The Impact of Packer Buyer Concentration on Live Cattle Prices

by

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WP-89 May 1986

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The authors gratefully acknowledge the assistance of Charles Stull and Elizabeth Schiferl during the data development phase of this project, the comments and suggestions of Jean-Paul Chavas, Reuben Buse, Willard F. Mueller and Marvin Hayenga, and the assistance of John Helmuth in obtaining necessary data.

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The effect of market concentration on market performance is one of the major topics of debate among industrial organization economists. Demsetz (1974) and Peltzman (1977) argue that the positive relationship found in many studies between concentration and profits is because concentrated industries are more efficient, not because they charge higher prices. Thus, concentrated industries should be applauded, not condemned. Devotees of contestable market theory relegate market concentration to a secondary role for other reasons (Baumol, 1982). This theory identifies entry and exit conditions as the key structural elements. In perfectly contestable markets, concentration can be ignored.

Nearly all of these debates can be resolved by examining concentration-price relationships. A positive relationship between concentration and prices is inconsistent with either the superior efficiency argument or contestability theory.

This paper contributes to this debate by examining empirically concentration-price relationships in the markets for fed cattle. Unlike most studies, we examine the impacts of buyer concentration rather than seller concentration.

Live Cattle Markets

In 1983, the commercial cattle slaughter in the U.S. was made up of grain fed steers and heifers -- 69%, nonfed steers and heifers -- 8%, and cows and bulls -- 22% (Monfort of Colorado, Inc. v. Cargill Inc. and

Excel Corp., p. 4). Packers tend to specialize in the slaughter of either fed cattle or nonfed cattle. For example, cow and bull slaughter represented only 0.3% of the 1982 slaughter by major packers, including IBP, Excel, Spencer and Monfort (Monfort of Colorado, p. 14). This paper focuses on the markets for fed cattle. Non-fed cattle, cows and bulls, which mainly go into ground beef, are largely ignored since they are poor substitutes for fed cattle and have little effect on fed cattle markets.

Between 1972 and 1982, the number of firms reporting steer and heifer slaughter to the Packers and Stockyard Administration dropped from 710 to 471. During this period, the percent of U.S. steers and heifers slaughtered by the largest 20 packers increased from 59.7 to 76.3; the share held by the largest eight packers jumped from 43 to 61 percent (Helmuth, 1984). The concentration of steer and heifer slaughter has also increased rapidly at the state or regional level. The four leading slaughterers in each of the 23 major fed cattle states accounted for, on average, 56 percent of the steers and heifers slaughtered in each state in 1969, 66% in 1977 and 81% in 1982 (Helmuth, 1984). This has raised a growing concern as to whether feedlots have adequate market alternatives for their cattle. Is there effective competition in live cattle procurement markets, or can packers buy cattle at sub-competitive prices in some markets? This is the primary question that the research in this paper sought to answer. Before reporting these results, however, it is important to understand recent changes in the beef subsector and the theoretical and empirical base on which this research depends.

Changes in Cattle Feeding and Meat Packing

The cattle feeding and beef packing industries have undergone substantial evolution since 1960. Cattle feeding shifted to the Western Corn Belt and High Plains in part because new milo varieties and expanded irrigation greatly increased grain supplies in the southwest. By 1982, over two-thirds of the fed cattle were produced in five states: Texas, Nebraska, Kansas, Iowa and Colorado. Large feedlots have increased in importance. Of all fed cattle marketed in the 23 leading states, the percent from feedlots with a capacity of 1,000 head or more steadily increased from 55% in 1970 to 73% in 1981. Total feedlot numbers dropped from 184,550 to 104,409 during this period. The 381 feedlots with capacity of 8,000 head or more marketed over half of the fed cattle in 1982 (USDA, 1983).

The importance of large feedlots varies considerably by state. Whereas large commercial feedlots tend to characterize western and south-western states, relatively small farm feedlots are more common in the cornbelt. For example, whereas over 90% of the fed cattle in California, Texas, Colorado, and Kansas came from feedlots of 1,000 head or more capacity in 1981, this was true for less than 15% of the fed cattle in Ohio, Indiana, Illinois, Wisconsin and Minnesota. Iowa and Nebraska fall in between these extremes but have been rapidly shifting from farm feedlots to commercial feedlots.

As cattle feeding shifted from the eastern cornbelt, several new packing companies emerged, led by IBP Inc. This new generation of packers located large, efficient, specialized beef slaughtering plants in cattle feeding areas and hired workers at substantially lower wages (and fringes) than the old line packers. The employees of most of the

old line packers were covered by the "master" labor union contract which provided for uniform wages across packers and contained a cost of living adjustment (COLA) clause. The automatic wage increases that were triggered by double-digit inflation during the 1970s exacerbated the cost disadvantage of old line packers. Several companies closed, sold or changed ownership of plants, and/or negotiated new labor contracts.

The geographic distribution of steer and heifer slaughter closely parallels the location of cattle feeding. Most fed cattle are purchased within 100 miles of the slaughter plant; nearly all are purchased within 200 miles of the slaughter plant (Monfort of Colorado Inc. p. 17-18). Transportation costs and liveweight shrinkage encourage relatively compact market areas.

Cattle are slaughtered at two types of plants: plants that slaughter only and plants that both slaughter and fabricate beef. Integrated slaughtering-fabricating plants are largely owned by the top 20 beef packing companies. Concentration of steer and heifer slaughter rose sharply after 1977; the four largest packers slaughtered 29% of the U.S. total in 1977 and 45% in 1982 (Helmuth, 1984). The sale of Armour's slaughtering plants to Swift Independent and the decline of the Spencer division of Land-O-Lakes has led to three dominant fed beef slaughtering companies in the U.S.: 1) IBP (subsidiary of Occidental Petroleum), 2) Excel (subsidiary of Cargill) and, 3) Swift Independent.

The most dramatic development in beef packing in the last 20 years is boxed beef. Whereas in the 1960s, nearly all beef left the packer as forequarters or hindquarters, much of it is now cut into primal or sub-primal cuts by the packer, sealed in vacuum-pack bags, and shipped in cardboard boxes. Boxed beef has grown rapidly in acceptance: P&SA

data indicate that packer shipments of boxed beef accounted for 43 percent of steer and heifer slaughter in 1979 and 58 percent by 1982 (Helmuth, 1984). Fabrication of carcasses into boxed beef is performed by both integrated slaughtering-fabricating firms and by independent fabricators or "breakers" which do no slaughtering. Breakers are generally located in or near centers of population. In 1979, integrated slaughter-fabricators accounted for 86% of boxed beef production while breakers did 14% (USDA, 1982b).

Boxed beef has provided an important means for packers to differentiate a commodity -- USDA choice carcasses -- but also provides many benefits to the packer-retailing stages in transportation, shrink and labor cost savings, product quality and shelf life, and merchandising flexibility. In the Monfort-Excel case, boxed beef was judged an economically significant submarket of the beef industry.

The largest four beef packers emphasize boxed beef processing and sales. About 80% of the steers and heifers (S/H) slaughtered by these firms were fabricated into boxed beef in 1982. Carcass sales by these companies primarily involve those carcasses that do not meet their standards for boxed beef. The 5th to 12th and 13th to 20th largest beef slaughters fabricated somewhat lower percentages (49% and 28% respectively) of the S/H that they slaughtered. The remaining 451 beef packers in 1982 fabricated only 5% of the S/H they slaughtered; most of their output was sold in carcass form (unpublished Packers and Stockyards Administration data).

The top 20 boxed beef companies also purchase carcasses from other packers for fabrication into boxed beef. In 1982, purchased carcasses accounted for 14% of the boxed beef output of these companies. This

ranged from 6% for the top four companies to 50 percent for the 13th to 20th companies (unpublished P&SA data).

As the above suggests, concentration of boxed beef sales is higher than the concentration of steer and heifer slaughter. For 1982, P&SA data reveal the following (Helmuth, 1984):

	U.S. Steer and Heifer Slaughter	U.S. Boxed Beef Production
CR4	45	66
CR8	61	82
CR20	76	97

Most packers smaller than the top 20 do not have the facilities to produce boxed beef. Thus, they are limited to selling their output in carcass form. As boxed beef has grown rapidly in acceptance, the market for carcass beef has shrunk. The largest packers have significantly expanded their share of cattle slaughtered as boxed beef has achieved greater market penetration. For example, from 1979 to 1982, boxed beef increased from 43 to 58 percent of the steers and heifers slaughtered, an increase of 15 percentage points. During the same time, the percent of the steers and heifers slaughtered by the top 8 firms increased by 10 percentage points. As the largest firms have expanded their share of steers and heifers slaughtered, they have gradually reduced the volume of carcasses purchased for boxing from other packers. As this trend continues, the market for specialized slaughtering firms may gradually dry up.

Economies of scale exist in both beef slaughtering and processing, but are difficult to assess. In the major cattle feeding areas, a specialized slaughtering plant that kills 250 thousand head per year using two shifts will apparently realize most of the scale economies

available. This represents about 1 percent of the U.S. fed cattle slaughter in recent years. Although recent figures are unavailable, the 20th largest beef packer in 1978 slaughtered 255,000 head of steers and heifers. Economies of scale appear to be greater in boxed beef processing (Cothern et al, 1978). Most of the new combination beef slaughtering-processing plants have a slaughtering capacity of 500,000 to 1 million head per year.

Entry barriers into beef packing were judged significant in the Monfort case because of the cost of building an efficient size plant ($20 to 40 million), the lack of efficient plants that could be acquired, and the difficulty of achieving market penetration (Monfort of Colorado Inc., p. 28-29). The displacement effect of an efficient size new plant in relevant procurement markets is an important barrier to denovo entry (Scherer et al, 1975). For example, in 10 of the 13 regions examined in this study, a plant killing 250,000 head per year would require at least 10 percent or more of the total supply, and often much more than that. However, incumbent packers would not easily give up 10 percent of their supply to a new entrant since packer operating costs are heavily affected by plant utilization. Thus, a new plant requiring 10 percent or more of a region's fed cattle supply would substantially increase regional slaughter capacity and short-run procurement competition and therefore cattle prices during the period necessary to force some capacity from the market.

Exchange between feedlots and packers has changed greatly since 1960, with a sharp decline in the importance of terminals and an offsetting increase in direct marketing. Whereas 39 percent of cattle were sold directly from feedlots to packers in 1960, this had increased to 88

percent by 1982 (USDA, 1984). Packers have more control over scheduling supplies when buying direct since cattle may be purchased up to 10 days prior to shipment from feedlot to packer.

The price packers are willing to pay for fed cattle depends upon the price they expect to receive in the wholesale meat market. Since the National Provisioner's "Yellow Sheet" is the most heavily used source of price information for the wholesale market, the prices of fed cattle tend to follow the Yellow Sheet quotes.

Packer sales of carcass beef are predominantly formula priced using the Yellow Sheet. One-third or less of carcass sales are priced by private negotiation or offer-acceptance arrangements. In contrast to carcass pricing, most boxed beef sales (85%) involved negotiated prices in 1979 (USDA, 1982b).

Packers sell beef in a wholesale market that is essentially national in scope but segmented by type of product. Although national concentration of wholesale beef sales has generally been modest, concentration has increased in recent years as several large beef packers have either been acquired or withdrawn from the fresh beef business. Concentration within certain product submarkets -- such as the boxed beef submarket -- is relatively high.

Boxed and carcass beef tends to be shipped from the major production/processing areas to the centers of population -- particularly the eastern U.S. The approximate continental dividing line for beef shipments to the east or west is a line from Texas to Colorado (Faminow and Sarhan, 1983).

The wholesale beef market reflects general supply and demand conditions for beef and largely determines the derived demand for fed

cattle. National and regional market information is readily available to feedlot sellers and packer buyers. However, buyers and sellers still must determine the price for a specific lot of cattle, considering such factors as lot size and location, the sex, estimated grade, yield, and weight of the cattle, and the bargaining position and skills of buyers and sellers. Buyers generally have an informational and skill advantage in negotiating specific transactions. This is particularly true for the largest packers which have many buyers operating in different geographic areas who relay daily market information to plant or corporate directors of procurement.

Large commercial feedlots tend to have more information on current market conditions than farm feedlots because the former sell cattle continually; they are constantly in the market. However, their information is primarily for their particular geographic market since they rarely sell to buyers from other regions. Farm feedlot operators are only spasmodically in the market and generally have more difficulty staying current on market conditions.

Feedlot-packer negotiations nearly always occur at the feedlot. For the most part, sellers are dependent on buyers coming to the feedlot, inspecting their cattle, and making an offer. Rarely does a feedlot operator contact buyers from other regions to solicit bids. Very few cattle are sold by description over the phone. These characteristics of the feedlot-packer transaction mean that sellers are normally dependent on packer buyers within roughly a 100 mile radius of the feedlot. Transactions are usually private treaty in nature in which the buyer makes an offer that is either accepted or rejected by the seller. Offers are sometimes good for several hours in which case

sellers may be able to choose between two or more offers. However, in the majority of cases, sellers must accept or reject an offer at the time it is given.

Because cattle are purchased live and the exact market value is only known after they are slaughtered, determining the value of a specific lot of cattle is an imprecise undertaking. Well informed sellers usually know the range of price within which their cattle should sell (e.g., $65.00 to $67.00 per cwt). Because they are constantly buying cattle and have superior market information, buyers can estimate the market price of a pen of cattle more accurately (e.g., $66.00 to $67.00), but will pay no more than necessary. Thus, the bargaining range at commercial feedlots is usually not large in relative terms -- but can represent substantial sums when thousands of head of cattle are involved. The bargaining range at small farm feedlots can be much larger because these sellers are generally less accurate in estimating the market value of their cattle.

Because of transportation costs, shrinkage in cattle weight and uncertainties concerning the price they will receive in other regions, feedlots rarely ship cattle to packers outside their region. USDA Market News usually specifies a price range for different markets (e.g., "$65.50 to $67.00, mostly $66.50"). Even if the price feeders have been offered by nearby packers is, say, $65.00 per cwt, they do not know the price their lot of cattle would bring in adjacent regions.

Previous Research on Monopsony (Oligopsony) Power in Livestock Markets

Although many studies have examined the monopoly power of sellers, relatively few have studied the monopsony power of buyers. We therefore have a relatively meager empirical base from which to launch a study of

livestock markets.

Love and Shuffett (1965) did a comparative study of hog prices at the Louisville terminal market before and after one of two major buyers withdrew from the market. The remaining large buyer purchased about 80 percent of the hogs sold at the terminal. More than 50% of hogs slaughtered by the two Louisville firms were imported from outside the market region. The second firm did not close down but withdrew from the terminal market and began buying most of its hogs directly from farmers. Information on the local terminal price was widely reported and governed the general price level for hogs in the local area. The firm which was buying directly from farmers is assumed to have been paying prices similar to the terminal prices.

