol. 6, No. 2 (1981), pp. 147-153.

In this study, cattle prices in 1972 and 1977 were found to be negatively and statistically significantly related to meat-packer concentration. Concentration was the only variable of five that was significant for both years studied. Average annual fed-cattle prices in each state studied were expressed also as a function of meat-packing wages, the cattle surplus/deficit position of the state, beef prices, and average feedlot size. Twelve states were included in the 1972 analysis and 15 states for 1977; each state constituted an observation.<sup>2</sup> The structural variables of interest were meat-packer concentration and feedlot size. Each market consisted of one state. Ordinary least squares (OLS) regression analysis was used to estimate a separate equation for each year.

This paper explicitly incorporates the countervailing power of feedlots by including a "feedlot size" variable. The sign of this variable was positive and the variable was statistically significant for 1977. The strong positive relationship between feedlot size and fed-cattle price in 1977 is important to note. The statistical significance suggests that empirical models of beef-packer concentration and cattle prices might be more appropriately specified if they account explicitly for factors which may, according to economic theory, offset the oligopsonistic tendencies of beef packers to force down cattle prices. The authors suggest that the positive sign may indicate a countervailing power structure between beef packers and feedlots when operating as a bilateral oligopoly.

Although this study concludes that fed-cattle prices were lower when meat-packing markets were more concentrated, the study's results may have been affected by errors in measuring market boundaries. It is generally agreed that individual states were too small to accurately reflect the boundaries of fed-cattle markets and that relevant markets crossed state lines. Measurement error in a regression model can invalidate the results. In addition, the 1972 and 1977 results are not comparable since different states were used in the 1977 analysis than in that of 1972.

Multop, John R. and John W. Helmuth. "Relationship Between Structure and Performance in the Steer and Heifer Slaughter Industry." Staff

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<sup>2</sup>The author states that the study results should be interpreted conditionally, in part due to the few degrees of freedom.

Report. Committee on Small Business, U.S. House of Representatives, Washington, D.C.: September 1980.

In a series of price equations, average quarterly steer prices for 1969 through 1978 were positively associated with higher concentration levels. As noted above, economic theory suggests that in more highly concentrated markets, beef packers could force steer prices down; such a relationship would imply that steer prices would be negatively associated with concentration levels. The interpretation of this study's finding that the level of national meat-packer concentration was positively related to fed-cattle prices is not clear from the literature. The finding was attributed by the authors to increased feedlot concentration in the High Plains as well as to other factors. Subsequent researchers, questioning this interpretation of the results, have stated that the positive relationship between national packer concentration and steer prices was coincidental, not causal. The model has been termed "misspecified" for its failure to include a variable to measure shifts in aggregate supply and to analyze the relationships between steer prices and packer concentration using national, rather than regional, data.

Ward, Clement E. "Short Period Pricing Models for Fed Cattle and Impacts of Wholesale Carcass Beef and Live Cattle Futures Market Prices." Southern Journal of Agricultural Economics, Vol. 13, No. 1 (1981), pp. 125-132.

This study found that during one month of 1979, in one of the four equations which included it, the number of bids received per sale lot and heifer prices were directly related. In three of the twelve equations which included steer prices, the prices were found to increase as the number of buyers rose. The author characterized the results as indicating considerable variation in the ability of selected variables across regions to explain the price discovery process for fed cattle.

This study did not explicitly incorporate a variable to measure concentration. We included the study in our review because it relates to the theoretical notion that market prices rise as the number of buyers increases. The study incorporates the number of bids received per sale lot and the number of different meat packers bidding on each lot to represent bidder and buyer effect. The author hypothesized that both of these variables would be positively related to cattle prices. Since high collinearity between the two variables was anticipated, only one of these variables was used in a single equation.

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Ward, Clement E. "Relationship Between Fed Cattle, Market Shares, and Prices Paid by Beef Packers in Localized Markets." Western Journal of Agricultural Economics, Vol. 7, No. 1 (1982), pp. 79-86.

This study found that during one month of 1979, larger buyers generally paid neither lower nor higher prices than the smallest buyer in the localized markets studied. The statistical correlation between buyer market shares and average prices paid was also nonsignificant.

Cattle prices for steers and heifers were regressed on binary variables representing different cattle buyers in order to test whether the average price paid by any of the largest buyers in the market was significantly different from the price paid by the smallest buyers.

