THE VETERINARY CLINICS
Food Animal Practice

Vet Clin Food Anim 19 (2003) 519–544

Market power in the United States red meatpacking industry

Stephen R. Koontz, PhD

Department of Agricultural and Resource Economics, Colorado State University, B 324 Clark Building, Fort Collins, CO 80523-1172, USA

All agricultural production, processing, marketing, food retail, and agricultural input service sectors are becoming increasingly concentrated; that is, populated by fewer and larger firms. This appears to be a universal condition in the agriculture and food sectors of the United States economy. In fact, it is difficult to identify an agricultural industry or industry subsector where increasing concentration is not the case. The United States meatpacking industry, however, draws some of the most intense criticism with respect to this ubiquitous trend. Some of this criticism is deserved because the United States meatpacking industry is one of the most concentrated. Producers and policy makers are concerned that this economic environment results in the exercise of market power by firms to the detriment of producers and consumers.

This article presents research evidence addressing this persistent and important question: Is there evidence that meatpacking firms exercise market power? To place the question in context, structural change in United States meatpacking is also discussed. (For more detailed information on structural change and its causes, see the article by MacDonald elsewhere in this issue.) Specifically, this article addresses the following questions: What evidence is there that economic behavior in the United States red meatpacking sector is noncompetitive? What evidence is there that structural changes and conduct have resulted in adverse economic performance? This article reviews a large portion of the research pertaining to these questions and provides some interpretive insights as to the answers. A number of studies that have been conducted over the past 20 years are reviewed. Although the studies use alternative approaches and varying data sources, the conclusion appears to be consistent.

E-mail address: skoontz@agsci.colostate.edu

doi:10.1016/S0749-0720(03)00030-6

Criticism of the meatpacking industry is not new and some of it is deserved. The meatpacking industry has always evolved in response to changing technology. River transportation and increased livestock production encouraged the development of meatpacking in the eastern Midwest in the early 1800s. By the mid-1800s, railroad transportation permitted the practical movement of cattle and hogs and encouraged the growth of animal feeding in Corn Belt states. By the 1880s, refrigerated railcars permitted slaughter to occur nearer the point of production, and Chicago became a city of meatpackers. The early innovators became the major packers. Armour, Cudahy, Morris, Swift, and Wilson were well-known names. Scale economies in distribution, division of labor, and by-product use favored the larger operations.

Improvements in transportation also lowered costs of hauling, resulting in lower meat prices and higher net cattle prices to producers. Significant increases in production led to a "bust" in 1885, the first instance of what is called the "cattle cycle." Several large packers were charged in 1890 in the Vest Report with collusion in the trading of meat and fixing of prices. Packers formed several trusts or pools between 1890 and 1920. The Allerton Pool, a subject of the Vest Report, operated until 1893. The Veeder Pool operated between 1893 and 1903, interrupted by new packers outside the pool. In 1902, several packers formed the National Packing Company, a nationwide holding company, to circumvent the Sherman Antitrust Act.

Criminal antitrust action was taken against the National Packing Company in 1910. Several other investigations between 1903 and 1920 culminated in the Packer Consent Decree of 1920 and passage of the Packers and Stockyards Act. The Consent Decree required that the packers involved in the lawsuit terminate their interests in affiliated businesses such as production and transportation.

By the late 1950s, refrigerated trucking and an improved highway system had reduced shipping costs of meat. Feeding moved to the western Corn Belt and Southern Plains. Terminal stockyards and older plants became obsolete as new meatpackers established themselves in these new feeding areas. New slaughter technology, the introduction of federal grading, and the emergence of retail chain stores that relied on independent wholesalers rather than packer branch houses encouraged the new packers. By 1970, the Chicago Stockyards had closed.

The development of boxed beef in the 1970s was a change in the marketing system and in technology. It contributed to increased efficiency in shipping, labor use, and large-scale disassembly, and also served new specialized demands. Several leading packers were purchased by other entities not previously involved in livestock slaughter or packing during the conglomeration of the 1970s. A decline in red meat production and consumption had left the industry with excess slaughter capacity by the late 1970s. Mergers and acquisitions continuing through the 1980s reduced the number of packing plants and increased their size.

Meatpacking is a dynamic and aggressive industry, and antitrust concerns are nothing new. The conclusions from research on economic behavior, however, are not as unanimous. Some of the first comprehensive work on industry organization and assessment of economic performance addressed issues in agriculture and, specifically, the meatpacking industry [1]. In 1940, Nicholls [2] stated,

> Only after considerable further investigation will we know whether or not reform in the packing industry is necessary. It is conceivable that such monopoly elements as exist yield desirable results. A less extreme possibility is that results are undesirable but not sufficiently bad to bother about.

Investigation and research has continued since Nicholls wrote that conclusion. Does the research community know the answer?

Structural change

Structural changes in the beef industry preceded similar changes in the pork industry. This section focuses on steer and heifer slaughtering, boxed beef production, and hog slaughtering. It summarizes information in the 2000 Grain Inspection, Packers, and Stockyards Administration (GIPSA) statistical report [3].

In 1980, steer and heifer slaughtering plants in the United States totaled 626. By 2000, there were 143. These numbers include a very large number of very small plants that are essentially economically noncommercial. Thus, it is useful to limit the discussion to commercially viable plants. In 1980, there were 106 steer and heifer slaughtering plants with annual slaughter of 50,000 head or more. These plants slaughtered 21 million cattle. Plants with annual steer and heifer slaughter exceeding 500,000 animals—the largest GIPSA category—numbered 8 and accounted for 24% of total steer and heifer slaughter and 28% of slaughter by all firms in the category of over 50,000 head per year. Annual slaughter in these 8 largest plants averaged 735,000 head.

Data for 2000 show substantial changes. The number of plants in the category of 50,000 head or more per year declined to 40, but slaughter in these plants increased to 29 million head. Sixteen plants each slaughtered 1 million or more cattle in 2000—the new largest GIPSA category. The 16 plants accounted for 72% of total steer and heifer slaughter and 73% of slaughter in the category of 50,000 head or more. Annual slaughter in the 16 largest plants averaged 1.3 million head. The same structural changes happened in boxed beef production plants. Plants producing boxed beef are largely a subset of plants within the steer and heifer slaughter numbers. Further, the numbers and percentages reflect the fact that only the largest firms entered and participate in boxed beef production.

As plant size increased, there was growth and consolidation that resulted in larger beef packing firms. There can be no argument that concentration in

steer and heifer slaughter and boxed beef production is high. In 1980, the four largest firms accounted for 35.7% of total steer and heifer slaughter. By 2000, the four largest firms accounted for 82% of total steer and heifer slaughter. The share of boxed beef processing was even higher, increasing from 52.9% in 1980 to 84.7% in 2000. The four largest firms in 1980, however, were not the same four largest firms in 2000. Mergers and acquisitions are largely responsible for the difference. For example, mergers and acquisitions in 1987 involving some of the largest meatpacking firms increased the four-firm concentration in steer and heifer slaughter by 12 percentage points, from 55.1 to 67.1.

Structural changes in pork packing were similar to beef packing but were not as dramatic because of fewer mergers and acquisitions. In 1980, there were 144 plants with annual slaughter of 50,000 or more hogs. These plants slaughtered 90.1 million hogs, and 41 of the plants had an annual slaughter exceeding 1 million head. Those 41 plants accounted for 63% of total hog slaughter and 65% of the total for plants that slaughter 50,000 or more hogs per year. Average slaughter for the 41 largest plants averaged 14.3 million hogs.

By 2000, the number of plants slaughtering 50,000 or more hogs annually declined to 73, but annual slaughter increased to 92.4 million hogs. The number of plants slaughtering 1 million or more hogs annually decreased to 29, but the share of total slaughter increased to 89% of total hog slaughter and 90% of slaughter in the category of 50,000 head or more. Average annual slaughter for the 29 largest plants increased to 28.7 million hogs.

As in the beef industry, growth and consolidation led to larger pork packing firms. The four largest hog slaughtering firms in 1980 had a combined market share of 33.6%. The four-firm concentration for hog slaughter 2 decades ago exceeded that for steer and heifer slaughter; however, since then, concentration in hog slaughter has not increased as rapidly as it has for steer and heifer slaughter. The market share of the four largest hog slaughtering firms was 57.1% in 2000.