Weekly price differences between Louisville and surrounding markets were computed for 69 weeks before the structural change and for 87 weeks after. Price differences were adjusted by regression procedures for changing relative supplies of hogs in the different markets in order to isolate the structural influence on price. Before the structural change, Louisville hogs averaged 5.5¢ per cwt. more than Indianapolis and 9.5¢ more than Chicago. After the change the Louisville price declined by 22¢ relative to Indianapolis and 27¢ relative to Chicago. Both declines were statistically significant.

Miller and Harris (1981) did a cross sectional analysis of monopsony power in hog markets using state level data for one year, 1978. State hog prices were functionally related to the type of market (direct, terminal or auction), region of the country (south or other), buyer power (proxied by state slaughter concentration ratios CR_2, CR_3, or CR_4), relative market supplies (proxied by per capita hog

marketings), and packer costs (represented by BLS wage rates for food and kindred products [SIC 20] and density of hog marketings as a proxy for packers' assembly costs).

All of the estimated coefficients with the exception of density of hog marketings had the expected signs. The three and four firm concentration ratio coefficients were negative and significant at the 10 percent level. The wage variable was negative but insignificant. The results were consistent with the monopsony power hypothesis. However, this study used only one year of data and employed geographic market definitions that are probably too narrow.

Two recent studies have examined competition in fed cattle markets. Multop and Helmuth (1980) estimated a series of price equations for various markets within the beef channel. Dependent variables were net farm value, steer prices, net carcass value, boxed beef value and carcass-retail spread. All equations were estimated using national data on a quarterly basis for 1969 through 1978. No attempt was made to model cattle cycle effects on prices. The authors found a significant positive relationship between packer national concentration and average national steer prices from their time series analysis. This finding is attributed by the authors to increased feedlot concentration in the High Plains (and therefore bilateral monopoly) as well as other factors. However, there is an alternate and more plausible explanation, in our view: national concentration of cattle slaughter among the top 4 or 8 packers tends to be negatively related to national cattle supply. That is, packer concentration tends to be high when cattle numbers are low and -- cattle prices high. Since the cattle cycle has a major influence on cattle prices, a model that does not include a variable to measure

shifts in aggregate supply and demand is misspecified. In the Multop-Helmuth study, we believe the positive relationship between national packer concentration and steer prices is coincidental, not causal. In addition, analysis of steer price-packer concentration relationships using national data is inappropriate. The relevant geographic markets for live cattle are much smaller.

A recent Packers and Stockyards Administration (1982) study by J.C. Williamson and staff examined the geographic size of markets for fed cattle (USDA, 1982a). The study focused its attention on two regions (High Plains and Iowa-Nebraska) having high-production density cores surrounded by relatively low-production density areas. The study's prime objective was to determine whether these two regions were price independent and hence were different markets. Since this study reportedly found that the two regions were not separate markets (contrary to our assumption) and has been widely misinterpreted, we will critique it in some detail.

Data on fed cattle marketings, slaughter and prices in the two regions were gathered for selected periods during April 1979-March 1980. Analysis of fed cattle movement revealed that total transfers of cattle between the two regions amounted to less than ten percent of either marketings or slaughter for the regions.[1/]

Prices paid by packers for cattle were gathered during April 1979 and March 1980 in each of the two major regions and analyzed to determine whether the two regions were "price independent."[2/] The price data were combined with published wholesale carcass price information to estimate carcass-live cattle price differences. Since a national carcass price was used for both regions, differences in regional

"margins" are solely due to differences in live cattle prices. Regional margins are therefore proxies for regional live cattle prices.

Carcass-live cattle margins were regressed on several binary variables. The basic model employed was:

$$P = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_1 X_3 + \beta_5 X_2 X_3$$

where:

P = lot margin or the difference between wholesale carcass prices and live cattle prices per hundred weight per lot in 1979 and 1980.

X_1 = sales contract which equalled one (1) when cattle were purchased on a dressed weight basis and zero (Ø) when purchased on a liveweight basis.

X_2 = time period which equalled one (1) for 1980 observations and zero (Ø) for 1979 observations.

X_3 = regional market which equalled one (1) for Iowa-Nebraska and zero (Ø) for the High Plains region.

X_1X_3 = an interaction variable between X_1 and X_3. This variable equals one (1) for cattle purchased on a dressed weight basis in Iowa-Nebraska, otherwise zero (Ø).

X_2X_3 = an interaction variable between X_2 and X_3. This variable equals one (1) for Iowa-Nebraska cattle in 1980, otherwise zero (Ø).

The authors contend that a significant coefficient on the interaction term, X_2X_3, is evidence of price independence among markets; conversely, an insignificant coefficient indicates the two markets are not price independent. The regression results generally have a significant negative coefficient for X_2 and a significant positive coefficient for X_1X_3. All other coefficients are insignificant. The results indicate that lot margins were significantly different in the two time periods, but when all else was held constant, there was no difference in margins in the two geographic markets or by type of sales contract. Cattle purchased in Iowa-Nebraska on a dressed weight basis

had significantly higher lot margins than all other cattle purchased. Based upon the lack of significance of the time and market interaction variable, the authors conclude that the two markets are not price independent and therefore parts of the same geographic market. In reviewing the P&SA study we find that this interpretation is unwarranted. The study has serious theoretical and research design flaws.

The theoretical rationale for the P&SA analysis is that markets can be defined by examining the extent to which two or more geographic or product markets have similar price movements over time. This is the approach proposed by Stigler and Sherwin (1985) and recently tested for petroleum products by Slade (1986). This may be an appropriate procedure in some situations, but clearly is not in others. If the products in two geographic markets are formula priced off the same reference price, they will move in parallel fashion whether or not they are in the same market. Formula pricing off national price indices is common in agriculture. Market order prices for milk are priced relative to the Minnesota and Wisconsin price for manufactured grade milk. Cheese tends to be formula priced off the Green Bay Cheese Exchange prices. Eggs are generally priced relative to the Urner-Barry price report. Wholesale pork and beef are frequently formula priced off the "Yellow Sheet" of the National Provisioner. Under these pricing arrangements, temporal price movements in different geographic areas will obviously be parallel simply because of the method of price determination.

Prices in local procurement markets may also move in parallel fashion if the processed product is sold in a national market so that

buyers are responding to the same derived demand. For example, meat packers buy live cattle in relatively small geographic markets, but sell carcasses and boxed beef in a national market. National supply and demand forces influence wholesale beef prices and the prices packers are willing to pay for live cattle throughout the country. Another way to visualize the problem is to consider the change in prices that would occur if a monopsonist bought in one region and competitive firms in another. If, over time, the firms in the two regions faced the same derived demand and supply curves and had similar cost functions, prices in the two regions would move up and down together. However, the monopsonist would pay a lower level of prices for cattle than would the competitive firms. Thus, a finding that cattle prices move in parallel fashion over time in different regions is not a sufficient reason for inferring that regions are in the same relevant economic market.[3/]

The research design employed in the P&SA study also provided a weak test of the theoretical premise. The extent to which weekly or daily prices move parallel over time is a far more rigorous test than annual price changes. The P&SA analysis compared the mean prices or lot margins during April 1979 with those in March 1980 for the two regions examined. Hence, their conclusions are based on only two mean values for each region (and their standard errors). Given the fact that meat packers in both regions sell dressed beef in a national market and therefore face the same derived demand curve, it is hardly surprising that changes in live cattle prices over the one year period were similar in the two regions. Because of the major theoretical and empirical limitations of the P&SA study, it does not provide a meaningful test of the geographic size of live cattle markets.

Clement Ward (1982) attempted to test the hypothesis that prices paid to feedlots were inversely related to buyer (packer) market share. Cattle prices during July 1979 were collected from 26 commercial feedlots and 3 marketing agents representing six "local markets" (ranging from 3 to 23 counties in size) in Texas, Oklahoma, Kansas, Nebraska and Iowa. Cattle lot prices for steers and heifers in each local market were regressed on binary variables representing different cattle buyers. The analysis essentially tested whether the average price paid by any of the larger buyers in the market was significantly different from the price paid by the smallest buyers. Other variables included in the regressions were a trend variable and several variables to control for cattle quality differences (e.g., percentage of cattle in each lot estimated to be quality grade choice or above, estimated average dressing percentage of the lot, etc.). The statistical results generally found no significant difference in the prices paid by different buyers. Ward also calculated Spearmans coefficient of rank correlation between buyer market shares and average prices paid. The Spearmans coefficient was not significant.

The theoretical foundations of this study are not clear. Whereas industrial organization theory provides clear hypotheses regarding the effects of market concentration on firm interdependence and therefore on market prices, it is ambiguous about the relationship between firm market share and firm prices within a market. Whereas price differences exist among firms selling differentiated products (Wills 1983), one would not expect price differences among competitors in selling or buying homogeneous products. If price leadership or effective collusion is hypothesized, market prices may be below a competitive level but all

firms may pay a similar price. Cartel theory, however, suggests that firms in a coordinated oligopsony may differ in prices because of the incentives to "cheat" in order to reap greater profits. But such cheating is least likely in homogeneous products purchased in relatively open markets. Thus, there seems to be little theoretical basis for expecting beef prices to vary significantly among buyers within local markets.

If Ward's local markets were relevant geographic markets -- a point that is not clear -- buyer concentration was extremely high. In five of the six markets, buyer CR4 exceeded 80 percent. Thus, oligopsonistic coordination may have allowed some lowering of cattle prices without being reflected in firm market share-price relationships. Ward's results are not inconsistent with effective collusion or price leadership among packer buyers. The study does not test for the presence or absence of monopsony power. 4/

In two other studies, Ward examined the price effects of the number of buyers bidding on pens of cattle and lots of lambs (Ward 1981; 1984). In both studies, the number of different buyers bidding had a positive and significant relationship with the transaction price. While the number of bidders gives no indication of the degree of dominance of leading buyers, it provides one measure of the structure of the buying market for a particular transaction. The higher prices resulting from more bidders may have been due to either increased competition between buyers and/or improved seller information

Monopsony power has also been studied in manufacturing-retailing markets. 5/ Unlike the studies found in the agricultural industries, most of these are studies of bilateral monopoly. In one of the best

known, S. Lustgarten (1975) conducted a study of selling price-cost margins for 327 manufacturing industries and included buyer concentration as an explanatory variable. Buyer concentration was statistically significant and was inversely related to price-cost margins as hypothesized. Additional studies by D.R. Brooks (1973), Clevenger and Campbell (1977), and LaFrance (1979) provided additional empirical evidence that buyer power reduces the ability of sellers to raise prices.[6/]

Theoretical Framework

Nichols (1941) provides one of the more complete theoretical discussions of the competitive characteristics of producer-first handler markets. Here we will briefly review three cases, all developed assuming a competitive agricultural production industry. First, we will consider a first handler industry that is competitive in buying inputs and in selling outputs. Second, we will consider a monopsonistic buyer that sells in a competitive market. Finally, we will consider the case of a first handler industry characterized by monopsony on the buying side and monopoly on the selling side. In all instances, we draw heavily from Nichols but use the fed cattle market for illustration.

Demand for cattle by a slaughter/beef packing firm is a function of (or derived from) the demand by wholesalers, retailers and (ultimately) consumers for beef products. A packer will take into account the price(s) he expects to be able to sell boxed or carcass beef and the variable costs associated with processing the cattle in determining the price he can pay for cattle from a feedlot. The determination of the quantity of cattle a given meat packing firm will demand when it operates in purely competitive buying and selling markets is graphically

depicted in Figure 1a. The net derived average revenue product and marginal revenue product curves represent the subtraction of average and marginal cost curves for variable inputs other than cattle (e.g., labor) per head of cattle from the horizontal demand curves perceived by the packer. The supply curve perceived by the packer in this case is horizontal -- P_1 or P_2. The marginal revenue product curve is equated with the supply curve to determine the profit maximizing number of cattle. If the supply price faced by the packer is P_1, he would purchase X_0 head of cattle and realize a gross profit of ab per head. If the supply price is P_2, X_1 head of cattle would be purchased by the packer with average revenue just equaling average cost of the input (price). Thus the firm would just cover its variable costs, allowing for no contribution towards fixed costs and profits.

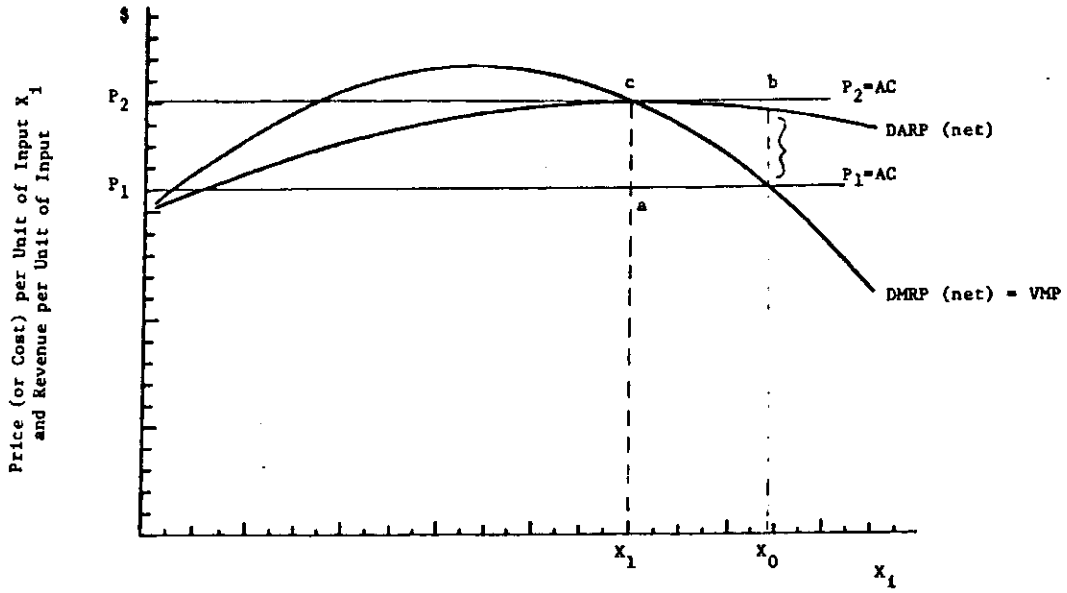
The derived marginal revenue product curve for a monopsonist that sells in a competitive market is the same as the above example. The monopsonist, however, will recognize that the cattle supply curve is upward sloping as in Figure 1b. The packer monopsonist choosing to maximize profits will equate the derived marginal revenue product of cattle with its marginal cost. Hence, the monopsonist will use the curve marginal to the prevailing supply curve to determine the quantity of cattle to purchase. In Figure 1b, the marginal cost of the last head of cattle equals the marginal revenue product of that unit at point A. Thus, X_m head of cattle would be purchased at a price of P_m. The competitive outcome would be X_c head of cattle at P_c price. The monopsonist would restrict purchases and pay lower prices than with a competitive market.