The study has been criticized for the absence of a theoretical foundation, since industrial organization theory does not suggest a relationship between firm market share and firm prices within a market. On the contrary, industrial organization theory does suggest that under price leadership, market prices may not differ across firms, although all prices may be below a competitive level.

The author states that the results were contrary to the inverse relationship hypothesized between market share and average price paid in the industrial organization tradition. He also says that the results suggest that price differences among beef packers may occur but are dependent on variables other than market share, such as access to and ability to use information on demand and supply, plant location and transportation costs, and slaughtering and processing costs.

Quail, Gwen et al. "The Impact of Packer Buyer Concentration on Live Cattle Prices." Working Paper 89. North Central Project 117. University of Wisconsin-Madison: May 1986.

This study found that lower fed-steer prices were associated with higher levels of beef-packer concentration during the 1971-80 period for 13 regions covering 25 states.<sup>3</sup> For each specification, packer concentration

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<sup>3</sup>A 1990 extension of this study, however, indicates that the negative statistically significant relationship between beef-packer concentration and fed-cattle prices disappeared in the 1981-1986 period.

was represented by either concentration ratios<sup>4</sup> or Herfindahl Indexes<sup>5</sup> of regional packer concentration. The model was estimated with pooled cross-sectional/time-series data and employed OLS or generalized least squares regression analysis. Concentration ratios were statistically significant and negatively related to steer prices in both equations that incorporated the ratios. Herfindahl Indexes were statistically significant and negatively related to steer prices in all 13 of the equations that incorporated the Indexes. However, no correlation coefficients (indicating goodness of fit) were reported for any of the equations.

The concentration-price results of this study should probably not be directly applied to fed-cattle markets in the 1980s, since there is some evidence that excess slaughter and processing capacity precluded fed-cattle buyers from forcing prices down during that period.

As in the case of the Multop-Helmuth study, the structural variables of interest included beef-packer concentration and feedlot size. Feedlot size was positively and significantly related to steer price in ten of the eleven equations in which it appeared. The study incorporated additional structural variables, but none were consistently statistically significant in explaining steer price variation. The additional structural variables represented the size of the largest beef packer, the slaughter surplus/deficit position, and the relative share instability of the top four beef-packing firms, all for each year and region.

Two additional independent variables were significant in explaining steer prices in seven or more of the 15 specifications—market type and distance. The variable included to isolate the effect of lower steer prices at terminal markets (relative to prices determined at direct sales to beef packers) was negatively related to steer price in eight of the ten equations that incorporated it. In seven of the fifteen equations that included a variable to isolate the negative effects on price of the distance from the midpoint of each region to the east and west coasts, the variable was statistically significant and negative. The variable representing labor costs of beef packers, although included in eight specifications, was statistically significant in one specification only and then displayed a positive sign.

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<sup>4</sup>Concentration ratios are calculations that represent the market share of the few largest firms—usually four or eight—in an industry.

<sup>5</sup>Herfindahl Indexes measure market power by summing the squares of the market shares of the firms in the industry.

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Hayenga, Marvin and Dan O'Brien. "Competition for Fed Cattle in Colorado vs. Other Markets: The Impact of the Decline in Packers and the Ascent of Contracting." Paper presented at the NCR Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management. Chicago, IL: Apr. 23-24, 1990.

Preliminary results from this study of competition for fed cattle in Colorado suggest that prices have not declined relative to prices in other cattle-feeding states. The study incorporates data for the 1973-89 period, when the number of large fed-cattle slaughter firms declined by a greater proportion in Colorado (from eight to two) than in neighboring states.

In their April 1990 report, the authors state that if further analysis confirms initial findings, the relevant geographic market for structural and competitive analysis is much larger than any state. The relevant market's size, which may be much larger than that of the trade areas of individual firms, may also be due to the indirect competitive effects of "third party" firms, in the dynamic arbitrage process.

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## New Empirical Industrial Organization Studies

We also reviewed three empirical studies of the NEIO type, which focused on the exercise of market power by beef packers but did not incorporate explicitly cattle prices. The studies we evaluated incorporated two competitive indicators, conjectural elasticities<sup>6</sup> and market power indexes.<sup>7</sup>

In the NEIO framework, the exercise of market power by meat packers in the fed-cattle market can be detected by comparing statistical estimates of conjectural elasticities and of market power indexes with values suggested by microeconomic theory of the firm. Empirical estimates of conjectural elasticities and market power indexes are evaluated relative to a zero value, which theory suggests is consistent with a perfectly competitive market.