The United States red meatpacking industry has increased in economic concentration since the mid-1970s. The most dramatic shifts occurred in the late 1980s following unchallenged mergers and acquisitions. Concentration levels are among the highest of any industry in the United States and are well above levels generally considered to allow noncompetitive behavior and to result in adverse economic performance. Traditionally, this economic phenomenon would generate antitrust investigations and regulatory actions, or a least challenges to mergers. Some agricultural economists and others see this as enigmatic. Although civil antitrust lawsuits have been filed against the largest meatpacking firms, there have been no major antitrust decisions against those firms and there have been no significant federal government antitrust actions brought against the largest meatpacking firms over the period of major structural changes.

Evolution of economic thought on market power

Azzam and Anderson [4] provided a discussion of the evolution of economists' views of competition, theories, and empiric approaches to understanding and measuring competition. The classical school of economics held that competition equated to rivalry between particular firms. Price cutting, mergers, and cartels were all viewed as acceptable business practices. If monopoly threatened any harmful economic effects, entry of new firms would serve as a solution. The classical school of economics followed the case study approach that detailed how individual firms behaved but did not suggest generalizable theory.

The neoclassical school of economic thought held that competition did not refer to rivalry but to a market structure comprised of abstract, indivisible firms making abstract quantity and price decisions. The neoclassical approach was more concerned with general theory that applied across all firms than with explaining the behavior of any actual firm. The major gap between theory and reality persisted.

The first attempts to bridge the gap were made in the late 1920s and continued into the 1960s. The approach began to incorporate business characteristics such as concentration, entry, and product differentiation into analysis of actual business or market performance. This approach evolved into what is known as the structure–conduct–performance (SCP) paradigm of industrial organization. The SCP approach originally focused on individual firms. Research shifted to across-industry analysis in the 1960s. Concentration was believed to lead to collusion and to higher prices and profits. Structure is easy to measure and performance is easy to measure, but there are few direct measures of conduct. Therefore, performance is implied through structure. Antitrust policy prompted major suits against industries or firms thought to be exercising monopoly power.

Although the SCP approach continues to be applied, disagreement has risen over the years. SCP was criticized as subject to measurement and specification errors and for its failure to properly deal with causality and simultaneity. For example, high profits and large size could be simultaneous results of greater efficiency, but SCP methods would conclude a size–power relationship. Conversely, if monopoly power led to inflated costs, cost biases could mask any market power effects of concentration. The SCP approach was also criticized on conceptual grounds. The hypothesis that prices and profits increase with concentration also ascribes to concentration overt or tacit collusive behavior, but the models do not describe the nature of this behavior. Various approaches have attempted to model behavior more directly, whereas others have sought to overcome the empiric weaknesses of simplified SCP analyses.

Starting in the 1970s, studies began attempting to measure conduct directly. Known as the new empiric industrial organization (NEIO) paradigm, these studies model the gap between prices and costs as

a parameter to be estimated. The empiric analyses provide a conduct parameter, which places an industry on the continuum between perfect competition and monopoly. This conduct parameter satisfies conceptual objections regarding the failure of SCP studies to account for behavior explicitly; however, the estimated conduct parameter is an indicator of equilibrium outcomes of firm behavior. Conclusions about the individual firm behavior generating the results requires more detailed information and analysis. Even when NEIO analyses incorporate fully developed modeling of the decision-making environment of firms, the results are subject to varying interpretation and the models are empirically demanding.

Approaches to measuring market power

The new paradigm for measuring market power is summarized in the following equation that piece-wise, has a graphic interpretation [5,6]. The profit-maximizing condition for the industry is

$$P_{output}\left(1+\frac{\theta}{\eta}\right) = P_{input}\left(1+\frac{\phi}{\varepsilon}\right) + \frac{\partial C}{\partial Q} \quad (1)$$

where P denotes price, θ describes firm behavior in the output (meat) market, ϕ describes firm behavior in the input (cattle) market, η is the elasticity of output demand, ε is the elasticity of input supply, and the last term (ie, $\frac{\partial C}{\partial Q}$) denotes non-animal marginal costs. The parameters describing behavior range between zero and one. If both are zero, then the output and input markets are competitive. If both equal one, then the equation is the solution to the monopoly and monopsony problem. (See Schmalensee [7] for a comprehensive review of the methods.)

The graphic interpretation is as follows. We have to look at the output market and the input market separately. Under monopoly in the output market, the monopolist sets output level where the marginal revenue equals marginal costs (Fig. 1): price is high, marginal costs are low, quantity sold is relatively low, and the monopolist makes pure economic profits. Under competition, the marginal revenue for an additional unit sold is the market price. The monopoly price is well above marginal costs, so the individual has incentive to sell additional output. All firms have this incentive and all sell additional output, driving the market price down until the price received equals the marginal cost: price is lower, marginal costs are higher, quantity sold is higher, and no pure profits are earned. Antitrust law fits well with this model. The monopolist must "restrain trade" to extract monopoly rents. Restraint of trade is an important element of the Sherman Antitrust Act. Most markets are not monopolist or competitive. The behavior of firms is somewhere in between the two extremes. Research has attempted to measure the gap between price and marginal relationships with the behavioral parameters.

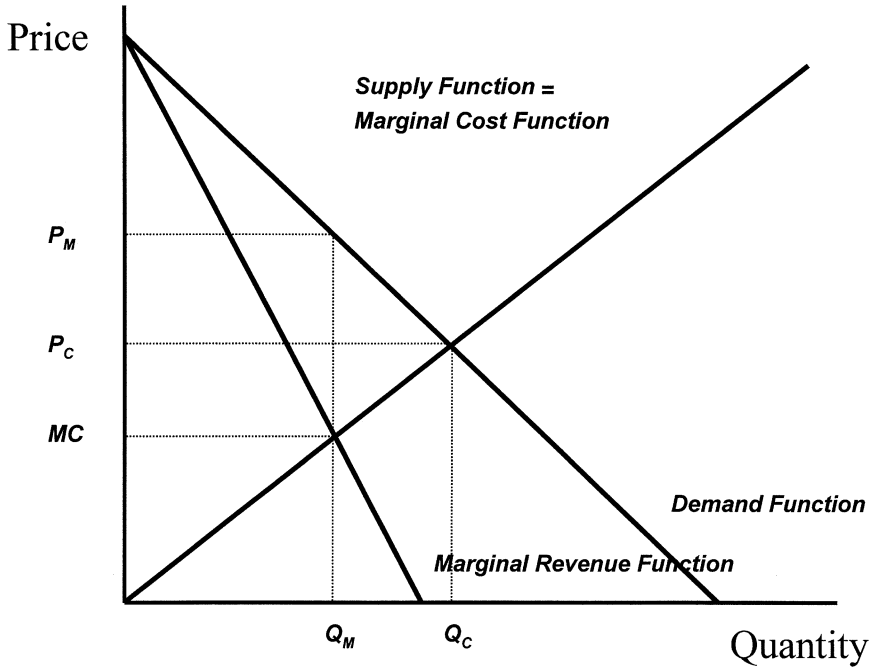

Fig. 1. The oligopoly problem. MC, marginal cost; P_C, competitive price; P_M, monopoly price; Q_C, competive quantity; Q_M, monopoly quantity.

Under monopsony in the input market, the firm sets input level where the marginal cost equals marginal revenue (Fig. 2): price is low, marginal revenue is high, quantity transacted is relatively low, and the monopsonist makes pure economic profits. Under competition, the marginal value of an additional unit purchased is the market price. The monopsony price is well above marginal returns, so the individual has incentive to purchase additional input. All firms have this incentive and all purchase additional input, driving the market price up until the price paid equals the marginal return: price is higher, marginal returns are lower, quantity sold is higher, and no pure profits are earned. Again, this model and antitrust law fit well together.

The classical approach to measuring market power is similar [8,9]. Ignoring the input market, the first equation can be reworked to yield

$$\frac{(P_{output} - MC)}{P_{output}} = f(\eta,\ \text{structure measures},\ \text{conduct measures}) \qquad (2)$$

where *MC* denotes the marginal costs of production. The equation measures the distance between the market price and marginal costs of production. This is similar to the left-hand side of the first equation. The difference between price and marginal costs is zero in competitive markets.