Finally consider the case where the packer is not only a monop-

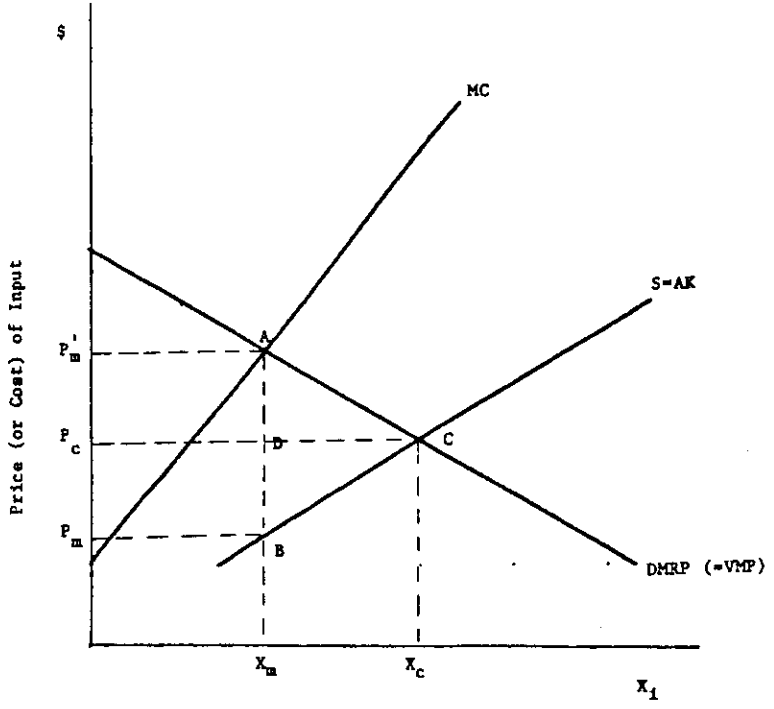
sonist in the input market but also a monopolist in the output market. Under this situation the market demand curve facing the buyer would be downward sloping rather than horizontal as assumed in 1a and 1b. All else the same, this would shift the packer's derived demand curve to the left relative to the situation in a competitive market. In Fig. 1c, the monopolist/monopsonist packer would equate DMRP with MC (Point A) and purchase quantity X_{mm} head of cattle at a price of P_{mm} (Point B). The net revenue per unit of input will be $P_{mm'}$ which exceeds the price paid for each unit of input by $P_{mm'} - P_{mm}$. If this same firm were <u>selling</u> in a purely competitive market the equilibrium price and quantity for the monopsonist would have been determined at Point D with input price P_m (Point E) and quantity X_m. Finally, if the packer <u>bought and sold</u> in purely competitive markets equilibrium would be at Point F or input price P_c and quantity demanded X_c. In moving from competitive/competitive to monopsonistic/competitive to monopsonistic/monopolistic market structures the input selling industry realizes progressively less of the value of the marginal product. What is more, the input industry (feedlots) sells less output in each of the successive market structures analyzed at successively lower prices ($P_c >, P_m, > P_{mm}$).

All regional live cattle markets have more than one meat slaughtering/packing firm; thus none have only one monopsonistic buyer. Most of these markets are more appropriately characterized as concentrated oligopsonies. Leading firms operating in an oligopsonistic market generally recognize that the quantity of the particular input they purchase jointly affects market price. To the extent that they can effectively coordinate their purchases (tacit or explicit collusion),

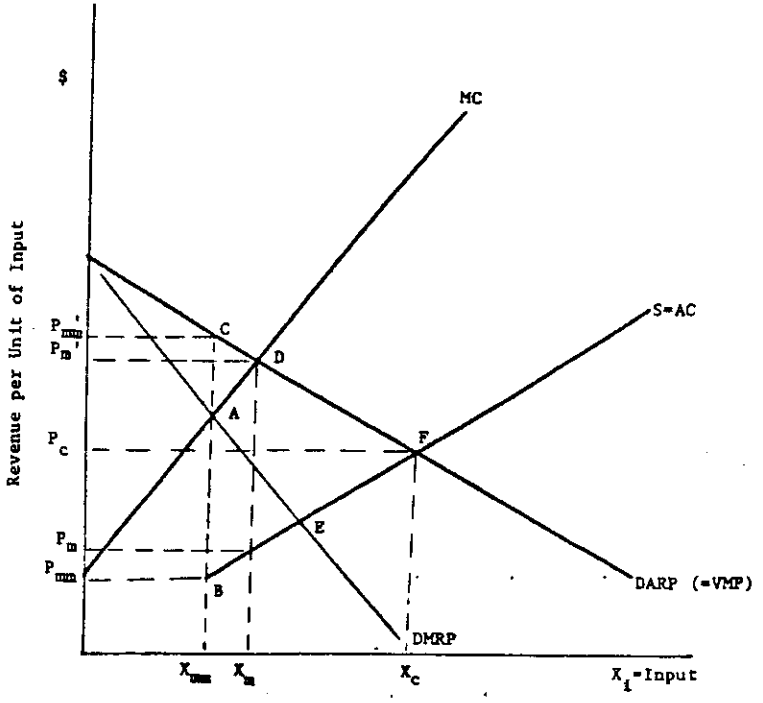
Figure 1: Theoretical Price and Quantity Solutions for Different Market Structures of Beef Packing Industries.



1a.



1b.



1c.

the market purchase price approaches that of a monopsonist. Explicit collusion is, however, difficult to achieve and maintain due to legal restrictions and incentives to cheat. Imperfect information and lack of coordination among buyers can lead to input prices and quantities above the joint profit maximizing levels. A complete breakdown of coordination can lead to competitive input price and quantity levels.

Entry conditions can have an important effect on market outcomes. If there are no entry barriers, new firms can enter to take advantage of sub-competitive input prices or supra competitive output prices; even a concentrated oligopsony would be compelled to pay prices close to the competitive level.[7/] However, in most industries, entry barriers of some level exist. The available evidence indicates there are substantial barriers to denovo entry in beef slaughtering and processing (see earlier discussion). We therefore expect buyer concentration to be inversely related to fed cattle prices.

Fed cattle markets are atomistic on the selling side, but moderate to highly concentrated on the buying side. In the regional markets defined for this study, the largest four slaughterers of steers and heifers accounted for 26 to 97 percent of all steers and heifers slaughtered in 1975. Given significant barriers to de novo entry of packers into these regional markets, this range suggests that competitive rivalry in buying cattle may be relatively intense in some markets and relatively soft in others.

While packers buy cattle in relatively small geographic markets, they sell dressed beef in a national market. However, they may operate in different product markets (i.e., boxed beef vs. carcass beef). The national boxed beef market, in particular, has become highly

concentrated in recent years with the largest eight boxed beef processors accounting for 82% of shipments in 1982. In addition, entry barriers into this market segment are substantially higher than for the carcass beef segment (Cothern et al, 1978). Thus, an oligopsony/oligopoly theoretical model appears to be the most appropriate one for the steer and heifer packing industry.

Empirical Analysis of Fed Cattle Prices

The main objective of this study was to test the hypothesis that in markets where packers exercise monopsony power fed cattle prices were lower than in more competitively structured markets. In order to test statistically the hypothesis that concentration at the packer level has resulted in the exercise of monopsony power it is first necessary to define relevant product and geographic markets. The product market examined was fed steers and heifers. To avoid variations in quality, prices for U.S.D.A. choice steers weighing 900 to 1100 pounds were compared across regions and over time. Most fed cattle slaughtered are grade U.S.D.A. choice or equivalent. Choice steers and heifers are close substitutes; their prices were found to be highly correlated.

Cattle are both bulky and perishable, resulting in a relatively high total cost of transporting fed cattle. Estimates place 1982 transportation costs at $1.50/cwt. for up to 100 miles. The incremental cost beyond 100 miles averaged $.20/cwt. for each additional 100 miles (USDA 1982b). Thus, the cost to ship cattle 200 miles was about $1.70/cwt.; this was 2½ percent of the average price of fed steers in 1982. It is estimated that the net profit for both packers and feedlots averaged at or less than 1 percent of sales in recent years. Thus transportation costs discourage long shipments of cattle and are a major force in

determining the geographic scope of feedlot-packer markets. The location of feedlots and packing plants obviously play a central role in determining geographic markets. Packing plants have tended to locate in areas of relatively dense cattle feeding. As one would expect, packing plants are fewer and smaller in areas of relatively sparse cattle feeding where the greater efficiencies of large plants are frequently offset by higher costs of buying and shipping live cattle. Figure 2 shows the national distribution of fed cattle in 1974.

Defining relevant geographic markets for fed cattle is, at best, a subjective task. In a study conducted for the Committee on Small Business, U.S. House of Representatives, (Part IV, 1979), Willard Williams defined 14 fed cattle marketing regions based upon prevailing procurement territories of packers. Information on procurement territories was based in part on interviews with a number of USDA livestock market news reporters in key areas. Subsequently, Williams made a few very minor modifications in regional definitions. The 14 regional markets shown in Figure 3 were the result; 13 were used in our empirical analysis. The descriptions of these regions are included in Appendix A.

Model

The theoretical model hypothesized to explain regional variation among fed cattle prices was:

$$P = f(C, F, S, D, W, M, X, T), \text{ where}$$

P = fed cattle prices in a region,
C = concentration of fed cattle slaughter among largest packers in region,
F = feedlot size
S = plant scale economies,
D = distribution costs,
W = employee costs,

M = market type,
X = supply availability, and
T = market turbulence.

Empirically, these variables were measured as follows:

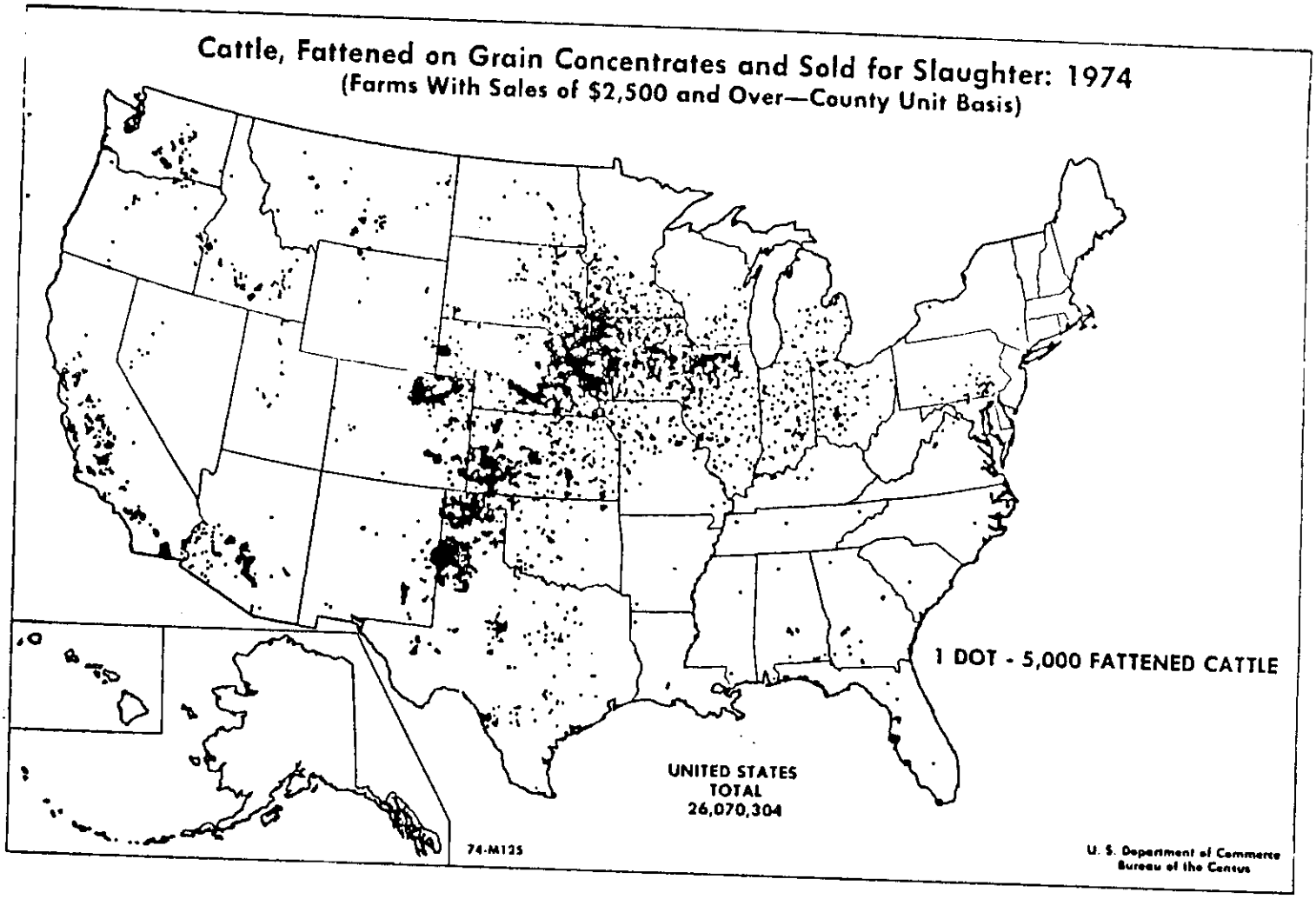
Cattle Prices: Fed cattle prices reported by the USDA Market News for 32 markets were used to develop annual average prices for each region. Prices used were for choice grade steers weighing 900-1100 lbs., expressed in cents per cwt. live weight. Many regions contained more than one Market News market. Regional average prices were calculated by weighting each Market News price by the volume of cattle sold in that market. The details of regional price calculations are included in Appendix A.

The Market News Service collects fed cattle prices daily from numerous locations in the U.S. Daily prices are aggregated up to weekly, monthly and yearly averages. Prices are collected from three types of markets: direct sales at feedlots, terminal markets and auction markets. No auction prices were used in regional price calculations. The average price calculated for each region represented either direct sales or terminals, not a combination of the two.

In 1970, about 70% of fed cattle were sold direct; by 1980, this had increased to 87%. In direct sales, buyers travel to the feedlot to negotiate terms. However, the price negotiated is normally FOB packing plant. In most cases, cattle are weighed at the feedlot and a 3% shrink deducted from the weight. In the case of terminal market sales, buyers negotiate for lots of cattle, FOB terminal market, without shrinkage allowances.

Packer Concentration: Packer buying concentration is the primary variable of interest for hypothesis testing. Within the 13 geographic

Figure 2.