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<sup>6</sup>A conjectural elasticity is the percentage change in all other firms' output sales (or input purchases) that one firm expects in response to a 1-percent change in its own output (input use). If the value of the conjectural elasticity is zero, the firm is operating in a perfectly competitive market. If the value is +1, the market consists of a monopoly (monopsony).

The formula for the conjectural elasticity is the following:  $\theta = (dQ/dq)(q/Q)$ , where  $dQ/dq$  is the firm's conjecture about other firms' output (or input) response, and  $q/Q$  is the firm,  $q$ 's, market share of the entire market,  $Q$ .

<sup>7</sup>For the studies we reviewed, the degree of oligopsony power was calculated by dividing the conjectural elasticity by the elasticity of fed-cattle supply.

Since conjectural elasticities are hypothesized to be zero, a rejection of this hypothesis points to the conclusion that firms take into account other firms' input purchases. The elasticities are hypothesized to take on a zero value for empirical testing because in a perfectly competitive market a firm does not expect other firms to change their input purchases as a result of the competitive firm's decision to buy more or less of an input.

Market power indexes are also hypothesized to be zero because, unless firms have market power, the input prices they pay will be identical to the marginal value of the output produced with the input.

The studies of national market behavior find some empirical evidence that meat packers have exercised market power in purchasing fed cattle during the 1951-1983 period but no evidence that performance has been less competitive in the later years of the analysis. The study of regional behavior projects that buyer power has small effects. It is generally accepted that markets for fed cattle are regional, not national, since cattle are not often transported more than 250 miles to slaughter plants, and fed cattle are raised in distant U.S. regions.

Schroeter, John R. "Estimating the Degree of Market Power in the Beef-packing Industry." The Review of Economics and Statistics, Vol. 70, No. 1 (1988), pp. 158-162.

Schroeter detected small, but statistically significant, buyer power price distortions in his study which extends prior work to include buyer market power. Prior to the 1980s, the market power of sellers only had been emphasized in the research literature.

In the Schroeter study, 1951 through 1983 annual national data from the beef-packing industry were used to estimate a system of equations by the full information maximum likelihood technique. Conjectural elasticities were modeled as a general function of all the exogenous variables in the system and market power indexes were calculated by dividing the conjectural elasticities by the estimated fed-cattle supply elasticity of +1.69. The fed-cattle input is employed in fixed proportions relative to the meat output. The labor input is employed in variable proportions. The conjectural elasticities estimated for each year are constrained to be identical in the fed-cattle and the beef market.

The results indicate that meat packers had some discretion over prices paid for fed cattle. According to the underlying microeconomic theory of

imperfect competition, values greater than zero indicate that the hypothesis of price-taking behavior should be rejected. In the Schroeter study, estimated values of the conjectural elasticities were positive and statistically significantly different from zero at the 95-percent confidence level in 28 of the 33 years. The author concluded that beef packers had some discretion over prices paid for fed cattle during the period studied.

The detected levels of beef-packer/buyer price distortion in this study were significant but small.<sup>8</sup> The estimated price distortion, which was small for the entire period, declined to about 1 percent in the later years of the sample. The author notes that the increase in beef-packer market concentration since 1977 did not increase the size of the price distortion, which has been relatively stable since 1970.

Azzam, Azzedine and Emilio Pagoulatos. "Testing Oligopolistic and Oligopsonistic Behavior: An Application to the US Meat-Packing Industry." Forthcoming, Journal of Agricultural Economics.

Azzam and Pagoulatos found that the U.S. meat-packing industry exercised market power in both the output (meat) and input (live animals) markets during the 1959 through 1982 time period. They defined the meat-packing industry as consisting of beef, pork, sheep, and lamb slaughter and processing on a national level. (The authors note that data on output and input use by kind of meat would be preferable to aggregate data, but disaggregated data of the desired type is not available.) The level of data aggregation limits the study's usefulness for this report. However, the study is important for its similarity to the Appelbaum<sup>9</sup> and Schroeter studies.