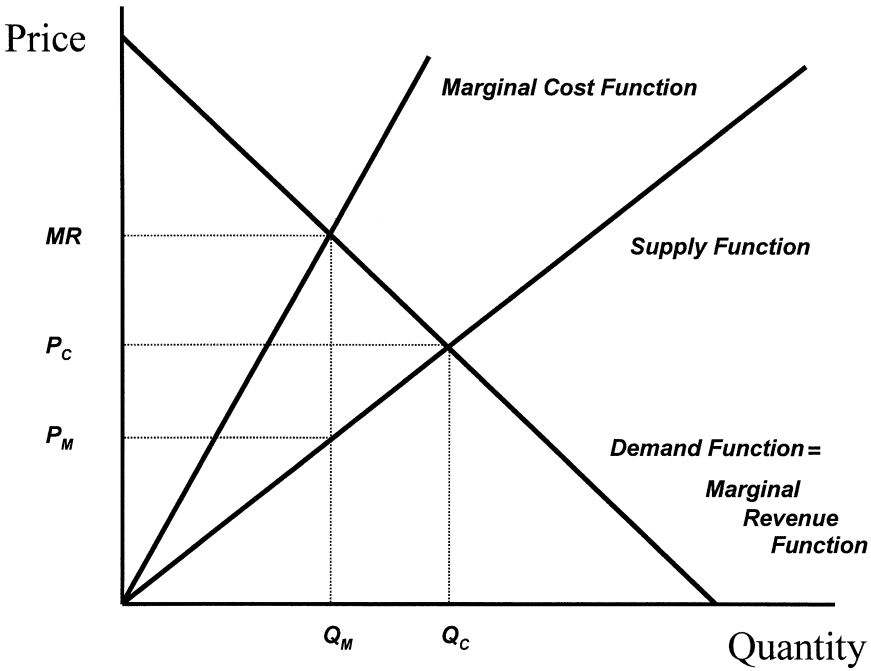

Fig. 2. The oligopsony problem. MR, marginal revenue; P_C, competive price, P_M, monopsony price, Q_C, competitive quantity; Q_M, monopsony quantity.

The same exercise can be done for input markets. The extent of the profits is usually measured as a function of [denoted by f(•) in equation 2] the economic conditions in the marketplace (ie, η, measures of market structure, and if available, measures of firm conduct). This is the SCP paradigm of Bain [10]. Other models in the paradigm may use the margin or price on the left-hand side. (See Bresnahan [11] for a comprehensive review.)

One of the things seen with the NEIO approach is that market power is measured indirectly [12]. Market power is implied from the gap between prices and marginal costs or marginal returns, which is in slight contrast to the SCP approach where market power is directly concluded from the impact of structural variables on margins or prices. Nonetheless, the SCP measure of market power also remains an indirect measure unless the impact is measured through a conduct variable.

Economic behavior and market performance

The research on market power reviewed in this article is separated into four areas, each with strengths and weaknesses. The approaches typically have different conceptual foundations, require different data, have different implicit levels of complexity, and provide different information. This review borrows heavily from Azzam and Anderson [4] and Ward [13].

Traditional-approach market-level research

Many studies have examined the relationship between prices for livestock and structural characteristics of the marketplace. These studies generally followed the traditional industrial organization paradigm, in that structural characteristics are causally related to performance measures. These studies used econometric models—statistical models that recognize the limitations and problems with nonexperimental economic data—to explore relationships between measures of market structure and measures of performance, such as price and margins. Studies have analyzed price spreads, or margins between marketing stages, as they relate to measures of concentration. Margins suggest noncompetition behavior if they exceed the marginal cost of transformation between marketing stages. Research reviewed in this section also used price-dependent econometric models that include factors that influence prices, such as supply, demand, quality, quantity, time, and place variables. The focus of the models is on the relationship between price and market structure variables such as number of bids, number of bidders, buyers, plants or firms, and buyer concentration.

Menkhaus et al [14] used annual data across several states for the years 1972 and 1977 to examine the relationship between prices paid by packers and market structure variables. Results were similar across the state-level concentration variable and years. Higher concentration was associated with lower prices, and these researchers concluded that the concern over concentration in beef packing was confirmed. National levels of concentration in steer and heifer slaughter were 26% in 1972 and 27% in 1977.

Marion and Geithman [15,16] used cross-sectional time-series data to study the price–concentration relationship in 13 regional fed cattle markets over the 1971-to-1986 period. They concluded that buyer concentration had a negative effect on fed cattle prices. These investigators estimated several different model specifications and separated the data into different time periods. The results regarding the effects of concentration on fed cattle prices were mixed. When the effects for 1971 to 1978 versus 1979 to 1986 were investigated, they found that the concentration effect was negative in both periods and more severe in the latter period when regional concentration was higher. When they estimated the model for the entire period, however, the concentration variable was insignificant. They included a variable in some models for the change in concentration and found a significant positive effect on fed cattle prices. These investigators explained the positive relationship as larger buyers paying higher prices for fed cattle as they increased their market share.

Several other studies examined the effects of concentration on prices. Most of these dealt with the effect of concentration in meatpacking on prices paid to livestock producers, or oligopsony power. The research used price data with different levels of geographic aggregation. At the national level, higher concentration was associated with higher prices to producers [17]. In

smaller geographic areas, prices to producers tended to be lower as packer concentration increased [18]. Quail et al [18] also suggested countervailing power was present in cattle feeding because prices paid for cattle tended to increase with regional feedlot size.

Two studies addressed the effect of selling power on margins between wholesale and retail prices. One of these studies determined that a 10% increase in four-firm concentration in food retailing was associated with a 4% increase in margins [19]. The other suggested a positive relationship between packer concentration and wholesale–retail margins as evidence that increased packer concentration raised the retail price of beef [17]. Another margin study examined the effect of packer buying power in farm markets and found that beef farm-to-wholesale margins narrowed as concentration increased, supporting the argument that larger firms are more efficient [20]. The study also showed no relationship between pork packer concentration and margins for pork.

Ward [20,21] also examined the relationships between concentration and profits and between concentration and productivity. No relationship was found between concentration and profits, although data from individual meatpackers revealed a weak positive relationship between returns and firm size. A separate study determined no association between productivity and concentration [22].

Ward and Stevens [23] approached the question of concentration impacts on marketing margins by examining price linkages from the producer-to-retail level. Data were monthly observations over the 1974-to-1994 period. They found that increased meatpacker concentration did not weaken the price linkage between producers and packers or between packers and wholesalers. They also found evidence that most of the pricing behavior change occurred at the retail level and not the meatpacker level. These investigators found that concentration has not adversely influenced the speed of price transmission in the beef chain; thus, they concluded that increased beef packer concentration has little effects on price behavior between producers and packers.

Matthews et al [24] estimated the effect that concentration has on farm-to-wholesale and wholesale-to-retail margins in the beef industry. They estimated a price adjustment model to determine whether or not price spreads change at the same rate when prices are increasing as when prices are decreasing. These researchers examined monthly data for the time period 1979 to 1996 and for the 1992-to-1996 subsample. For the entire period, concentration had no significant effect on marketing margins; however, there was a significant positive effect in the subsample. Increased concentration was associated with higher fed cattle prices and lower farm-to-wholesale marketing margins. Although unexpected based on the SCP paradigm, the positive effect was small. Matthews et al [24] hypothesized that the gains were from economies of size that were passed down into cattle prices.

Plant exit models analyze the effects of increased concentration resulting from plant closure. If increased packer concentration has a depressing effect on price, a reduction in the number of plants in a region should lead to a decline in prices paid to producers. Hayenga et al [25] examined the price impacts from closing and opening hog slaughtering plants in a Corn Belt region. Six plant closings during 1978 to 1981 were studied, along with reopening two of the plants in 1983. Using weekly data, price declines lasting 2 weeks or more were found for four of the six plant closings and one of the two plant openings. Hayenga et al [25] concluded that concerns about adverse price impacts from plant closings may not be warranted. Adverse effects, when found, were temporary until the market adjusted to the plant closing. Two other studies, however, found that prices paid to producers declined after major buyers exited [26,27].