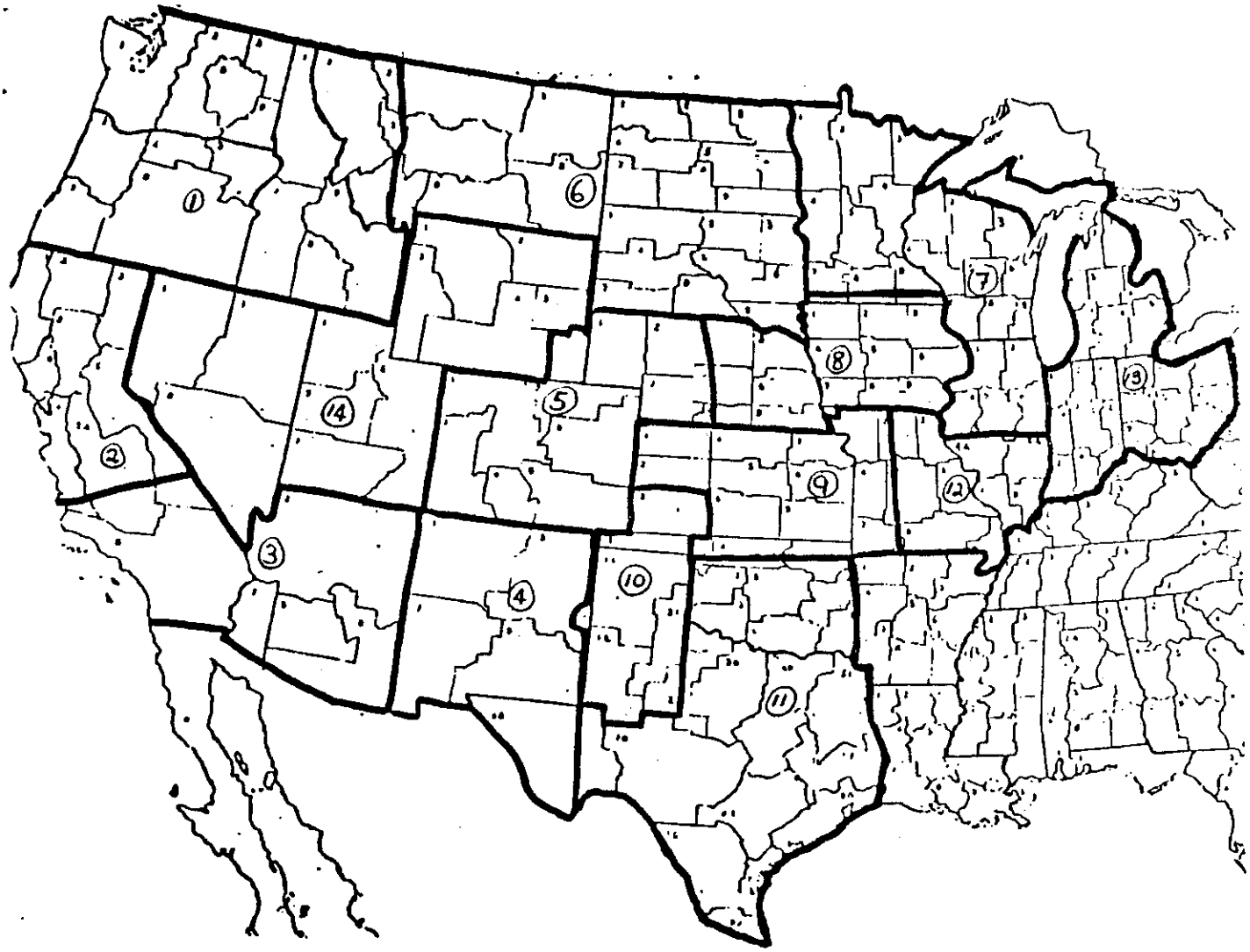
More recent (e.g. 1980) is probably available.

markets defined, the concentration of steer and heifer slaughter among the leading packers is used as a proxy of buyer concentration. Concentration ratios for the top 3, 4 and 8 packers were calculated for each year and each region.[8/] However, only CR3 and CR4 are included in the tables of the regression results. In addition, an alternate measure of concentration, the Herfindahl-Hirschman Index was calculated for each region and year.[9/] The four-firm concentration ratios and Herfindahl Index for each region and each year are shown in Appendix Tables B.1 and B.2.

Packer buying concentration measures the extent to which packers are expected to recognize their interdependence and behave accordingly. All other things equal, we expect fed cattle prices will be negatively related to packer concentration. With very high levels of concentration, packers are expected to tacitly or explicitly collude in an effort to jointly maximize profits.

Feedlot Size: The size of feedlots varies considerably from region to region. In the eastern corn belt, farm feedlots predominate and are generally small in size. In the west and southwest, large commercial feedlots are the norm. Feedlot size may affect cattle prices for at least two reasons. Large feedlots typically have much better market information than small feedlots. Large feedlots may sell cattle every week of the year. They also are more likely to participate in market intelligence systems such as Cattle Fax or the Texas Cattle Feeders information exchange than small feedlots. Because large feedlots have better market information than small feedlots, they are in a stronger bargaining position in negotiating with packer buyers. Sub-competitive prices are less likely.

Figure 3. Geographic Boundaries of 14 Regional Fed Cattle Markets.



In addition, packer procurement costs are lower when buying from large feedlots. These procurement cost differences may be reflected in higher prices in regions with large feedlots. Both of the above suggest a positive relationship between feedlot size and cattle prices.

This variable was measured by the percent of fed cattle in each region that came from feedlots of 1,000 head or more capacity. Fed cattle marketings by feedlot size are provided for the major cattle producing states by the U.S. Department of Agriculture (1981). Where regions included more than one state, the feedlot size percentage figures for each state were weighted by the proportion of fed cattle marketed in the region that came from each state. In most cases, regions were either at one extreme or the other. Farm feedlot regions generally had only 10 percent or so of fed cattle from feedlots of 1,000 head or more capacity, whereas commercial feedlot regions generally had 85 percent or more. (See Appendix for feedlot size values).

Plant size, distribution costs and employee costs are variables used to indicate packer costs. They affect the shape and level of the derived marginal revenue product curve. Across regions or over time, changes in each of these costs would result in shifts in the derived demand curve.

Plant Size: Large plants may enjoy two cost advantages over small plants. First, they are more likely to include state-of-the-arts technology. Second, they are more likely to capture available plant economies of scale. Although precise estimates of minimum efficient size (MES) plants are not available, most industry sources estimate that economies are fully realized by plants slaughtering 250,000 to 500,000 head per year.

The presence of "new generation" plants in different regions varies greatly. In some regional markets, there are no plants that slaughter 250,000 head per year; in other regions, there may be several plants of this size. Since large efficient plants generally have lower costs per head slaughtered, they can pay a higher price for cattle, if necessary, than smaller plants. The derived demand curve of efficient plants is shifted to the right vis a vis less efficient plants. However, the effect of large plants on cattle prices depends upon the extent to which there is effective competition between large plants in the buying of cattle. For example, a single large plant in a region with many small plants may find that it can maximize profits by paying the same prices as the smaller plants. Large plants without effective competition from other large plants may also be able to exercise some price leadership in the procurement of cattle. Thus, the hypothesized sign for this variable is ambiguous. With effective competition, we would expect large plants to pay more for cattle. However, if they are price leaders in a region with ineffective competition, cattle prices could be depressed.

Zero-one binary variables were used to indicate the presence of one or more "new generation" plants in a region. The following alternative measures of "new generation" plants were used:

- plants slaughtering more than 250,000 head per year,
- plants slaughtering more than 350,000 head per year.

Distribution Costs: Although plants buy live cattle in a relatively small geographic area, they sell their output in the national market. Wholesale beef is shipped as carcasses or boxed beef to the major consumption areas that are deficit meat markets -- especially the east coast but also to the west coast. Plants located closer to the major

consumption markets have lower shipping costs for their output. Thus, the derived demand curve of these plants should be to the right of plants located at greater distance, all else the same.

The Texas High Plains and Colorado are considered the dividing line for shipments east or west. Studies have consistently identified these as the theoretical continental divide for beef shipments east and west. 10/ If packers in Amarillo and Denver are indifferent between selling to New York or Los Angeles, the carcass price in the latter two cities should reflect the cost difference in transporting dressed beef from the major production areas.

The following distance relationships exist:

LA ← 1090 miles → Amarillo TX ← 1704 miles → New York

LA is 614 miles closer to Amarillo than is New York.

LA ← 1059 miles → Denver CO ← 1771 miles → New York

LA is 712 miles closer to Denver than is New York.

From the Amarillo-Denver dividing line, LA is, on average, 663 miles closer than New York. Therefore the carcass price differential between New York and Los Angeles is expected to approximate the cost of shipping dressed beef 663 miles.

The cost of shipping wholesale beef to major beef markets was estimated using the distance of the region from either New York or Los Angeles (with the 663 mile adjustment). 11/ It assumes that transportation costs are a linear function of miles shipped. We expect the Distance variable to be negatively related to live cattle prices.

Employee Costs: Labor costs per head slaughtered can vary for many reasons. New technology plants generally allow greater output per labor hour. Hourly wages and fringes also varied considerably from plant to

plant during the 1970s. Given the same level of productivity, higher wages result in higher labor costs; derived demand for cattle is shifted to the left. However, if higher wages result in or are the result of more productive employees, wage rates may have no affect (or even a negative effect)on labor cost per unit of output. The theoretically expected relationship is therefore ambiguous.

In the meat packing industry during the 1970s, wage rates were strongly influenced by whether or not a plant was on the union "master contract". Plants on this contract tended to have much higher wage rates. Many of the new breed packers (e.g., IBP and Excel) avoided the "master contract" and enjoyed much lower wages throughout most of the 1970s. This suggests that higher wage rates were not a result of higher productivity, but were the result of union-management bargaining. Under competitive conditions, higher labor costs would result in lower prices that can be paid for cattle. If markets are not competitive, the expected relationship between wages and cattle prices is indeterminate.

Ideally, the wage variable should measure the true contribution of wages in beef slaughtering to the cost of output (carcasses). The wage variable should be such that it takes into account the base wage (common labor rate), fringes and bonuses, the amount of overtime and the length of service of the workers. Unfortunately, wage information of this type was not available.

Labor cost data were estimated using the following alternative approaches:

a. Census wage information for production employees in SIC 2011 (meat products) plants in each state were available for 1971-78. These data included both beef and pork slaughtering plants.[12/]

State level data included the number of production workers (an average of four monthly figures), production worker hours (including actual overtime hours and excluding paid hours for vacations and sick leave), and wages (including bonuses, vacation and sick leave pay and prior to deductions for social security, group insurance, union dues, savings bonds, and withholding taxes).

Since regional markets often included portions of more than one state, state wage data were weighted by the proportion of the region's slaughter accounted for by each state. Two labor cost variables were calculated for each region and each year: average wages per hour, and annual wage per worker. Both variables performed in a similar way in the regression analysis. Only the wages per hour variable is included in the reported results.

b. Data from the United Food and Commercial Workers Union allowed calculation of the percent slaughtered in each region by plants under the union master contract for 1970, 1973, 1976, 1978, and 1981. After the fall 1976 contract negotiation period there was a major break from the union master contract, with essentially only the major old line packers left with the master contract. After 1976, the value for this variable in many regions is zero or involves disclosure problems because so few old line packers are represented. The union information also does not cover the smaller plants after 1976. The variable varies each year not only because labor conditions change but also because of the quantity variation. Because this variable was considered inferior to the Census wage variable, it is only used in the 1971-80 regression runs. Census wage data were not available for 1979 and 1980.

Market Type: Price data were obtained from USDA Market News for about

30 "markets." In some cases, these prices were for terminal markets; in most cases they were prices for direct sales from feedlots to packers. Since prices at terminals tend to be lower than direct sale prices, a dummy variable is used to identify the type of market in each region, with zero for direct sale markets and one for terminal markets.

Supply Surplus/Deficit: The supply surplus (deficit) variable is included in the base model to account for short-run imbalances between supply (cattle) and demand in the regional markets. If there are too few cattle produced in a region to meet the demands of packers, competition for the available supply might be more aggressive than when the available supply exceeds packer demands. In order for cattle to flow from surplus to deficit regions, economic theory indicates that the equilibrium prices in the two regions must differ by the cost of transportation. However, other theoretical scenarios are also plausible given imperfect information and the predominance of direct sales. Packers located in deficit supply regions may send their buyers to feedlots in other regions to purchase cattle. Under these institutional arrangements, a monopsonist (or collusive oligopsonist) in a deficit region could employ price discrimination, paying a low price in his region for part of his needs and then satisfying the rest of his needs from other regions -- possibly at a higher cost (purchase price plus transportation). Regional markets are related to a degree. However, even with perfect information, prices in two adjacent regions can differ by up to the cost of transportation before arbitrage will take place. If monopsony power and price discrimination are assumed, the theoretical effects of cattle surpluses or deficits on price are indeterminant.

The direction of causality of this variable is also not clear. For

example, one can either argue that a cattle surplus in a region results in low prices, or that low prices lead to an outflow of cattle and the appearances of a surplus.

The supply surplus/deficit variable was defined as:

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

where: M = fed cattle marketed from farms in region i in year j

S = head of steers and heifers slaughtered in plants in region i in year j.

A positive value indicates a surplus of cattle and net exports out of the region. A negative value indicates a deficit of cattle and net imports into the region.

Fed cattle marketed in a region was calculated using state and county data from the USDA Statistical Reporting Service. In some cases where only state data were available on fed cattle marketed and the state was partitioned into two or more regions, state fed cattle marketing were allocated to regions using county data on beef cow inventory, cattle on feed or number of cattle and calves. The data series most closely approximating beef animal numbers was used.

The numbers of steers and heifers slaughtered in a region were based upon P&SA data on packing plants. These are the same data that were used to construct the concentration variables. The slaughter capacity of plants in each region would be preferred to the number of heifers and steers slaughtered as a measure of regional demand. However, capacity data are not generally available.

Controlling for Market Dynamics: Fed cattle markets are not necessarily in equilibrium. Disequilibrium is particularly likely when killing capacity in a region is altered by plant closings, plant expansions or

denova entry by a new packer. Changes in plant ownership may also change the competitive balance and behavior in a market.

During disequilibrium, fed cattle prices may not be influenced by monopsony power in the same way that they are in equilibrium. For example, if IBP builds a large new plant in a region, cattle prices may be bid up during the period in which IBP is obtaining a sufficient share of the cattle supply to operate its plant at the desired utilization level. When the supply market has been restructured, prices may return to an equilibrium level that reflects the new market structure.

In order to control for short run market dynamics, a market turbulence variable was developed and included in some models. Market turbulence was measured by the relative change in the market share of each of the top four firms in a region from one year to the next. Relative share instability (RSI)--the measure of market turbulence--was calculated as follows for region i for 1978-79:

$$RSI_i = \sum_{j=1}^{4} \left| \frac{MS_{j78} - MS_{j79}}{MS_{j78}} \right|$$

where MS_{j78} is the market share of the jth ranking firm in 1978, similarly MS_{j79} for 1979. We hypothesize a positive relationship between RSI and live cattle prices since we expect aggressive rivalry between buyers will result in both considerable shifts in the market shares of the leading firms, and bidding up of cattle prices.

Presence of IBP: IBP was the dominant force in beef packing during most of the 1970s and aggressively built its market share during that decade. It had strong established positions in two regions throughout the study period and entered two other regions in the mid 1970s. The presence of IBP is measured by a zero-one binary variable. This variable is

included in several equations to determine whether IBP had an influence on cattle prices that was independent of the presence of large plants. Since there are reasons for expecting both a positive and negative influence from IBP, the hypothesized sign on this variable is ambiguous.