Like Appelbaum and Schroeter, Azzam and Pagoulatos jointly determine the conjectural elasticities along with other parameters in the model. In contrast to Appelbaum and Schroeter, they dropped the assumption of fixed proportions in fed-cattle slaughter and processing, which permitted them to test for identical behavior in the fed-cattle and beef markets.

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<sup>8</sup>Price distortion refers to the gap between observed price paid and the price that would be paid if beef packers were perfect competitors in their purchase of fed cattle.

<sup>9</sup>Elie Appelbaum, "The Estimation of the Degree of Monopoly Power," Journal of Econometrics, Vol. 19 (1982), pp. 287-299.

The authors characterize the meat-packing industry as displaying the same level of noncompetitive behavior in both the input and output markets. The extent of noncompetitive behavior in purchasing live animals was represented by the value of the estimated conjectural elasticity in the input market.

The authors found that the degree of market power in purchasing live animals for slaughter was significantly higher than in selling the meat from these animals. A contributing factor to this result is that the elasticity of live animal supply used in the study was one-third the size of the absolute value of the elasticity of meat demand (.16 vs. .49). (As in the Appelbaum and Schroeter studies, the conjectural elasticity was divided by the elasticity of live animal supply to derive the market power indicator.)

This study extends the Schroeter work and tests price-taking behavior in the meat and live animal markets without restricting the conjectural elasticities in the respective markets to be identical. The analysis is based on the formulation and estimation of a simultaneous-equation model consisting of a production function and four first-order optimality conditions associated with factor employment. The elasticities of livestock supply and meat demand are exogenous. As noted earlier, the conjectural elasticities are estimated jointly with other parameters of the model.

The authors selected a production function that enabled them to avoid imposing any constraints on the production characteristics of the industry. (The transcendental logarithmic translog form used allowed them to do this.) In addition to the livestock input, labor, capital, and nonlivestock material comprise the competitively priced inputs utilized by the meat-packing industry for purposes of this estimation. The instrumental variables technique was used to estimate the value of each regressor as a function of a set of variables considered exogenous to the meat-packing industry. The iterative nonlinear three-stage least squares technique was used to estimate the model, which was based on annual aggregate time series data from 1959 through 1982.

Azzam, Azzedine and John Schroeter. "Implications of Increased Regional Concentration and Oligopsonistic Coordination in the Beef Packing Industry." Draft paper. Apr. 1990.

Preliminary results from this study suggest small price and quantity effects from an increase in regional meat-packer concentration. The

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authors emphasize that the results are intended primarily to provide an illustration of the method outlined in the paper. This method can be used to project the price effects of changes in regional concentration anticipated in response to specific merger proposals, but the results would be highly dependent on the values assumed for the underlying conjectural elasticities and oligopsony price distortions.

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## Game Theoretic Study

Koontz, Stephen R. et al. "Oligopsony Power, Meatpacker Conduct, and Price Dynamics: A Preliminary Investigation of Live Cattle Markets." Applied Commodity Price Analysis, Forecasting and Market Risk Management. Proceedings NCR-134 Conference, Chicago: April 20-21, 1989, pp. 318-330.

This study focuses on the cooperative pricing behavior of individual meat packers. The focus of this approach is to examine the effects of market power on the short-run dynamics of the pricing process of beef packers in their fed-cattle procurement. Like the NEIO work, this type of study focuses on the behavior of firms, but instead of dealing with aggregate industry behavior and average market prices, it is concerned with the degree of price coordination among firms in a particular market. Prices paid for cattle by each meat packer were indicators of whether the firms' pricing behavior was cooperative or noncooperative during various time periods.

This type of study has the advantage of being based on the microeconomic theory of the oligopsonistic firm, and the results do not appear to refute the theory. Although it does not directly consider whether fed-cattle prices were lower due to market concentration of fed-cattle buyers (the focus of our report), we included this study in our review because it deals with oligopsonistic behavior of meat packers.

The results of this study indicate that meat packers priced cooperatively during some time periods and priced noncooperatively during other times. All four markets studied exhibited evidence of noncooperative pricing at least 65 percent of the time. However, switching between the cooperative and noncooperative regimes appeared to increase in later periods. The principal author told us that in his expanded analysis, he has found that the ability of beef packers to force down cattle prices has increased over time, but that the packers have exercised this power less. He said that he attributes the competitive environment in the recent period to excess cattle slaughter and processing capacity in the industry.

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