Plant ownership models are similar to plant exit–price models, but the number of independent firm owners may be a more accurate measure of buyer concentration in a market area than the number of physical facilities. It is likely that buying conduct of multiple plants operated by the same firm is coordinated. The study by Hayenga and O'Brien [28], however, found no relationship between number of owners and fed cattle prices paid to producers.

Traditional-approach transaction-price research

This section again reviews studies that have examined the relationship between prices for livestock and structural characteristics of the marketplace; however, these studies deserve close examination because of the use of transaction prices. The data are unique because of the detail. There are no aggregation issues, and conclusions can be drawn about the direct impact of market structure on price received by livestock producers. Transaction-price models used data on prices paid to sellers for individual transactions rather than average prices aggregated over some geographic area. In most cases, the measure of concentration was number of bidders rather than market share of individual buyers or groups of buyers.

Ward [29] used transaction data from 1979 and found a positive significant relationship between prices paid and either number of bids received or number of buyers bidding on each sale lot. Ward [30], using the same data, found that prices differed significantly between the smallest buyer and larger buyers in half of the markets. Overall, larger buyers did not pay significantly lower prices than smaller rivals.

The development of an electronic market for slaughter hogs in 1980 allowed one study to examine the relationship between prices paid and increased buyer competition [31]. Rhodus et al [31] compared prices observed in the Hog Accelerated Marketing System electronic market with other markets for slaughter hogs. Prices received by producers marketing hogs through the electronic media were higher relative to traditional hog

markets during the1979-to-1981 period. The authors concluded that the electronic market enhanced prices to producers due to increased buyer competition.

Mergers during 1987 changed the buyer structure in markets for fed cattle in the Southern Plains. These mergers created what has been called the ''big three'' packers. Ward [32] collected transaction data in 1989 to determine whether buyer consolidation affected prices paid for fed cattle. Price differences were found among buyers, and prices were significant and positively related to number of buyers bidding on fed cattle. Both findings are similar to earlier work. Ward [32] also grouped the three largest buyers together to determine price effects from the big three packers. Price differences were found among the three largest firms and between the three largest firms and other buyers. The three largest firms together paid significantly lower prices for fed cattle than did their rival firms in all local markets studied. When examined independently, however, not all of the three largest packers paid lower prices than their competitors.

Williams et al [33] provided the most recent and comprehensive analysis of fed cattle transaction prices. The data were made available through Congressional mandate of a study on meatpacking concentration. All transactions were collected from the 43 largest steer and heifer slaughtering plants, owned by 25 firms, for the 1-year period April 1992 to April 1993. Thus, the analysis is on a population more so than on a sample. The results suggested that concentration has a negative impact on transaction prices but concentration is one of the least important factors. The R^2 of the transaction price model is slightly more than 50%. Thus, about half of the variation in individual transaction prices is unexplained. The most important sets of explanatory factors are boxed beef price, pen quality attributes such as grade and yield, procurement method, and packing plant capacity use. Transaction prices are primarily determined by derived demand for cattle and plant economics. Williams et al [33], however, did not examine prices specific to individual packers. Further, the concentration result was not similar across geographic regions, and the results were mixed: concentration had no impact in the primary cattle feeding regions (Texas, Oklahoma, Kansas, and Nebraska), had a negative impact as the SCP paradigm suggests in the Pacific Northwest and the Southwest, and had a positive impact in the eastern Corn Belt.

The beef studies found that producer prices tended to increase as the number of potential bidders increased. The 1992 study [32] found lower prices paid by larger buyers, whereas the 1982 study [30] found no relationship between buyer size and price levels. Further, concentration variables have mixed impacts on fed cattle prices. Although transaction prices are useful, caution is warranted as to sample-specific results. Clearly, no general conclusions can be drawn if the conclusions change with the sample. Market conditions in the sample time period appear to be as important as structure variables, and this is a weakness of the SCP paradigm.

Oligopoly and oligopsony market power

The most recent, published research makes use of the new approach for measuring market power. The intent is to measure the effect that behavior has on performance. These studies start from a model of firm optimization to generate testable hypotheses about market power. The studies estimate a parameter that is an index of conduct. The parameter is derived from an economic model of profit maximization. The estimated value of the parameter may range from competitive conduct to monopoly/monopsony conduct. This is the oligopoly/oligopsony price distortion and is evidence of market power.

Schroeter [34] was the first to apply the conduct parameter approach to beef packing. The model is similar to Appelbaum's [5] model. The sample included annual data for the 1951-to-1983 period. The estimates were significantly different from competitive conduct for 28 of the 33 years. This is statistically significant market power. Monopoly and monopsony price distortions were relatively small: 3% of the wholesale meat price and 1% of the farm cattle price. The degree of monopoly and monopsony distortion had decreased during the later years of the sample, when beef packing concentration was beginning to increase sharply.

Schroeter and Azzam [35] extended the conduct parameter approach from Schroeter [34] to the entire red meatpacking industry. Several of the largest meatpacking firms operate both cattle and hog plants. The decisions of a firm in the market for one product may affect and be affected by responses in the other market. Such joint production of substitute products is a more complex source of market power. The model specifically examines the degree of monopoly/monopsony power in farm-to-retail price spreads. The sample period was quarterly data for 1976 to 1986. Evidence of monopoly/monopsony conduct was found and estimated to be approximately one half of farm-to-retail price spreads for beef and pork (55% and 37%, respectively). Basic calculations make these magnitudes difficult to believe; however, the model does not account for changes in some retailing services and the authors recognized data limitations in estimating the model.

Azzam and Pagoulatos [36] modified the approach to allow different parameters for input and output markets. They also studied the entire United States meatpacking industry. The model is estimated with annual Census of Manufacturers data for the meatpacking industry for the years 1959 to 1982. They found noncompetitive behavior in both the output and input markets. The extent of oligopsony power was significantly higher than that for oligopoly power. Thus, the effects of market power were larger on prices in the livestock market than in the meat market.

Azzam et al [37] studied pork packing and found noncompetitive prices from 1972 to 1979 but a return to competitive pricing from 1980 to 1986. The study suggested that the emergence of very large hog producers might have acted as a check on any market power exercised by hog packers in later years.

A second study of pork found that risk of changes in output prices tended to increase marketing margins but found no oligopoly distortions [38]. This work is interesting in that it develops a framework to decompose marketing margins into components that include risk and oligopsony and oligopoly price distortions. The model was applied to the pork packing industry with weekly data for 1972 to 1988. Four-firm concentration ranged from 31.6% to 33.5% in this period. Schroeter and Azzam [38] found that oligopsony and oligopoly price distortions were not significant for the period studied. In testing for differences in behavior across the 1970s and 1980s, these researchers found less evidence of oligopsony and oligopoly price distortions in the latter period, despite increased regional concentration in hog slaughter. Oligopsony distortions—the exercise of market power—early in the sample period eroded as concentration increased later in the period. When the model was modified to force the effect of price risk to zero, re-estimation using the same data resulted in statistically significant oligopoly power throughout the entire sample period. Thus, empiric models see market power when the margins change due to risk.

Azzam [39] modeled the relationship between price changes in input and output markets and changes in industry output rather than the conduct parameter. If an industry is competitive, then individual firms should not encounter price changes as they change output levels. This is the definition of competition: individual firms cannot impact market prices. Results showed that there was oligopsony power in the live-cattle input market but no oligopoly power in marketing beef.

A limitation of conduct parameter studies is the extent of data aggregation across regions and over time. Azzam and Schroeder [40] addressed this problem as it relates to the input market for cattle where markets are more regional or local in nature. They estimated oligopsony price distortions in 13 regional fed cattle procurement markets in 1986. They then used simulation to measure price distortion for varying levels of regional beef packing concentration and behavior. When their results were compared with previous research that used econometric modeling, Azzam and Schroeder [40] found slightly lower price effects across market areas (less than 1% of the price level) compared with about 1.2% to 2.5% across market areas or time periods in previous research [14,18,29]. The results indicated that there was less oligopsony price distortion as a result of increasing buyer concentration than had been found in previous research. The study results also indicated that even perfect collusion might have only minor effects, with cattle prices depressed about 1% and volume, 1.5%. The relatively small simulated effects reflect the large estimate of regional supply elasticity. The model was subsequently used to evaluate the trade-off between market power and efficiency gains as the industry consolidates. The theoretic simulation suggested that the benefits of efficiency increases during recent consolidation in beef packing may have offset any negative effects of increased market power.