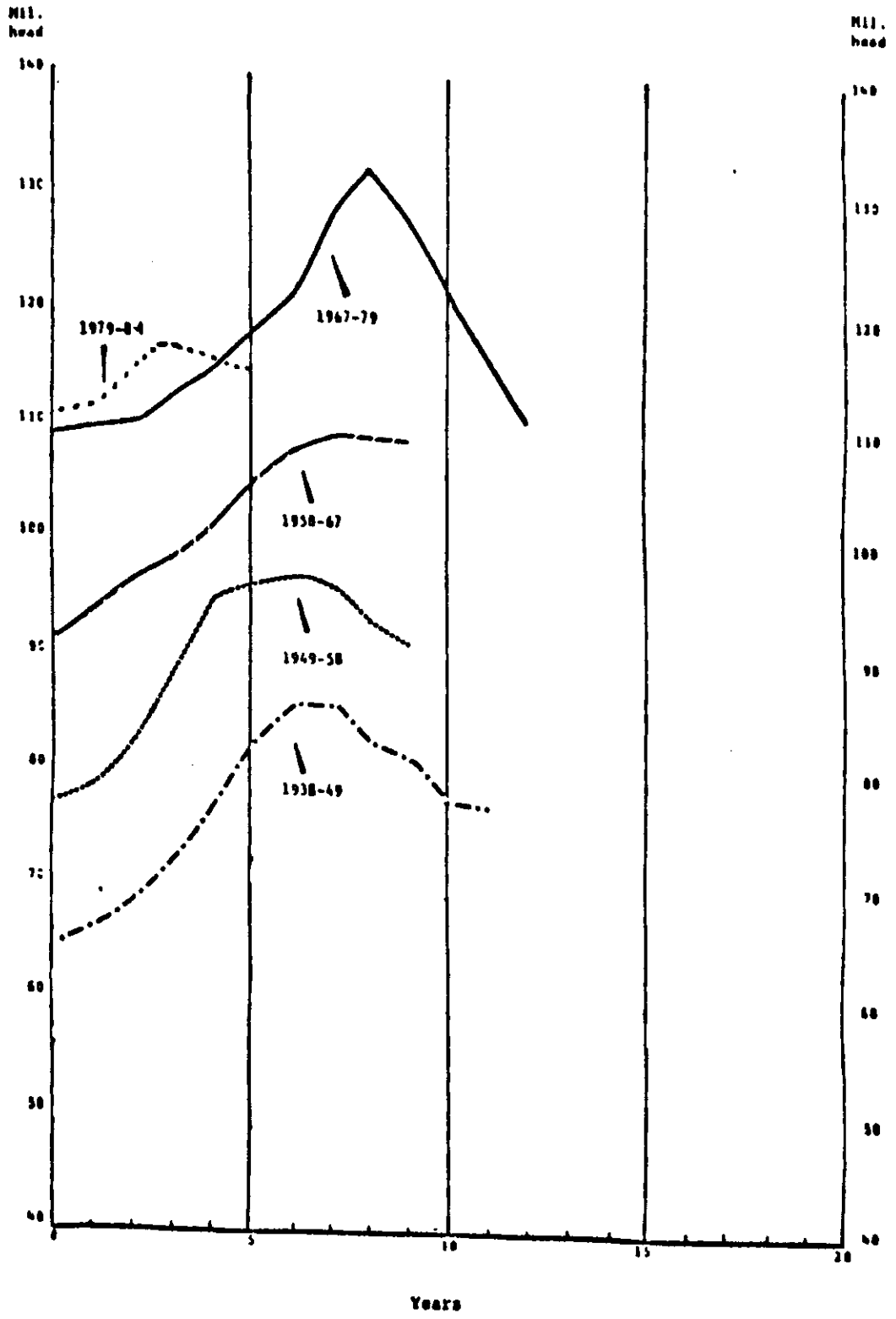
Controlling for Cattle Cycle: Multiple regression analysis was used to examine various sub-sets of the pooled time series-cross sectional data set. For example, when the Census wage variable was included in the model, the data set was limited to 1971-1978. Since our analysis examined fed cattle prices over time, the empirical model was specified to isolate the influence of the cattle cycle.

The supply of cattle follows a cyclical pattern, typically eight to 12 years in duration, which is determined by market prices and the biological nature of cattle production. The cycle begins with a herd building phase. Breeding heifers are withheld from the market and prices begin to rise in response to fewer cattle being marketed. After four to eight years of rising prices, cattle production reaches a stage where increasing numbers of cattle are coming to market. Prices weaken and producers stop herd building, resulting in even more cattle on the market and further price weakness. As prices fall producers liquidate their herds to avoid losses and prices fall further.

The late 1960s and early 1970s were herd building years peaking between 1973 and 1974. There were several shocks to the market in 1973-76, including a period of price controls on retail beef in 1973, and a sharp increase in grain prices during 1974-76. A massive liquidation of breeding herds occurred during 1974-76. A new cycle began in 1979 (see Figure 4).

In order to eliminate the effects of national supply-demand forces

Figure 4. Cattle Inventory Cycles, 1938-1984.



Source: Nelson, 1984

on national prices for wholesale beef and therefore on packer derived demand schedules, two different approaches were used. In some models, zero-one binary variables were used for each year in the data set. It is assumed that these binaries account for variations in the national level of prices received by packers in different years. Shifts in national prices over time may reflect a number of factors including the national demand for beef, shifts in national beef supply and inflation.

The second approach involved including the USDA midwest price for choice steer carcasses, 700-800 pounds, as an independent variable. While the two approaches are conceptually similar, they represent quite different statistical approaches to controlling for variations in national beef prices.

Empirical Model and Results

The empirical model used to explain regional and temporal variations in fed cattle prices was:

$$P_{ij} = \beta_1 CR_{ij} + \beta_2 F_{ij} + \beta_3 S_{ij} + \beta_4 D_{ij} + \beta_5 W_{ij} + \beta_6 M_{ij} + \beta_7 X_{ij} + \beta_8 RSI_{ij} + \beta_9 IBP_{ij} + \sum_{j=1}^{10} \beta_j T_j + e_{ij}$$

Hypotheses: $\beta_1<0$, $\beta_2>0$, $\beta_3\neq0$, $\beta_4<0$, $\beta_5<0$, $\beta_6\neq0$, $\beta_7\neq0$, $\beta_8>0$, $\beta_9\neq0$, and $\beta_j\neq0$

where:

P_{ij} = the annual average price for choice steers weighing 900-1100 pounds in region i in year j.

CR = the three-firm or four-firm concentration ratios or the Herfindahl Index of regional packer concentration.

F = the percentage of fed cattle marketed in a region that came from feedlots of 1,000 head or more capacity.

S = a binary variable equal to one (1) if a region contained one or more plants slaughtering 250,000 head of cattle during the year, otherwise zero (0).

D = the distance from the midpoint of each region to either New York City or Los Angeles.

W = average wages paid by packers in a given region (1971-78 models), or the percent of regional slaughter by plants on the master contract (1971-80 models).

M = a binary variable equal to one (1) if market news prices for the region were for terminal markets, otherwise zero (0).

X = the percentage that a region's slaughter exceeded (deficit) or fell short of (surplus) the number of fed cattle marketed in the region.

RSI = relative share instability of the top four firms in a region from year to year.

IBP = A binary variable equal to one if IBP operated one or more plants in region i in year j, otherwise zero.

T = a set of binary variables, each variable representing a particular year (e.g., 1971, 1972, ... 1980) and equalling one (1) if the price observation was for the particular year, otherwise zero (0).

BMW = The annual average midwest carcass price for U.S. Choice beef. This variable was used in some models instead of the time dummies.

e = residual term.

The data were analyzed using ordinary least squares, or when appropriate, feasible generalized least squares. Prior economic studies using cross-section data have often tested for and found the OLS residuals to be heteroskedastic. In a similar vein, studies using time series data have often found the OLS residuals to be autoregressive. When the disturbances are heteroskedastic or autoregressive, ordinary least squares estimators of the regression coefficients are unbiased but their standard errors are biased. Tests of hypotheses using standard t-tests may no longer give correct results. [See Kmenta, Chapter 8 for a discussion of these properties.] In this study we tested for first order autoregression and heteroskedasticity using the OLS residuals.[13/]

When the residuals were found to be first order autoregressive we corrected using a single-pass of the Cochrane-Orcatt method. Heteroskadasticity was tested for and when found significant (at the 5 percent level) corrected for by assuming that the disturbances with non-constant variances are functionally related to either regional slaughter or regional feedlot size. [See Kmenta, Chapters 8 and 12 for a discussion of methods for correcting for these disturbance properties.] Feasible generalized least squares (FGLS) results are presented when appropriate along with the OLS results in the following tables.

Table 1 presents results for the 1971-78 period only but employs several specifications of the model to test the sensitivity of the results. Equations 1-7 and 10-13 include time dummies and are essentially stacked cross sectional equations in which each year has a different constant. The results are identical to a gross margin model in which steer prices are deducted from wholesale carcass prices and regressed against the same independent variables including the time dummies.

Equations 8 and 9 use the midwest carcass price instead of the time dummies. Although these models are conceptually similar to the time dummy models, we believe they are statistically less desirable since all years are forced to have the same intercept.

The "t" values are sharply lower on most of the variables when wholesale carcass price is used instead of yearly dummies. This is as expected since the time dummies substantially reduce the standard error of estimate for the equations, thereby tending to increase the significance of the remaining independent variables.

Packer concentration is negatively related to fed cattle prices and is statistically significant at the 95% or 99% confidence level in all the models. The Herfindahl Index, which is particularly sensitive to the distribution of leading firm market shares, is more strongly related to cattle prices than the three-firm or four-firm concentration ratios. This suggests that the degree of inequality in the market shares of leading packers has a strong influence on prices. That is, given the same four-firm concentration ratio, those markets in which the top one or two firms have more dominant positions tend to have lower prices for cattle. The three-firm concentration ratio performed somewhat more strongly than the four-firm concentration ratio. This is consistent with the greater significance of the Herfindahl Index.

Three other variables have unambiguous hypothesized signs: Terminal (-), Distance (-), and Feedlot Size (+). Unfortunately, the three are also highly collinear (simple r of .7 or higher for any two). The four regions with terminal prices are the regions closest to the east coast and tend to have small farm feedlots. When the feedlot size variable is not in the equation, the terminal variable is negative and highly significant. When both the terminal and feedlot size variables are included, the coefficient and significance of terminal drops sharply -- although it remains consistently negative and is still significant at the 10% level or higher in many equations. The reverse is true with the distance variable. Although consistently negative, as hypothesized, it is generally not significant when feedlot size is omitted from the equation. With feedlot size in the equation, distance is frequently significant at the 10% or higher level. Feedlot size is consistently positive and statistically significant in nearly all equations. Thus,

terminal markets, distance and feedlot size appear to have the hypothesized influence on fed cattle prices but collinearity makes interpretation difficult.

Plant size is consistently negative and usually significant with a two-tailed test. Although large plants are generally held to be more efficient, apparently this does not lead to higher procurement prices in the regions where they are located (the competitive market hypothesis). Seven of the 13 regions had no large plants during 1971-78. Four of the 13 regions (#5, #8, #9, #10) had one or more large plant in all of these years. An alternative size variable, size 350, was used in some equations with similar results (not shown). Size 250 was chosen because it was less correlated with other independent variables.

The labor cost variable fluctuated in sign (usually positive) and was insignificant in all equations in Table 1. The surplus/deficit variable also varied in sign and was insignificant in all equations. The effects of the labor cost and supply surplus/deficit variables are inconsistent with competitive market hypotheses.

The presence of IBP in regional markets had a significant negative effect on live cattle prices during 1971-78 (eq. 6). Relative share instability, a variable that attempts to measure the degree of short run market rivalry, had an insignificant effect on cattle prices (equation 7) in all equations in which it was included.

The GLS equations (#12 and #13) generally had lower "t" values than the OLS models, particularly for the Herfindahl Index, Distance and Feedlot size. The Herfindahl Index remained significant at the 99% confidence level, however.

Table 1: Regression Results Explaining the Prices of Live Steers in 13 Regional Markets, 1971-78.

Eq.	N	Herf.	CR3 or CR4	Labor Cost	Term.	Dist.	Feedlot Size	Size 250	Surp.	IBP	RSI	Midwest Carcass Price	Time Dummies	Inter.
1	100	-300.7** (4.25)											yes	
2	100	-338.0 (5.70)**		-0.926 (0.12)	-99.0 (6.04)**	-0.018 (0.77)		-52.0 (4.70)**					yes	
3	100	-352.0 (5.88)**		-1.85 (.24)	-14.9 (.66)	-.059 (2.44)**	1.39 (4.56)**						yes	
4	100	-349.7 (6.05)**		.75 (.10)	-50.3 (1.99)*	-.041 (1.68)**	.87 (2.49)**	-34.6 (2.71)**					yes	
5	100	-348.7 (5.05)**		-2.00 (.26)	-13.5 (.51)	-.058 (2.26)*	1.40 (4.39)**		-2.60 (.10)				yes	
6	100	-300.9 (5.08)**		1.62 (.23)	-98.1 (3.18)**	-.041 (1.74)*	.33 (.83)	-27.4 (2.16)*		-45.6 (2.55)*			yes	
7	100	-358.0 (6.09)**		-.59 (.08)	-49.6 (1.96)*	-.044 (1.78)*	.89 (2.52)**	-31.4 (2.34)*			7.79 (.81)		yes	
8	100	-311.8 (2.01)*		2.25 (.18)	-34.4 (.50)	-.057 (.86)	1.16 (1.22)	-19.1 (.55)				.631 (33.41)**	no	108.4 (0.75)
9	100	-478.5 (2.73)**		8.15 (.62)	-36.4 (.65)	-.062 (1.15)	1.36 (1.78)*		103.2 (1.64)			.643 (41.47)**	no	
10[a]	100		-164.1 (5.33)**	.93 (.12)	-49.5 (1.88)*	-.021 (.78)	.72 (1.98)*	-31.2 (2.35)*					yes	
11[b]	100		-155.3 (4.74)**	1.76 (.22)	-48.1 (1.76)*	-.016 (.56)	.69 (1.84)*	-30.2 (2.22)*					yes	
12[c]	85	-354.7 (3.91)**		.94 (0.09)	-64.2 (1.50)+	-.027 (0.61)	.95 (1.54)+	-49.2 (2.31)*					yes	
13[c]	85	-323.1 (3.02)**		.59 (0.05)	-13.6 (0.31)	-.062 (1.35)	1.80 (3.16)**		-8.13 (0.28)				yes	

[a] Includes three-firm concentration ratio (CR_3).

[b] Includes four-firm concentration ratio (CR_4).