Koontz et al [41] expanded the conduct parameter approach through developing a measure that is consistent with a dynamic pricing game. Game theory is used to explain tacit collusion among meatpackers. The dynamic game requires that collusive behavior be expressed by a two-phased strategy. Firms will follow a cooperative pricing strategy at times and pay non-competitive prices. At other times, however, firms follow a noncooperative strategy and pay competitive prices. Daily fed cattle prices from four regional markets for two time periods were used in the empiric estimation. Times chosen were two periods of relative structural stability in the beef industry: 1980 to 1982 and 1984 to 1986. Koontz et al [41] found evidence of oligopsony behavior consistent with trigger pricing strategies in all regions and both time periods. Their estimated parameters of price distortion were in the range of 0.5% to 0.8%; however, they found a reduction in the oligopsony effect in the later period when buyer concentration was higher. Overall, behavior was consistent with cooperative pricing strategies.

Koontz and Garcia [42] extended the Koontz et al [41] noncooperative game to measure the competitiveness of pricing across regional fed cattle markets. Multiplant firms encounter each other in multiple markets. Thus, stronger tacit collusion can be exercised by coordinating across regional markets. The model examined the across-region coordination. Again, daily data was used from eight regional fed cattle markets for the periods 1980 to 1982 and 1984 to 1986. Multiple-market oligopsony was found across geographic fed cattle markets, and evidence indicated coordinated behavior across markets. The oligopsony finding was consistent with previous research on single-market oligopsony. Also consistent were the findings that the extent of oligopsony was small and the effect was greater in the earlier period than the later period, despite regional concentration being higher in the later period. Overall, Koontz and Garcia [42] concluded that oligopsony behavior in fed cattle procurement is nonconstant over time and space.

Azzam and Park [43] also used a model that allows for dynamic conduct. The technique allows the data to identify changes in the exercise of power, with respect to amount and timing. The results indicated no statistically significant evidence of market power in cattle markets from 1960 until 1977. Following a transition period during 1977 to 1982, a small but statistically significant degree of market power was evidenced in cattle markets after 1982.

At the same time that there have been large structural changes in the meatpacking industry, there have been large decreases in consumer demand for red meats [44]. Weliwita and Azzam [45] considered the impact of declining demand on meatpacking behavior. They argued that an oligopoly or oligopsony would become more competitive with an unexpected decline in output demand. In a game theory framework, firms may not distinguish between declining demand and noncooperation on the part of rivals and, thus, elicit further noncooperative behavior. Weliwita and Azzam [45] tested for cooperative pricing behavior after unexpected declines in beef demand. The model is applied to quarterly data for 1978 to 1993. Results indicated

that declining demand did not increase the competitiveness of packers, either in fed cattle or beef markets. Packers did not follow a cooperative pricing strategy either in fed cattle or beef markets. Oligopsony price distortions of about 2.7% were found, which are within the range of those found in previous research.

Stiegert et al [46] examined pricing implications when fed cattle supplies include variations that are anticipated and unanticipated. They recognized that meatpacking firms have strong incentives to lower average processing costs through increased volumes. Economies of size affect costs and profitability. Therefore, variation in fed cattle supplies may be important in measuring the power–efficiency trade-off. Stiegert et al [46] used quarterly data for 1972 to 1986. Their results suggested that beef packing firms follow average-cost rather than marginal-cost pricing. Fed cattle were priced below marginal costs in 31 of 59 quarters. Packers appear to bid to ensure that margins cover average processing costs. The analysis indicated that packers follow an average processing cost pricing strategy, and continue with the strategy in the face of anticipated supply shortfalls and unanticipated small shortfalls. There were large unexpected supply shortfalls, however, and packers competed aggressively and margins narrowed. Packer response to unanticipated supplies suggested that pricing response is dependent on the supply shocks. These investigators concluded that decreasing buyer concentration is unlikely to result in improved fed cattle prices for producers.

Economies of size suggest that increased efficiencies have occurred over time in meatpacking as structural changes have taken place [47]. Azzam and Schroeder [48] addressed the trade-offs in efficiency gains and oligopsony losses. They developed the model for the beef packing industry and regional fed cattle procurement. They use the period 1986 to 1988 as a baseline to estimate the impacts of increasing concentration and then simulate impacts of further increases in regional concentration. Azzam and Schroeder [48] suggested that when consolidation leads to economies of size efficiencies and increased oligopsony pricing behavior, even modest efficiency gains offset the oligopsony or welfare losses. They estimated that cost savings of 2.4% or less would offset noncompetitive effects from a 50% increase in beef packing concentration. Their estimate of actual cost savings was 4%. Thus, they concluded that structural changes have been welfare enhancing in the beef packing industry.

Driscoll et al [49] and Kambhampaty et al [50] tested for profit-maximizing behavior by beef packing firms. The conduct parameter research assumes profit maximization by firms. Other research shows that costs are declining with volume and that average-cost pricing may be followed. In this case, conduct parameters are biased measures of market power. Nonparametric tests for profit maximization were applied to weekly data from 15 plants in two regions for a 1-year period in 1992 to 1993. Weekly, plant-level data was tested, merged into four levels of aggregation, and then ultimately merged into monthly, firm-level data. Plants and firms did not

appear to follow profit-maximizing behavior for weekly or monthly data. Plants regularly operated at production levels below those needed to achieve profit maximization. Results were consistent with use of average-cost pricing. Driscoll et al [49] found very little evidence of oligopolistic or oligopsonistic behavior when profit maximization was assumed, consistent with small price distortions found in previous research. They argued that use of the conduct parameter approach is inappropriate in the analysis of short-term transaction data. They did not, however, rule out profit-maximizing behavior over periods longer than 1 month.

Jones et al [51] also suggested that aggregation of prices and production variables over time and across different firms would limit the ability of econometric methods in estimating and describing behavior. They used a simulation model, assumed profit-maximizing behavior on the part of packers, and then introduced different levels of noncompetitive behavior. Standard econometric models are poor at estimating the cost structure of the firms and estimating the conduct parameter. Aggregation over time and over firms is the problem.

Paul [52] estimated oligopoly and oligopsony power with monthly, plant-level cost and revenue data for the 43 largest beef packing plants for a 1-year period in 1992 to 1993. The data were primarily from that used by Kambhampaty et al [50]. Cost functions were estimated and results for cost economies and market power were found to be robust. Findings confirmed significant economies of size, as discussed previously. There was also little evidence of price-depressing, oligopsonistic distortions for fed cattle. The findings were consistent with the previous research on trade-offs between cost efficiency gains and oligopsony losses [48].

An assumption commonly made in conduct parameter research is that technology is fixed proportions between livestock and other non-animal inputs. Fixed proportions technology implies that additional capital, energy, or labor can not be used to extract additional meat from a carcass. Schroeder [34] made this assumption, as did much of the following work. Muth and Wohlgenant [53] developed a model relaxing this assumption in favor of substitutability among inputs and applied the model to annual data for 1967 to 1993. They found negligible oligopsony price distortion, contrary to previous models using fixed proportions. Thus, empiric models see market power when substitution effects are not accounted for.

Bhuyan and Lopez [54] also estimated a conduct parameter for the meatpacking industry. The model examined only oligopoly power but examined farm-to-retail margins in all food and tobacco industries. Using Census of Manufacturers annual data, the model allowed for and found input substitution and economies of size. The results were appealing, in that they ranked the industries with the highest exercise of market power. For example, breakfast cereal, alcoholic beverages, and snack foods ranked the highest. The study, however, suggested that 40% of the margin in the red meat industry was due to power.

Schroeter [55] explored the market power question in relation to interaction between packers and retailers. This study was an effort to develop a framework to test market power at different stages in the marketing channel. Schroeter [55] evaluated three different types of relationships between packers and retailers: packer dominance, retailer dominance, and bargaining. A model was developed to test for bilateral oligopoly of meatpacking and retail firms but allow for oligopoly behavior by packers and oligopsony behavior by retailers. Using monthly data for 1990 to 1994, results suggested that bilateral oligopoly characterizes the wholesale beef market. Retailers exercise market power in retail sales, but a bargaining approach is used in packer–retailer transactions. Schroeter [55] found that meatpackers were price takers with little or no evidence of oligopoly behavior.

The one oligopoly model study examined explicitly incorporated long-run effects by allowing for changes in the number and size of firms [56]. This study implemented a model of price spreads under perfect competition to examine the response of retail meat prices to shifts in retail demand and farm commodity supply. The study's findings, based on 1955 to 1983 data, showed perfect competition.

The Holloway [56] study is part of a larger body of theoretic work on marketing margins that started with Gardner [57]. Margins between the farm-to-wholesale and farm-to-retail level are often used to as evidence of market power. Gardner [57] showed that this clearly is not the case and that margins will increase as more nonfarm inputs are used to satisfy consumer demand for increased food-related services. Holloway [56] expanded Gardner's [57] work to include noncompetitive behavior. Other work (eg, [58]) showed how increasing margins and increasing concentration are part of a competitive process. A conclusion from the theoretic work is that comprehensive empiric models estimating market power, cost efficiency, technologic change, and changing consumers will be difficult and unlikely. Rather, it is important to break the problem down into pieces that can be empirically addressed and then synthesize the empiric works into a comprehensive view.

Captive supplies research

One of the most contentious issues about the relationship between concentration and the behavior of livestock prices has centered on use of captive supplies. Captive supplies refer to vertical integration by meatpackers into livestock ownership and various forms of contract coordination between livestock producers and meatpackers. Research on this issue generally estimates transaction or aggregate market prices as a function of market conditions and the extent of captive supplies. Econometric tools are used where the focus of these models is on the relationship between price and captive supplies.

Elam [59] estimated the effect that variations in the volume of captive supplies had on monthly average fed cattle prices in the United States and in the individual states of Texas, Kansas, Colorado, and Nebraska. Variations in captive supply deliveries were inversely related to fed cattle prices over the period October 1988 to May 1991. For each 10,000 cattle delivered under captive supply arrangements the United States, price declined $0.03/hundredweight (cwt) to $0.09/cwt. This is approximately a 10% change in the contract levels. The results from individual state prices ranged from an insignificant impact to a negative impact of $0.37/cwt.

Schroeder et al [60] examined fed cattle transaction data from feedlots in southwestern Kansas during May 1990 to November 1990 and modeled the relationship between variations in forward-contracting volume and transaction prices for fed cattle. The volume of marketing-agreement cattle was included in the measure of captive supplies. Two measures of forward contracts were used. The first was contract deliveries as a percentage of the weekly total. The second was each meatpacker's share of contract deliveries for each week. A negative relationship was found between forward-contracting and fed cattle prices. The impact ranged from $0.15/cwt to $0.31/cwt over the 6-month data period. Impacts also were examined for 2-month subsamples and for individual packers. Price impacts were not significant for some time periods and some packers. Schroeder et al [60] also found a significant positive relationship between number of bids and prices paid by packers. Average prices paid by different packers were significantly different over the sample period.

Ward et al [61,62] presented results from the most extensive and comprehensive data to study price impacts from captive supplies. The data were made available through Congressional mandate of a study on meatpacking concentration. All transactions were collected from the 43 largest steer and heifer slaughtering plants, owned by 25 firms, for the 1-year period April 1992 to April 1993. The impacts of captive supplies on price were estimated with a variety of approaches. The interdependent nature of delivering cattle from three types of captive inventories and purchasing fed cattle in the cash market were examined. The three types of captive supplies are packer-owned cattle, marketing-agreement cattle, and forward-contracted cattle. First, the impact on transaction prices was modeled as a function of the size of captive supply inventories from which future deliveries could be made. Results suggested that increasing deliveries of cattle from two of the three types of captive supply inventories was associated with lower transaction prices for fed cattle. A 1% increase in captive supply deliveries was associated with a $0.05/cwt decline in fed cattle transaction prices for forward-contracted cattle and a $0.36/cwt decline for marketing-agreement cattle. There was no impact on the packer-owned cattle. Simultaneity was found between cash market transaction prices and percentage deliveries of forward-contracted and marketing-agreement cattle. This finding implied that packers delivered low-priced cattle. Second,

individual captive supply inventory variables had mixed impacts, whereas the impact of total captive supplies was not significant. A 1000-head increase in the size of captive supply inventory was associated with a $0.01/cwt increase in transaction prices for the forward-contract inventory, a $0.18/cwt decline for the packer-fed inventory, and a $0.02/cwt decline for marketing-agreement inventory. Ward et al [61,62] found a positive and significant relationship between plant use and prices paid by packers, although the magnitude was small. Significant price differences were found among plants and firms. There was a tendency for plants paying the highest prices to be larger or located close to the primary cattle feeding areas of Texas, Oklahoma, Kansas, Colorado, and Nebraska.

Schroeter and Azzam [63] used data similar to those of Ward et al [61,62] to examine the price and captive supplies relationship. Schroeter and Azzam [63] had access to transaction data from four plants in the Texas Panhandle region. The sample period is more recent: February 1995 to May 1996. Results suggested that packers expecting relatively large deliveries of captive supply cattle paid lower prices in the cash market; however, the magnitude was small. A 10% increase in captive deliveries was correlated with a $0.02/cwt to 0.04/cwt lower price. These researchers explained that the finding is consistent across studies and caution that the negative relationship is not necessarily causal in nature and not an indicator of noncompetitive behavior by packers. Packers simply deliver low-priced cattle whether those cattle are contracted or purchased in the cash market. This substituting behavior is not necessarily strategic. In addition, as in previous studies, results indicated that packing plants paid significantly different prices for fed cattle. Higher prices were found for fed cattle purchased under a marketing agreement than for fed cattle purchased in the cash market. Contrary to other studies, this study's results suggested that one plant paid higher prices for fed cattle purchased by forward contract; however, market conditions in these short time period studies may be important.

Empiric work estimating price effects from captive supplies is problem oriented but has lacked a theoretic framework for identifying the incentives for meatpacking firms to contract cattle supplies. Later work has addressed this issue. Azzam [64] developed a conceptual framework identifying a monopsony incentive for integration by meatpackers to capture fed cattle supplies. The resulting empiric model was estimated with aggregate quarterly data for 1978 to 1993. The model provided evidence that supported the model.

Azzam [65] further developed a conceptual model for estimating the price effects from captive supplies, without incorporating a backward integration motive. The model suggested that price effects depend on a complex combination of several variables, among them the respective fraction of cash market and captive procurement supplies. The model suggested that noncompetitive conduct is not a necessary condition for a negative relationship between cash prices and captive supplies. Thus, the study

suggested that the inverse relationship between fed cattle prices and captive supplies is not all due to noncompetitive behavior.

Love and Burton [66] developed a strategic rationale for backward integration by packers into livestock ownership. The model included various forms of captive supplies or backward integration. Two sources of gains were identified. First, a dominant firm benefits from efficiency gains associated with expanded production. Second, the integrating firm pays a lower price for captive supply purchases. The model results were consistent with previous empiric research. For example, other work found that meatpackers paid higher prices for marketing-agreement cattle than cash market cattle [33,61,62]; higher rates of capacity use were associated with higher fed cattle prices paid [61,62]; higher rates of capacity use were associated with higher rates of captive supply usage [67]; and larger meatpacking plants paid higher prices than smaller plants [33,61,62]. The model suggested that use of captive supplies can be a potential source of market power. The exercise of market power, however, is not the prime motive for vertical integration.

Zhang and Sexton [68] developed a spatial model to illustrate how meatpackers can use captive supplies strategically to influence cash market prices. The model results were due to the importance of transactions costs. As transaction costs increase, the more likely meatpacking plants will create a geographic buffer between them that reduces competition in the cash market. Schroeter and Azzam [63] examined the Texas Panhandle data to see whether conditions matched those predicted by the Zhang and Sexton [68] model. Two predictions implied from the Zhang and Sexton [68] model were not verified by the Texas data: fed cattle procured by non–cash market methods were shipped farther than those procured in the cash market, and packers did not compete in their rivals' cash market territory. Geographic region in the Schroeder and Azzam data, however, may have been too limited to test this hypothesis.