[c] GLS models to correct for auto-regressive disturbance. Compare to OLS equation #5 and #7.

Note: One-tailed tests of significance were used for all variables except labor cost, size 250, surplus and IBP. Significance levels are as follows: ** — 99%; * — 95%; + — 90%.

Table 2 presents OLS and GLS regression results for the full 1971-80 period and for various sub-samples. Whereas Table 1 presents results that demonstrate the effects of alternative model specifications, Table 2 focuses more on the sensitivity of results to different time period and regional samples. The first five equation reveal similar findings for 1971-80 as for 1971-78 which is not surprising given the addition of only two years. Equations 6 and 7 split the time period into 1971-75 and 1976-80. Although the coefficient on the Herfindahl Index is somewhat lower for the latter period, this equation is generally more robust than for the earlier period. The distance and feedlot size variables had a substantially stronger influence on cattle prices in the 1976-80 time period.

The eighth equation in this table excludes observations from regions 4, 6 and 12 -- the three small regions with very high levels of concentration. Since it may be difficult to reduce the level of packer concentration in these regions, it is important to determine whether they had a substantial influence on the regression results. The coefficient on the Herfindahl Index, rather than declining, is larger. The wage variable becomes significantly positive and the distance variable becomes positive. The remaining variables perform as in other equations. Thus, while the removal of these three small regions from the data set has some impact on the results, it strengthens our conclusions concerning the negative effects of buyer concentration.

In the ninth equation, the regions with terminal market prices (#6, #7, #12, #13) are dropped from the sample. Only the Herfindahl Index, Distance, Feedlot Size, and IBP are included in this equation along with the time dummies. This removes some of the collinearity problems

Table 2: Regression Results Explaining The Prices of Live Steers Using Different Regional and Time Period Samples.

Eq.	n	Sample	Herf.	CR4	Labor Cost	Term.	Dist.	Feedlot Size	Size 250	IBP	RSI	Time Dummies
1	126	1971-80	-307.2 (5.21)**			-132.9 (7.93)**	-.029 (1.14)		-55.6 (4.80)**			yes
2	126	1971-80	-309.8 (5.25)**		27.1 (1.07)	-130.2 (7.69)**	-0.28 (1.11)		-53.2 (4.52)**			yes
3	126	1971-80	-328.4 (5.77)**			-58.36 (2.11)*	-.063 (2.40)**	1.28 (3.31)**	-29.26 (2.14)*			yes
4	126	1971-80	-265.4 (4.44)**			-148.8 (8.51)**	-.043 (1.69)*		-35.0 (2.46)*	-45.6 (2.68)**	-1.89 (0.19)	yes
5	126	1971-80		-149.8 (4.58)**	-24.6 (0.86)	-52.4 (1.70)*	-.050 (1.68)*	1.28 (2.81)**	-23.5 (1.62)			yes
6	63	1971-75	-367.4 (5.75)**			-30.1 (1.06)	-.024 (0.88)	.53 (1.40)+	-23.0 (1.63)			yes
7	63	1976-80	-300.3 (4.23)**			-62.0 (1.61)+	-.115 (3.14)**	2.46 (4.31)**	-25.0 (1.31)			yes
8[a]	76	1971-78	-437.0 (3.50)**		21.26 (2.07)*	-65.0 (2.95)**	.038 (1.36)		-59.4 (4.13)**			yes
9[b]	86	1971-80	-288.3 (5.03)**				-.082 (3.28)**	1.30 (3.27)**		-43.8 (2.65)**		yes
10[c]	70	1971-80	-576.9 (5.09)**		-31.2 (0.93)		-.026 (1.08)	1.25 (3.41)**	-57.5 (3.60)**			yes
11[c]	56	1971-78	-668.2 (6.35)**		-16.1 (1.18)		-0.20 (.87)	.62 (1.90)*	-53.7 (3.86)**			yes
12[d]	111	1971-80	-283.9 (3.67)**			-56.6 (2.11)*	-.083 (2.19)*	1.63 (4.09)**	-19.8 (1.08)			yes
13[d]	111	1971-80		-101.3 (3.26)**	-41.4 (1.52)	-65.0 (2.28)*	-.088 (2.20)*	1.68 (3.74)**	-20.0 (1.05)			yes
14[d]	63	1971-80	-492.0 (3.04)**		-27.2 (.92)		-.033 (.72)	1.75 (2.59)**	-61.6 (2.15)*			yes
15[e]	49	1971-78	-675.8 (4.82)**		-23.3 (1.44)		-.010 (.29)	.44 (.96)	-70.9 (3.30)**			

[a] Three small and highly concentrated regions are omitted from data set.

[b] Four regions with terminal market prices are omitted from data set.

[c] Four regions with terminal market prices plus regions 4 and 11 are omitted from data set.

[d] GLS model to correct for auto regressive disturbances. Compare to OLS equations #3, #5 and #10 respectively.

[e] GLS model to correct for auto regressive disturbances and heteroskedasticity. Compare to OLS equation #11.

Note: One-tailed tests of significance were used for all variables except labor cost, size 250, and IBP. Significance levels are as follows: ** — 99%; * — 95%; + — 90%.

created by the Terminal and Size 250 variables. The first three variables have the hypothesized sign and are significant at the 99% confidence level. The zero-one binary for IBP is negative and significant at the 99% level as in Eq. #4. The presence of IBP in a region is estimated to depress regional cattle prices by 44 cents per hundred weight based upon these results.

Equations 10 and 11 use a sample that excludes the terminal market regions and regions 4 and 11. This removes the three small regions plus the terminal market regions. Region 11 is omitted because usable prices were available for only four years during 1971-78 and six years during 1971-80. In the GLS models, even fewer observations were available for region 11 (one and two respectively) because of the correction procedure. The remaining sample used in equations 10 and 11 includes the three west coast markets (#1, #2 and #3) plus four regions in the major producing areas (#5, #8, #9 and #10).

The coefficients on the Herfindahl Index in equations 10 and 11 are nearly double those with the full sample of 13 regions. The feedlot size and size 250 variables are significantly positive and negative, respectively, as in other equations. The labor cost and distance variables remain insignificant. These results suggest that the level of buyer concentration has an even more important effect on live cattle prices in the major producing regions than in the fringe regions.

Equations 12-15 are GLS results which correct for autoregressive disturbances and heteroskedasticity, where they occur (compare to OLS models 3, 5, 10 and 11). The major changes in the GLS models are in the "t" values for the different variables. Since the "t" values in these equations are unbiased, they are preferred over the OLS results for

hypothesis testing. The results of equations 12 and 13 are generally consistent with our hypotheses. Packer concentration, terminal distance and feedlot size are all significant at the 95% level with the hypothesized signs. Size 250 becomes insignificant. Labor costs are negatively related to cattle prices but still insignificant using a two-tail test.

In GLS equations 14 and 15 (sample of 7 regions), the distance variable is insignificant and size 250 becomes significant. The other variables perform similarly to the equations using the full samples. Theoretically and statistically, equations 12 and 13 are preferred over the other equations and will be used shortly to estimate the aggregate effects of monopsony power in cattle procurement.

The coefficients for the year binary variables are not included in Tables 1 and 2 since they are very similar from one equation to another. The range in values for these variables (in cents per cwt.) for the equations 1-5 in Table 2 are listed below. The low coefficients are from equation 3, the high from equation 4.

T_{1971} -- 3297-3383	T_{1976} -- 4003-4096
T_{1972} -- 3622-3709	T_{1977} -- 4110-4207
T_{1973} -- 4528-4615	T_{1978} -- 5294-5389
T_{1974} -- 4293-4380	T_{1979} -- 6882-6979
T_{1975} -- 4526-4618	T_{1980} -- 6848-6944

These coefficients indicate that when the other variables in the equation are held constant, prices in 1971 were approximately $12 per cwt. less than prices in 1975; similarly, prices in 1979 and 1980 were about $24 per cwt. higher than in 1975.

This empirical study rejects the null hypothesis of no relationship

between buyer concentration and cattle prices. The results are consistent with the alternative hypothesis that buyer power, as measured by concentration, depressed fed cattle prices in certain regions during the 1970s. The estimated effects of buyer concentration on cattle prices are indicated in Table 3. The middle year, 1975, was arbitrarily selected for illustration purposes. For every 10 percentage point increase in four-firm concentration, fed cattle prices are estimated to drop 10 cents per hundredweight, all else held constant (Table 2, equation 13). Four-firm concentration ranged from about 25 to 95 in the regions studied. Our results indicate that when other factors are held constant, a variation of about 70¢ per hundred-weight in prices paid was attributable to the variations in CR4.

The range in the Herfindahl Index is also shown in Table 3 along with the predicted prices for 1975 when all other variables were held constant. For every .05 increase in the Herfindahl Index, fed cattle prices are predicted to fall by 14 cents per cwt. (Table 2, equation 12). A variation of one dollar per hundred-weight in prices paid is attributable to variations in the Herfindahl Index.

The predicted effects of CR4 and the Herfindahl Index vary some, depending upon the model selected from Table 1 or Table 2. For example, the effect of a .05 change in Herfindahl Index ranged from 14 to 34 cents. The model selected for illustrative purposes had the lowest coefficient on the Herfindahl Index.

Because of the method of analysis (pooled time series cross sectional), the predicted effects of <u>changes</u> in concentration for a given equation are the same for all years. For example, predicted prices for 1978 for different levels of the Herfindahl Index are roughly $8.00

higher than the prices shown in Table 3 (e.g., $52.27 for a Herfindahl of .05 and $51.27 for a Herfindahl of .40).

In 1980, 8 of the 13 regions studied had four-firm concentration ratios over 65%; three had concentration ratios that exceeded 90%. There were four markets, by comparison, that had concentration ratios below 45%. Concentration increased during the 1970s. The distribution of regions by level of concentration in 1971 and 1980 are compared in Table 4.

The effects of the increases in concentration from 1971 to 1980 can be estimated. Weighted average four-firm concentration ratios were calculated for each year by weighting the regional CR4 by the number of cattle slaughtered. In 1971, the weighted average regional CR4 was .48; 23.8 million head of fed cattle were slaughtered in the 13 regions. In 1980, the weighted average regional CR4 was .67 with slaughter volume about the same as in 1971. Based upon our regression results, the increase in CR4 of .19 between 1971 and 1980 reduced cattle prices by roughly 19¢ per hundredweight. Assuming an average live weight of 1000 pounds per head slaughtered, there were 237,940,000 hundredweight of cattle purchased and slaughtered in the 13 regions in 1980. If prices were depressed .19/cwt because of increases in concentration during the decade, the estimated loss to feedlot operators in 1980 for this reason alone was $45.2 million. When the same calculation is done using the Herfindahl Index, the increase in the Herfindahl from .098 in 1971 to .171 in 1980 results in an estimated 1980 loss of $50 million.

Regional concentration levels may be influenced by the minimum efficient size (MES) plant. For example, if MES is 250,000 head per year, a region with a total slaughter of 1 million head could only

Table 3. Predicted Prices at Different Levels of Packer Concentration, 1975.[1]

Four-Firm Concentration CR4	Predicted Price[a] (dollars/cwt)	Herfindahl Index	Predicted Price[b] (dollars/cwt)
.25	44.50	.05	44.57
.35	44.40	.10	44.43
.45	44.30	.15	44.28
.55	44.20	.20	44.15
.65	44.10	.25	44.00
.75	44.00	.30	43.86
.85	43.90	.35	43.72
.95	43.80	.40	43.57

[a] Calculated using model #13, Table 2, for non-terminal markets.
[b] Calculated using model #12, Table 2, for non-terminal markets.

Table 4. Distribution of Regional Markets by Level of Packer Concentration, 1971 and 1980.

Four-firm Concentration	Number of Regions	
	1971	1980
Less than 45 ----------	5	4
45 to 54.9 ----------	2	1
55 to 64.9 ----------	3	0
65 to 74.9 ----------	1	3
75 to 89.9 ----------	1	2
over 90 ----------	1	3

accommodate four efficient size plants. In 1980, six of the 13 regions in this study slaughtered less than 1 million head of steers and heifers. Only two regions (#8 and #10) slaughtered over 2.5 million head in 1980 -- providing room for at least 10 MES plants.

The above suggests a possible conflict between the structure of markets needed to achieve operational efficiency (low costs per head slaughtered) and effective competition. One way to examine this is to construct hypothetical four-firm concentration ratios for each region in which each firm is assumed to operate one plant that slaughters 250,000 head per year. For example, if there is room for eight plants of this size in a region, the hypothetical CR4 would be 50.

Table 5 presents the results of this analysis using the average annual slaughter figures for each region for 1976-1980. Hypothetical CR4 values can be compared to the simple average of the actual CR4 in each region over this five year period. In nine of the 13 regions, average CR4 was less than the hypothetical. The four regions in which actual CR4 exceeded the hypothetical were the four largest volume regions (#5, 8, 9 and 10).

These data reveal an interesting pattern. The regions with the lowest actual CR4 levels during 1976-80 tended to be regions with moderate slaughter volumes (#3, 11 and 13). These regions had markedly lower levels of concentration than the hypothetical figures. Based upon our regression results, they also tended to be regions in which, when other factors were held constant, significantly higher prices were paid for fed cattle than in the more concentrated regions. For moderate size markets, any losses in operational efficiency due to sub-optimal size plants appears to be offset by the increase in allocative efficiency

Table 5. A Comparison of Hypothetical and Actual Packer Four-Firm Concentration Ratios, 13 Regional Markets.

Region	Average Annual Slaughter, 1976-80 (000)	Hypothetical CR4	Average CR4 1976-80
1	1063	.94	.69
2	628	1.00	.51
3	1486	.67	.34
4	333	1.00	.95
5	2445	.41	.64
6	392	1.00	.86
7	1671	.60	.48
8	8043	.12	.55
9	1845	.54	.85
10	4946	.20	.71
11	1097	.91	.36
12	223	1.00	.63
13	1084	.92	.30
	25,256		.59

resulting from more competitively structured markets.

The three largest volume regions (#5, 8 and 10) tend to be neither the highest nor the lowest in CR4. In general, actual concentration levels are higher than those dictated by MES of plants (the hypothetical CR4). In these regions, it appears that lower levels of concentration would likely lead to higher cattle prices with little if any sacrifice in operational efficiency.

The three small volume regions (#4, 6 and 12) tend to have both high actual and hypothetical levels of concentration. These regions present the most difficult public policy dilemma since there appears to be a clear conflict between operational efficiency and effective competition. For example, for region 6 to have had a CR4 of 50 during 1976-80, each of the top four companies could have slaughtered only 49,000 head per year. Average CR4 in this region was 86 during this five year period. The average slaughter per year for the top four firms

was 84,280 head. Thus, this region appears to have both suboptimal size plants and high market concentration.