Summary

The basic question asked in the beginning of this article was whether the evidence from research is persuasive enough to conclude that competition in the meatpacking industry is deficient. The literature review led to the conclusion that the answer is no. Research varies widely in terms of data and methodologic approaches. The research, however, clearly finds evidence of market power. Many SCP studies indicated the existence and exercise of market power, but the failure of the paradigm makes definitive conclusions dangerous. The NEIO studies showed a persistent gap between the price of livestock and marginal costs but the studies did not incorporate sufficient detail to prove specific behavior.

Azzam and Anderson [4] conducted an extensive review of competition in meatpacking. In their summary, they offered criticisms of the SCP approach

and the conduct parameter approach. These investigators concluded that the body of empiric evidence was insufficient to persuasively argue that the meatpacking industry was not competitive. Sexton [69] discussed more recent critiques of the conduct parameter approach. Despite its weaknesses, he concluded that market power estimates in meatpacking are modest but that structural changes on balance are beneficial, from an efficiency viewpoint. Examining the evidence either by data aggregation, methodology, or time period results in little difference in the qualitative interpretation. The research community has done what Nicholls [2] said was needed.

The need remains relevant. The research leaves us with a clear picture and nagging questions. Azzam and Anderson [4] recommended that further research focus on the process of competition or the rivalrous interaction between competitors, and on competitors' strategies for responding to technologic and market forces, as the business history of the industry suggests. Specifically, they recommended two approaches. First, to develop empiric pricing models for short-term monitoring. Such models infer conduct from spatial price linkages rather than from concentration as do SCP studies or estimation of conduct parameters as do NEIO studies. Second, to study the dynamics of the competitive process, making use of data describing changes at the firm and plant level, to better understand the effect of market and technologic forces on the evolution of firm behavior and industry structure.

After discussing existing research quality and future research needs, two practical things remain to do. The first centers on the following question: How important are the relatively small measures of market power? Most believable price distortions are found to be 3% or less. These distortions are below the 5% regulatory standards related to mergers used by the US Department of Justice and US Federal Trade Commission [70]. These standards, however, are guidelines and not law. Antitrust laws state that the exercise of market power is illegal. Courts and regulatory agencies also have not defined how much market power is significant and for how long a firm or firms must maintain significant market power [71].

From the viewpoint of public welfare, small impacts on price make a substantial difference to livestock producers and rival meatpacking firms. In relatively low-profit commodity businesses, small degrees of market power have significant profit implications. Small price or percentage impacts represent large total dollar amounts, especially over long time periods. To some, the evidence of market power provides clear reasons for antitrust lawsuits, conclusive evidence of weak and disinterested antitrust enforcement, and undeniable grounds for corrective legislation.

If we conclude that action is needed, then the second issue emerges: What should be done and will our actions result in a net improvement? The research reviewed in the article by MacDonald elsewhere in this issue clearly shows the economic benefits of large meat processing firms. Likewise, some

of the research reviewed here shows that increased concentration benefits producers and consumers. Some of the benefits of lower costs are passed on to producers through improved prices. The clear problems seen in the 1910s and 1920s—the pools and trusts—are not present in the 1990s and 2000s. Legislative action requiring the restructuring of the meatpacking industry or limiting behavior (similar to the Packer Consent Decree of 1920) will come at a large cost to the industry and society.

So what should be done? Some people want to do nothing and allow the market to function unencumbered by political action. This approach ignores the problems seen in research. Some people want to go back in time, forgetting the economic incentives for change. They would legislate change in the market structure where they perceive problems, break up large meatpacking firms, restrict supposed problematic conduct, and eliminate contracting and vertical integration. Some people want to treat agriculture as a unique sector of society and create laws and regulations applicable to agriculture alone, regardless of whether the issues driving these actions apply to other sectors of the economy. Little, if any, thought is given to public and private costs or public and private benefits.

Structural changes are clear. Research findings on the impacts and consequences are robust. What should be done, however, is not clear or robust. We are in the realm of second-best choices. The fact that we are in a realm of second-best choices is not satisfying to me nor will it likely be to agricultural producers and policy makers. What to do from here is not an economic decision (ie, economics cannot provide a clear best answer). Rather, it is a political and public choice question that has economic implications: What do we want our livestock and meat industry to look like?

References

[1] Nicholls WH. Imperfect competition in the agricultural industries. Ames (IA): Iowa State University; 1941.
[2] Nicholls WH. Market-sharing in the packing industry. J Polit Econ 1940;22:225–40.
[3] Grain Inspection, Packers and Stockyards Administration Packers and stockyards statistical report: 2000 reporting year. Washington, DC: US Department of Agriculture; 2000. SR-02–2.
[4] Azzam AM, Anderson DG. Assessing competition in meatpacking: economic history, theory, and evidence. Washington, DC: US Department of Agriculture; 1996. GIPSA-RR 96–6.
[5] Appelbaum E. The estimation of the degree of oligopoly power. J Econ 1982;19:287–99.
[6] Appelbaum E. Testing price taking behavior. J Econometrics 1979;9:283–94.
[7] Schmalansee R. Inter-industry studies of structure and performance. In: Schmalensee R, Willig R, editors. Handbook of industrial organization. New York: North Holland; 1989.
[8] Cowling K, Waterson M. Price-cost margins and market structure. Economica 1976;43:275–86.
[9] Clarke R, Davies SW. Market structure and price cost margins. Economica 1984;49: 277–87.
[10] Bain JS. Industrial organization. 2nd edition. New York: John Wiley & Sons; 1968.

[11] Bresnahan TF. Empirical studies of industries with market power. In: Schmalensee R, Willig R, editors. Handbook of industrial organization. Amsterdam: Elsevier Science; 1989.
[12] Geroski PA. In pursuit of monopoly power: recent quantitative work in industrial economics. J Appl Econometrics 1988;3:107–23.
[13] Ward CE. A review of causes for and consequences of economic concentration in the US meatpacking industry. Paper presented at the Canadian Agricultural Economics Society Conference: The Economics of Concentration in the Agri-Food Sector. Toronto, Ontario, April 2001.
[14] Menkhaus DJ, St. Clair JS, Ahmaddaud AZ. The effects of industry structure on price: a case in the beef industry. West J Agric Econ 1981;6:147–53.
[15] Marion BW, Geithman FE. Concentration-price relations in regional fed cattle markets. Research Report No. 25. Storrs (CT): University of Connecticut, Food Marketing Policy Center; 1994.
[16] Marion BW, Geithman FE. Concentration-price relations in regional fed cattle markets. Rev Indust Org 1995;10:1–19.
[17] Multop JR, Helmuth JW. Relationship between structure and performance in the steer and heifer slaughter industry. Staff report. Committee on Small Business, US House of Representatives. Washington, DC: Government Printing Office; 1980.
[18] Quail G, Marion B, Geithman F, Marquardt J. The impact of packer buyer concentration on live cattle prices. NC-117 Working Paper 89. Madison (WI): University of Wisconsin; 1986.
[19] Hall L, Schmitz A, Cothern J. Beef wholesale-retail marketing margins and concentration. Economica 1979;46:265–300.
[20] Ward CE. Meatpacking competition and pricing. Blacksburg (VA): Virginia Tech University, Research Institute on Livestock Pricing; 1988.
[21] Ward CE. Meatpacking plant capacity and utilization: implications for competition and pricing. Agribus: Int J 1990;6:65–73.
[22] Ward CE. Productivity-concentration relationship in the US meatpacking industry. South J Agric Econ 1987;19:217–22.
[23] Ward RW, Stevens T. Pricing linkages in the supply chain: the case for structural adjustments in the beef industry. Am J Agric Econ 2000;82:1112–22.
[24] Matthews KH Jr., Hahn WF, Nelson KE, Duewer LA, Gustafson RA. US beef industry: cattle cycles, price spreads, and packer concentration. Washington, DC: US Department of Agriculture, Economic Research Service; 1999. Technical Bulletin No. 1874.
[25] Hayenga ML, Deiter R, Montoya C. Price impacts association with the closing of hog slaughtering plants. N Cent J Agric Econ 1986;8:237–42.
[26] Love HG, Shuffett DM. Short-run price effects of a structural change in a terminal market for hogs. J Farm Econ 1965;47:803–12.
[27] Ward CE. Meatpacking: an unsettled industry (Agricultural Policy and Economic Issues 1983;5). Stillwater (OK): Cooperative Extension Service, Oklahoma State University.
[28] Hayenga ML, O'Brien D. Packer competition, forward contracting price impacts, and the relevant market for fed cattle [Research Bulletin 5–91]. In: Purcell WD, editor. Pricing and coordination in consolidated livestock markets, captive supplies, market power, IRS hedging policy. Blacksburg: Virginia Tech University, Research Institute on Livestock Pricing; 1992. p. 45–67.
[29] Ward CE. Short-period pricing models for fed cattle and impacts of wholesale carcass beef and live cattle futures market prices. SouthJ Agric Econ 1981;13:125–32.
[30] Ward CE. Relationship between fed cattle market shares and prices paid by beefpackers in localized markets. West J Agric Econ 1982;7:79–86.
[31] Rhodus WT, Baldwin ED, Henderson DR. Pricing accuracy and efficiency in a pilot electronic hog market. Am J Agric Econ 1989;71:874–82.
[32] Ward CE. Inter-firm differences between fed cattle prices in the Southern Plains. Am J Agric Econ 1992;74:480–5.

[33] Williams GW, Capps O Jr., Love HA, Goodwin HL, Davis EE, Nichols JP. Price determination in slaughter cattle procurement. Washington, DC: US Department of Agriculture; 1996. GIPSA-RR 96–2.
[34] Schroeter JR. Estimating the degree of market power in the beef packing industry. Rev Econ Stat 1988;70:158–62.
[35] Schroeter JR, Azzam AM. Measuring market power in multi-product oligopolies: the US meat industry. Appl Econ 1990;22:1365–76.
[36] Azzam AM, Pagoulatos E. Testing oligopolistic and oligsonistic behaviour: an application to the US meat-packing industry. J Agric Econ 1990;41:362–70.
[37] Azzam AM, Pagoulatos E, Schroeter JR. Price spreads and market power in food processing industries. NE-165, Working Paper No. 8 Storrs (CT): University of Connecticutt, Food Marketing Policy Center; 1989.
[38] Schroeter JR, Azzam AM. Marketing margins, market power, and price uncertainty. Am J Agric Econ 1991;73:990–9.
[39] Azzam AM. Testing the competitiveness of food price spreads. J Agric Econ 1992;43:248–56.
[40] Azzam AM, Schroeter JR. Implications of increased regional concentration and oligopsonistic coordination in the beef packing industry. West J Agric Econ 1991;16:374–81.
[41] Koontz SR, Garcia P, Hudson MA. Meatpacker conduct in fed cattle pricing: an investigation of oligopsony power. Am J Agric Econ 1993;75:537–48.
[42] Koontz SR, Garcia P. Meat-packer conduct in fed cattle pricing: multiple-market oligopsony power. J Agric Res Econ 1997;22:87–103.
[43] Azzam AM, Park T. Testing for switching market conduct. Applied Econ 1993;25:795–800.
[44] Purcell WD. Measures of changes in demand for beef, pork, and chicken, 1975–2000. Research Bulletin 4–2000. Blacksburg (VA): Virginia Tech University, Research Institute on Livestock Pricing; 2000.
[45] Weliwita A, Azzam AM. Identifying implicit collusion under declining output demand. J Agric Res Econ 1996;21:235–46.
[46] Stiegert KW, Azzam AM, Brorsen BW. Markdown pricing and cattle supply in the beef packing industry. Am J Agric Econ 1993;75:549–58.
[47] Azzam AM. Measuring market power and cost-efficiency effects of industrial concentration. J Indust Econ 1997;45:377–86.
[48] Azzam AM, Schroeter JR. The tradeoff between oligopsony power and cost efficiency in horizontal consolidation: an example from beef packing. Am J Agric Econ 1995;77: 825–36.
[49] Driscoll PJ, Kambhampaty SM, Purcell WD. Nonparametric tests of profit maximization in oligopsony with application to the beef packing industry. Am J Agric Econ 1997;79:872–9.
[50] Kambhampaty SM, Driscoll PJ, Purcell WD, Peterson EB. Effects of concentration on prices paid for cattle. Washington, DC: US Department of Agriculture; 1996. GIPSA-RR 96–4.
[51] Jones R, Purcell WD, Driscoll PJ, Peterson EB. Issues and cautions in employing behavioral modeling approaches to test for market power. Research Bulletin 1–96. Blacksburg (VA): Virginia Tech University, Research Institute on Livestock Pricing; 1996.
[52] Paul CJM. Market and cost structure in the US beef packing industry: a plant-level analysis. Am J Agric Econ 2001;83:64–76.
[53] Muth K, Wohlgenant MK. Measuring the degree of oligopsony power in the beef packing industry in the absence of marketing input quantity data. J Agric Res Econ 1999;24:299–312.
[54] Bhuyan S, Lopez RA. Oligopoly power in food and tobacco industries. Am J Agric Econ 1997;79:1035–43.
[55] Schroeter JR, Azzam AM, Zhang M. Measuring market power in bilateral oligopoly: the wholesale market for beef. South Econ J 2000;66:526–47.
[56] Holloway GJ. The farm-retail price spread in an imperfectly competitive food industry. Am J Agric Econ 1991;73:979–89.

[57] Gardner BL. The farm–retail price spread in a competitive food industry. Am J Agric Econ 1975;57:399–409.
[58] Hamilton SF, Sunding DL. The effect of farm supply shifts on concentration and market power in the food processing sector. Am J Agric Econ 1997;79:524–31.
[59] Elam E. Cash forward contracting vs. hedging of fed cattle, and the impact of cash contracting on cash prices. J Agric and Res Econ 1992;17:205–17.
[60] Schroeder TC, Jones R, Mintert J, Barkley AP. The impact of forward contracting on fed cattle prices. Rev Agric Econ 1993;15:325–37.
[61] Ward CE, Koontz SR, Schroeder TC. Short-run captive supply relationships with fed cattle transaction prices. In: Ward C, Schroeder T, Barkley A, Koontz S, editors. Role of captive supplies in beef packing. Washington, DC: US Department of Agriculture; 1996GIPSA-RR 96–3.
[62] Ward CE, Koontz SR, Schroeder TC. Impacts from captive supplies on fed cattle transaction prices. J Agric Res Econ 1998;23:494–514.
[63] Schroeter JR, Azzam AM. Econometric analysis of fed cattle procurement in the Texas Panhandle. Washington, DC: US Department of Agriculture, GIPSA, November, 1999.
[64] Azzam AM. Testing the monopsony-inefficiency incentive for backward integration. Am J Agric Econ 1996;78:585–90.
[65] Azzam AM. Captive supplies, market conduct, and the open-market price. Am J Agric Econ 1998;80:76–83.
[66] Love HA, Burton DM. A strategic rationale for captive supplies. J Agric Res Econ 1999;24:1–18.
[67] Barkley AP, Schroeder TC. Long-run impacts of captive supplies. In: Ward CE, Schroeder TC, Barkeley AP, Koontz SR, editors. Role of captive supplies in beef packing. Washington, DC: US Department of Agriculture; 1996GIPSA-RR 96–3.
[68] Zhang M, Sexton RJ. Captive supplies and the cash market price: a spatial markets approach. J Agric Res Econ 2000;25:88–108.
[69] Sexton RJ. Industrialization and consolidation in the US food sector: implications for competition and welfare. Am J Agric Econ 2000;82:1087–104.
[70] US Department of Justice and Federal Trade Commission. Horizontal merger guidelines. Washington, DC: US Department of Justice and Federal Trade Commission; 1992. (revised 1997).
[71] Carlton DW, Perloff JM. Modern industrial organization. 2nd edition. New York: HarperCollins; 1994.