Policy Implications

These results carry implications for public policies at both the regional and national level. Several of the larger volume regions are more concentrated than necessary to achieve plant economies of scale. In regions #5, 8, 9 and 10, public policies aimed at reducing the levels of concentration appear to be appropriate. Mergers between the leading firms or that eliminate primary potential entrants should probably be challenged. Because these four regions accounted for two-thirds of the cattle slaughtered in the 13 regions during 1976-80, competitive conditions can have an important influence on returns received by U.S. cattle feeders. For example, if the four-firm concentration ratio in these regions had been .40 during 1976-80 instead of the average CR4 shown in Table 5, average price would have been roughly 24¢ per cwt higher and annual returns to feeders in these four regions would have been nearly $42 million greater, based upon our regression estimates. This is a conservative estimate since it uses the CR4 model for all regions rather than the Herfindahl model for the major producing regions (Eq. #14, Table 2). If equation #14 is used, this estimate nearly doubles to an increase of 47¢ per cwt.

In the smallest regions (#4, #6 and #12), a different approach is called for. These regions have both sub-optimal size plants and high levels of concentration. Public policies that broaden the geographic scope of markets may be the main hope for improving competition in these regions. For example, most forms of electronic marketing broaden the geographic scope of markets and reduce the level of buyer concentration.

Telephone auctions for lambs have substantially broadened lamb markets and increased the returns to growers. There may be similar opportunities to improve the returns to cattle feeders in low volume parts of the country.

In the remaining six moderate volume regions, concentration is low in four of these regions. Although plant size may be sub-optimal, competition appears to be effective. On balance, cattle feeders are apparently well served by the existing structure. Of the remaining two regions (#1 and #2), region 2 is relatively unconcentrated given its small volume. Region 1 probably warrants concern since four-firm concentration has risen sharply since 1976 and was 84% in 1980. The entrance of IBP with two plants in 1977 appears to have had a strong concentrating effect. Thus, this region might also benefit from public policy actions to broaden markets or to encourage deconcentration. Clearly different public policies are warranted for different regions.

The results of this study contribute to the growing body of empirical evidence concerning concentration-price relationships. Approximately 30 studies have examined concentration-price relationships across different geographic markets of the same industry. A remarkable consistency is emerging: market concentration <u>is</u> positively and significantly related to prices. For the industries studied, these findings are inconsistent with either market contestability or the superior efficiency view of industrial organization, and are consistent with the more traditional interpretation that market concentration is a useful (albeit not perfect) measure of buyer or seller market power.

FOOTNOTES

1/ Three subregions within the High Plains were also examined. Cattle movements between the subregions were found to be substantial.

2/ "Price independence is used herein to mean that over some range of price change in one market, other appropriate things the same, there is no parallel price change in the other" (USDA, 1982a, p. 29).

3/ For an interesting analysis of the extent to which weekly steer prices in the Denver and Omaha markets moved in parallel fashion during 1955-1968, see Tomek (1980).

4/ Another paper we reviewed was an unpublished study by McFall Lamm, "Competition in the Domestic Cattle Industry." In this study Lamm attempted to test the hypothesis that packer price-cost margins were positively related to buyer concentration. While his results provided no evidence of monopsony power, the model(s) was poorly specified with inappropriate market definitions among other problems. The problems with the study were probably sufficiently obvious to all reviewers so that the study was not published. As a result we have elected not to provide a critique of the study.

5/ See Scherer (1980) chapter 10 for a review of the various studies of buyer power.

6/ L.A. Guth, R.A. Schwartz and D.K. Whitcomb reworked Lustgarten's study and did not find support for Lustgarten's conclusions. Scherer has reported that the Guth et al study was fatally flawed due to index construction and sample selection (Scherer, op. cit., p. 311, fn. 47).

7/ For the greatly renewed interest in entry barriers, see the recent literature on contestable markets, especially Baumol, Panzer and Willig; Baumol (1982); and Shepherd (1984).

8/ USDA Packers and Stockyards Administration (P&SA) data were used to calculate packer market shares in each region and year. These are confidential data that are not generally available. The concentration ratios for 1971 through 1977 were calculated by Dr. Willard Williams and checked by Dr. John Helmuth, Chief Economist of the House Small Business Committee. Concentration ratios for 1978-1980 and the Herfindahl Indices for 1971-1980 were calculated by Dr. Helmuth.

9/ The Herfindahl-Hirschman Index (HHI) is calculated by summing the squared market shares of firms in a market. Although it is preferred to concentration ratios on theoretical grounds, empirical analyses generally have found that the two measures are highly correlated and perform similarly in regression analyses. The Department of Justice uses the HHI in their current merger guide-

lines (June 1984). The HHI is also used extensively by the Federal Trade Commission in evaluating horizontal mergers.

10/ Actual shipment data from production centers to demand points is not readily available. However, several theoretical models have been proposed for the livestock-beef industry. Each addresses itself to the direction of product flow from plants to demand centers. Colorado is consistently the dividing point for shipments east and west. The spatial models of Judge, Havlicek and Rizek from the early 1960s indicate that the optimum shipment patterns for beef carcasses were for states east of the Rockies to ship east and western states to ship west. North Dakota could ship both east and west but with the majority of shipments going east. Colorado appears as the center of the shipping pattern under all conditions of the models. Analysis indicates that Colorado could ship to all regions of the country usually with slightly more than 50% going to the east and and southeast. Optimum product flow from Texas was to the east and southeast.

In the late 1960s Dietrich and Williams used a multidimensional transshipment model to determine least cost shipments for dressed beef for 1968. Colorado was the dividing line with shipments going west from Colorado but east from Kansas. In these models West Texas shipped both to the west and southeast.

A recent study (Faminow and Sarhan 1984) modelled optimum location of fed cattle slaughtering and processing plants. Product flows to demand regions are predicted under various conditions of the model but the reported results indicate both Colorado and West Texas as the dividing line with these localities shipping both east and west.

11/ A transportation cost variable (TRANS) was also developed drawing on Faminow and Sarhan (1984). Faminow and Sarhan (1984) developed a transportation cost function for shipment of beef from plants to demand points. They based their series on transportation rate data provided by two commercial trucking companies. The load-mile rate is generally a decreasing function of distance. A 40,000 pound load is currently typical in the industry. Using ordinary least squares, Faminow and Sarhan estimated the following transportation cost function for beef shipments:

$$COST = -24.6935 + 1.5772D - 0.00021D^2 + 21964.937/D$$

where D = miles beef is shipped

The TRANS variable was constructed using the same distances calculated for the Distance variable. For this reason, the two variables were very highly correlated and gave essentially identical results.

12/ The inclusion of pork slaughtering has the following disadvantages:

a) Some areas of the country slaughter almost no pork; so in Texas, 2011 data will reflect beef slaughtering plants, while in Iowa the data will be a combination of beef and pork slaughtering operations.

b) The history of unionization is different in beef and pork. A much higher proportion of pork plants were unionized and

covered by the United Food and Commercial Workers master contract throughout the data period. In beef there was a marked movement away from the master contract after the 1976 contract renewal period. Therefore, it is expected that states slaughtering both beef and pork will have higher wages than those where beef slaughter predominates.

13/ In addition, some researchers have not only assumed heteroskedasticity and autoregressive disturbances but also contemporaneous correlation among the disturbances among cross-sections. We believe that inclusion of the time dummies corrects for correlated disturbances among regions if it exists. [See Kmenta, Chapter 12.]

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APPENDIX A

DEFINITION OF REGIONS

from W.F. Williams

Region 1

All of Washington, Oregon, and Idaho and that portion of Montana west of the Continental Divide. In Montana, Great Falls (in 1) and Highway 89 north of Great Falls splits the northern half into Region 1 and Region 6. Interstate 15 south of Great Falls divides the southern half. Butte and Dillon are classified as Region 1.

Region 2

Northern California and Reno, Nevada. The following locations are classed as Region 2: Hanaford, Los Banos, Saticoy, Selma, Soledad, Tulare, Union City and Watsonville.

Region 3

Southern California and Arizona. The principal point between Regions 2 and 3 is Tulare, California. Paso Robles is classed as Region 3.

Region 4

New Mexico and Southwest Texas (El Paso). Southwest Texas is defined as west of a line extending the North-South Texas-New Mexico border south to Mexico. Region 4 excludes 3 border counties of New Mexico; Curry County (Clovis), Quay County and Union County which are all in Region 10.

Region 5

All of Colorado, western Nebraska and the southeastern corner of Wyoming. Wyoming includes the counties of Laramie, Albany, Platte,

and Gosken but most of the feeding is near Torrington. Nebraska is divided, essentially, by Highway 183. Lexington is in Region 8.

Region 6

North and South Dakota and Montana east of the Continental Divide. The division of Montana is described in Region 1.

Region 7

Wisconsin, most of Minnesota, and northern Illinois. Minnesota loses the most southern tier of counties to Region 8. Illinois is divided into north and south by Springfield and Decatur (both in 12). West of Springfield the division follows Highway 125 to Highway 24 and then west to Quincy. East and West of Decatur the line is Highway 26.

Region 8

Iowa, eastern Nebraska (east of the line defined in 5), southern Minnesota as defined in 7 (one tier of counties), and Rockport, Missouri. MBPXL has a plant at Rockport.

Region 9

Kansas (excluding the SW corner), the western half of Missouri, and a northern slice of Oklahoma. In Oklahoma the dividing line extends from the SE corner of the Oklahoma panhandle eastward to the three state convergence point of Oklahoma, Missouri, and Arkansas (an eastward extension of the southern border of the panhandle). This takes us through about Billings on Interstate 35. From the SE corner of the Oklahoma panhandle it extends northward along the Beaver-Harper county line to Kansas. It then moves eastward along the Oklahoma-Kansas line to Highway183. In Missouri, the division between Regions 9 and 12 is Highway 65 all

the way from Arkansas to Iowa. Springfield, Marshall and Sedlia are classified as Region 9. In Kansas, USDA Crop Reporting District 3 is excluded and classed as Region 10.

Region 10

The southwestern corner of Kansas (Crop Reporting District 3), the Oklahoma panhandle, the Texas panhandle, and 3 counties (Curry, Quay and Union) in New Mexico. The Texas "panhandle" includes Crop Reporting Districts 1-N and 1-S (Andrews, Midland, and Glasscock from the southern edge of 1-S) plus counties in 2-N west of and including Childress, Cottle and King and in 2-S west of and including Stonewall, Fisher and Nolan.

Region 11

The remainder of Texas (excluding those parts in Regions 4 and 10) and Oklahoma (south of the line defined in Region 9).

Region 12

Eastern Missouri and southern Illinois, borders defined in Regions 7 and 9.

Region 13

This region consists of Indiana, Michigan and Ohio.

Region 14

Nevada (excluding Reno), Utah and the remainder of Wyoming.

DETAILS OF REGIONAL PRICE CONSTRUCTION

In some regions there is price information from more than one location. Where this occurs a volume weighted average price was constructed. Volume information for direct sales was supplied by Market News offices around the country from form LS11. This is the number of confirmed sales of steers and heifers in the price reporting district not just choice 900-1100 lb. steers. However, this was considered adequate to weight the relative importance of two or three direct markets in a region.

The volume information for terminal markets was Annual Saleable Receipts at Public Stockyards (USDA Statistical Bulletin 522, Livestock and Meat Statistics, and supplements). This is the number of all cattle sold but was the best volume data available and considered adequate to weight the contribution of 2 or 3 terminal markets in a region.

Region 1

There were two direct price series for this region, Washington-Oregon and Idaho-Utah-East Nevada. There were two changes during 1971-80, Oregon was added to Washington in 1977 and Idaho was split off from Utah-Nevada and added to Washington-Oregon in 1980.

A weighted average price was constructed using volume information supplied by Market News regional offices. See table. (Note the combined volume of reported sales is considerably less in 1980.)

Region 2

There were two direct price series for northern California, Stockton and Visalia which included Western Nevada from 1977 on. These prices were weighted by total numbers of steers and heifers sold (LS11 information). See table for data.

Region 3

Three direct price series were available; Phoenix, AZ; El Centro, CA; Los Angeles, CA. Los Angeles declined in importance during 1975 and from 1975 to 1978 there were several months during which no trades were reported. See table for data.

Region 1

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
PRICE										
ID-UT-NV	3230	3566	4506	4314	4452	3957	4068	5230	6757	6768
Washington	3272	3608	4530	4335	4563	4088	4132	5311	6849	6916
VOLUME										
ID-UT-NV										
steers	208057	198555	184140	149200	179335	191525	245626	174024	164430	36451
heifers	62377	122405	56775	50350	53205	60770	83855	58610	59910	17025
Total	270434	320960	240915	199550	232540	252295	329481	232634	224340	53476
Washington										
steers	87706	66760	80780	64790	45440	34890	52135	56995	62005	89000
heifers	24450	23615	21465	13845	12760	20405	19705	26205	10900	32130
Total	112156	90375	102245	78635	58200	55295	71840	83200	72905	121130
Regional										
Total	382590	411335	343160	278185	290740	307590	401321	315834	297245	174606
RATIO										
ID-UT-NV	.707	.780	.702	.717	.800	.820	.821	.737	.755	.306
Washington	.293	.220	.298	.283	.200	.180	.179	.263	.245	.694
WEIGHTED AVERAGE PRICE	3242	3575	4513	4320	4474	4020	4079	5251	6780	6871

Region 2

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
PRICE										
Stockton	3310	3615	4540	4371	4572	4064	4200	5341	6930	6915
Visalia	3302	3612	4531	4389	4554	4072	4210	5370	6966	6967
VOLUME (LS11)										
Stockton	85955	123345	103896	73178	76320	86652	128816	117157	112112	68910
Visalia	290900	222980	201500	171740	216700	-	192125	176560	148210	-
Total	376855	346325	305396	244918	293020	-	320941	293717	260322	-
VOLUME RATIO										
Stockton	.2281	.3562	.3402	.2988	.2605	.375*	.4013	.3989	.4307	.41*
Visalia	.7719	.6438	.6598	.7012	.7395	.675*	.5986	.6011	.5693	.59*
WEIGHTED AVERAGE PRICE	3304	3613	4534	4384	4559	4069	4206	5358	6950	6946

* Estimate

Region 3

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
PRICE										
Phoenix	3244	3545	4422	4274	4479	4083	4178	5363	7016	7018
El Centro	3259	3565	4461	4326	4572	4076	4198	5371	7022	7034
Los Angeles	3276	3593	4504	4370	4286	4080	4118	5293	closed	
VOLUME										
Phoenix										
Steers	524500	513700	588025	582428	412050	451247	435243	382951	422100	349621
Heifers	24630	16535	12260	11675	20625	25895	15105	13370	11220	9040
Total	549130	530235	600285	594103	432675	477142	450348	396321	433320	358661
El Centro										
Steers	442118	473685	499550	505555	364065	468065	449700	406505	424500	339875
Heifers	8835	7445	7954	10175	10700	10445	4145	9835	8035	13080
Total	450503	481130	507504	515730	374765	478510	453845	416340	432535	352955
Los Angeles										
Steers			61460	65268	32062	35369	28353	17091		
Heifers			3874	2372	6753	6148	9239	5605		
Total			65334	67640	38815	41517	37592	22696		
Regional										
Total	99963	1011365	1173123	1177473	846255	997169	941785	835357	865855	711616
RATIO										
Phoenix	.5493	.5243	.5117	.5046	.5113	.4785	.4782	.4744	.5005	.5040
El Centro	.4507	.4757	.4326	.4380	.4429	.4799	.4819	.4984	.4995	.4960
Los Angeles	0		.0557	.0575	.0459	.0416	.0399	.0272		
WEIGHTED AVERAGE PRICE	3251	3555	4443	4302	4511	4020	4185	5365	7019	7026

Region 4

There was only one price available, Clovis, NM. Clovis was actually located in Region 10, however discussions with Market News reporters indicated that most regions in New Mexico price off Clovis.

Region 5

Two direct prices were available, Greeley CO and Torrington, WY. They were weighted by LS11 volume information.

Region 6

Including the Dakotas and most of Montana, this is a geographically diverse area which posed several data problems. South Dakota grows mostly grain fed cattle while in North Dakota and Montana there is more grass feeding. There are several auction locations in Montana and North Dakota but all are small. Sioux Falls, SD and West Fargo, ND are both terminal markets while Billings, MT is an auction market. Sioux Falls and West Fargo prices were averaged. Using these border prices to represent the whole area is questionable, but the best available.

The Billings price series is for a very thin market, sometimes the yearly average was calculated from only one or two months trades. After 1978 there were no trades of choice animals recorded.

Region 5

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
PRICE										
Greeley	3259	3578	4481	4256	4581	3938	4062	5266	6809	6736
Torrington	3218	3550	4416	4181	4495	3881	4012	5168	6722	6672
VOLUME										
Greeley										
Steers	Not Available					278102	322797	314495	340295	249596
Heifers	Total is average of 1976-80					416511	462549	513440	395202	280217
Total	715241	715241	715241	715241	715241	694613	785346	827935	735497	529813
Torrington										
Steers	224165	225680	203305	193940	227745	171100	203850	193725	203725	206385
Heifers	120400	141855	126085	118770	158175	175500	161300	209875	173500	173625
Total	344205	367535	329390	312710	385920	346600	365150	403600	377225	380010
Regional Total	1059806	1082776	1044631	1027952	1101161	1041213	1150496	1231535	1112722	909823
RATIO										
Greeley	.675	.661	.675	.683	.636	.667	.683	.672	.662	.582
Torrington	.325	.339	.328	.317	.364	.333	.317	.328	.338	.418
WEIGHTED AVERAGE PRICE	3246	3569	4473	4232	4510	3907	4046	5234	6780	6709

Region 6

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
PRICE										
West Fargo	3115	3453	4291	3968	4257	3693	3814	5021	6520	6417
Sioux Falls	3171	3527	4385	4109	4413	3854	3976	5136	6689	6609
Billings	3020	3388	4856	3955	3888	3613	3861	5588	no trades	
VOLUME			Saleable receipts at public stockyards - all cattle							
West Fargo	321	324	316	309	416	433	376	323	264	289
Sioux Falls	398	371	462	579	711	694	579	541	473	500
Billings	260	284	310	320	362	311	338	248	243	272
RATIO										
West Fargo	.446	.446	.406	.348	.369	.384	.397	.374	.358	.366
Sioux Falls	.553	.533	.594	.652	.631	.616	.612	.626	.642	.634
WEIGHTED AVERAGE PRICE (West Fargo & Sioux Falls)	3146	3492	4346	4060	4357	3793	3916	5093	6628	6539

Region 7

This is an older region characterized by smaller plants and terminal markets near larger cities. The Chicago terminal closed in 1971 and was replaced by a modern facility at Joliet, IL. The regional average price was constructed from terminal prices weighted by the saleable receipts of all cattle at Joliet, IL, Peoria, IL and South St. Paul, MN. There was no compatible price series from the Milwaukee, WI terminal.

Region 8

Two direct price series were available, Iowa and Eastern Nebraska. They were weighted by LS11 volume information.

Region 9

The direct price series for Eastern Kansas reported from Wichita, KS was used. See table p.52 for this and all other regional prices.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Wichita	3158	2492	4354	4086	4373	3811	3998	4121	6742	6741

Region 10

Three direct prices were weighted by LS11 volume steers and heifers. The locations are Dodge City, KS, Clovis, NM, and Amarillo, TX.

Region 7

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
PRICE										
Joliet	-	3627	4550	4251	4434	3932	3989	5198	6745	6697
Peoria	3236	3604	4515	4214	4474	3878	4004	5223	6749	6688
St. Paul	3216	3549	4430	4177	4400	3827	3928	5147	6660	6554
VOLUME		Saleable receipts at public stockyards - all cattle								
Joliet	-	400	372	453	474	486	406	335	240	214
Peoria	151	269	243	249	273	326	289	275	248	181
St. Paul	817	829	805	931	1146	1096	837	839	645	661
RATIO										
Joliet	-	.2670	.2620	.2774	.2504	.2559	.2650	.2312	.2116	.2027
Peoria	.1560	.1796	.1711	.1525	.1442	.1706	.1886	.1900	.2187	.1714
St. Paul	.8440	.5534	.5670	.5701	.6054	.5735	.5463	.5790	.5688	.6260
WEIGHTED AVERAGE PRICE	3219	3580	4476	4203	4419	3863	3958	5174	6691	6607

Region 8 - Direct prices for Iowa and Eastern Nebraska were weighted by LS11 (Omaha - LS182) volume data.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
PRICE										
Iowa	3202	3552	4409	4133	4435	3866	3992	5184	6770	6728
E. Neb.	3252	3588	4467	4232	4435	3921	4020	5229	6795	6705
VOLUME										
Iowa	3171500	3441000	2696300	2128000	1817000	1472900	1336100	1448400	1538000	1919200
E. Neb.	1180449	1283184	1138751	980265	808412	993322	1124792	1245123	1119050	1118817
RATIO										
Iowa	.7288	.7284	.7034	.6846	.6937	.5972	.5429	.5377*	.5788	.6317
E. Neb.	.2712	.2716	.2966	.3154	.3063	.4028	.4571	.4623*	.4212	.3683
WEIGHTED AVERAGE PRICE	3216	3562	4426	4164	4435	3888	4005	5205	6781	6720

*Average 1976 & 1977.

Region 10

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
PRICE										
Dodge City	3242	3551	4443	4207	4478	3913	4041	5220	6848	6746
Clovis	3188	3491	4404	4191	4489	3997	4074	5224	6865	6824
Amarillo	3223	3536	4432	4230	4532	3956	4083	5251	6878	6850
VOLUME (LS11)										
Dodge City	829350	1049474	1032513	1063859	1215722	1651769	1904193	2084008	1821167	1630297
Clovis	170050	187750	202350	203625	231550	249150	219300	219750	227100	244850
Amarillo	2068660	2402250	2520900	2225100	1692200	2393900	2888100	3015600	2801200	2760100
WEIGHTED AVERAGE PRICE	3226	3538	4434	4221	4508	3942	4067	5238	6866	6811

Region 11

Price information for Texas and Oklahoma (other than the high plains) was very inconsistent. This is not a major fed cattle area. The San Antonio TX direct price series was used. Some yearly averages are calculated from only one reported monthly average. Two years, 1973 and 1976 reported no trades; 1978 data was from only one month and consistently produced outliers. The years 1973, 1975, 1976, and 1978 were all dropped from the analysis because of insufficient data.

	1971	1972	(1973)	1974	(1975)	(1976)	1977	(1978)	1979	1980
PRICE										
San Antonio	3238	3550	-	4250	(4292)	-	4088	(5900)	6950	6756
Giddings TX	2997	-	-	3818	-	-	-	-	-	-

Region 12

Southern Illinois and eastern Missouri, an area of small plants and farms. Two price series were considered. National stockyards in E. St. Louis, IL was selected as most representative of the area. This is a terminal market. Springfield, IL reports direct sale prices for both northern and southern IL.

Region 13

Michigan, Indiana and Ohio. A weighted average price was constructed from terminals at Cincinatti, OH, Evansville, IN, and Indianapolis, IN. No volume information was available for Cincinatti in 1980.

Region 13

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
PRICE										
Cincinatti	3284	3592	4484	4227	4330	3868	3897	4990	5939	6411
Evansville	3187	3442	4380	4152	4212	3849	3872	4981	6601	6609
Indianapolis	3262	3566	4505	4288	4439	3899	4013	5213	6740	6736
VOLUME	Saleable receipts at public stockyards -- all cattle									
Cincinatti	121	119	100	98	118	93	83	66	16	--
Evansville	66	57	53	54	67	67	66	66	47	43
Indianapolis	197	178	142	137	171	200	189	172	139	121
RATIO										
Cincinatti	.315			.339		.258		.217	.079	--
Evansville	.172			.187		.186		.217	.233	.262
Indianapolis	.513			.474		.556		.566	.688	.738
WEIGHTED AVERAGE PRICE	3256	3555	4475	4242	4354	3882	3957	5114	6644	6703

APPENDIX B

Appendix Table B.1.

REGIONAL CONCENTRATION OF BEEF SLAUGHTER (Steers and Heifers)
Four Firm Concentration Ratio (CR4) = sum of the market shares of the top four firms in a region.

REGION	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	Simple Mean 1976-80
1	.4477	.4668	.5362	.4727	.5442	.5185	.5937	.6872	.8140	.8402	.69
2	.4332	.3659	.4210	.3649	.3566	.4601	.4562	.4988	.5623	.5880	.51
3	.3233	.3345	.3218	.3030	.3323	.3447	.2822	.3260	.3750	.3731	.34
4	.9596	.9970	.9633	.9627	.9694	.9632	.9438	.9576	.9488	.9605	.95
5	.5524	.5672	.5702	.5646	.5784	.5958	.5784	.5755	.7047	.7269	.64
6	.7578	.7991	.7721	.8373	.8844	.8208	.8029	.8500	.8542	.9610	.86
7	.5275	.5835	.5294	.5062	.5028	.5048	.4847	.4776	.5191	.4325	.48
8	.4529	.5409	.5903	.5541	.5044	.5216	.4845	.4744	.5858	.6711	.55
9	.6458	.7371	.7520	.7519	.7642	.8221	.7686	.7996	.8873	.9672	.85
10	.6753	.6858	.7369	.6994	.6627	.6823	.7137	.6986	.7253	.7353	.71
11	.3003	.2879	.2995	.3169	.3231	.3234	.3467	.3766	.3813	.3761	.36
12	.5607	.5812	.6149	.6758	.5979	.5663	.6171	.6227	.5474	.7891	.63
13	.2388	.2622	.2610	.2672	.2554	.2535	.2595	.2922	.3552	.3254	.30
Wt'd Ave. CR4:	.48	.53	.56	.54	.52	.55	.54	.56	.64	.67	

Appendix Table B.2.

REGIONAL CONCENTRATION OF BEEF SLAUGHTER (Steers and Heifers)
Herfindahl Index = sum of the squared market shares(s) of n firms in a region.

$$= \sum_{i=1}^{n} S_i^2$$

REGION	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	Simple Mean 1976-80
1	.0716	.0754	.0919	.0778	.0970	.0868	.1112	.1840	.2900	.3130	.1970
2	.0757	.0600	.0780	.0640	.0648	.0807	.0879	.0960	.1110	.1100	.0971
3	.0546	.0567	.0517	.0472	.0533	.0537	.0477	.0570	.0660	.0660	.0581
4	.3274	.3786	.3713	.3903	.3938	.3725	.3669	.3910	.3750	.3790	.3769
5	.1032	.1088	.1056	.1082	.1167	.1235	.1155	.1160	.1560	.1720	.1366
6	.1772	.1849	.2254	.2583	.3140	.2759	.2474	.3440	.3350	.4280	.3261
7	.1072	.1120	.0927	.0945	.0958	.0965	.0923	.0900	.0990	.0820	.0920
8	.0901	.1099	.1167	.1080	.0941	.1044	.0860	.0950	.1410	.1630	.1179
9	.1904	.2552	.2711	.2630	.2564	.2726	.2228	.2250	.2640	.3500	.2669
10	.1396	.1432	.1536	.1467	.1358	.1343	.1472	.1430	.1550	.1580	.1475
11	.0426	.0400	.0438	.0451	.0480	.0482	.0502	.0550	.0590	.0520	.0529
12	.0968	.1090	.1149	.1317	.1055	.1066	.1233	.1250	.0970	.1870	.1278
13	.0336	.0378	.0365	.0377	.0357	.0354	.0381	.0400	.0510	.0470	.0423

Appendix Table B.3.

REGIONAL SLAUGHTER OF STEERS AND HEIFERS (thousand head)

Region	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	$\bar{X}$ (76-80)
1	998	948	729	754	702	962	986	1130	1064	1171	1063
2	994	926	874	920	861	783	743	551	540	522	628
3	1668	1732	1576	1769	1766	1897	1856	1305	1209	1161	1486
4	156	159	173	171	253	304	358	382	333	286	333
5	2335	2617	2417	2573	2197	2335	2618	2776	2194	2303	2445
6	543	585	483	506	401	451	486	359	350	313	392
7	1705	1668	1457	1500	1557	1560	1791	1843	1652	1511	1671
8	8577	8547	8201	8541	8303	7906	8683	8457	7436	7735	8043
9	1528	1656	1683	1669	1678	1722	1953	1972	1926	1651	1845
10	2402	2568	2618	2743	3195	4208	4815	5255	5134	5318	4946
11	1239	1113	1031	998	1075	1264	1285	1171	895	871	1097
12	217	268	237	236	304	272	238	228	214	162	223
13	1441	1326	1153	1145	1272	1311	1316	1192	847	752	1084
Total	23803	24113	22632	23525	23564	24975	27128	26621	23794	23756	25256

Appendix Table B.4

WEIGHTED AVERAGE ANNUAL PRICE -- CHOICE STEERS 9-1100 LBS.

REGION	YEAR 1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
1	3230	3566	4506	4314	4452	3957	4068	5230	6757	6768
2	3304	3613	4534	4384	4559	4069	4206	5358	6950	6946
3	3251	3555	4443	4302	4511	4020	4185	5365	7019	7026
4	3188	3491	4404	4191	4489	3997	4074	5224	6865	6824
5	3246	3569	4473	4232	4510	3907	4046	5234	6780	6709
6	3146	3492	4346	4060	4357	3793	3916	5093	6628	6539
7	3219	3580	4476	4203	4419	3863	3958	5174	6691	6607
8	3216	3562	4426	4164	4435	3888	4005	5205	6781	6720
9	3158	3492	4354	4086	4373	3811	3998	5121	6742	6741
10	3226	3538	4434	4221	4508	3942	4067	5238	6866	6811
11	3238	3550	-	4250	4292	-	4088	5900	6950	6756
12	3233	3555	4472	4203	4366	3848	3948	5152	6702	6647
13	3256	3555	4475	4242	4354	3882	3957	5114	6644	6740