Economics of Competition in the U.S. Livestock Industry

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Paper Background and Objectives

Questions of market structure changes, their causes, and impacts for pricing and competition have been focus areas for the author over his entire 35-year career (1974-2009). Pricing and competition are highly emotional issues to many and focusing on factual, objective economic analyses is critical. This paper is the author's contribution to that effort.

The objectives of this paper are to: (1) put meatpacking competition issues in historical perspective, (2) highlight market structure changes in meatpacking, (3) note some key lawsuits and court rulings that contribute to the historical perspective and regulatory environment, and (4) summarize the body of research related to concentration and competition issues. These were the same objectives I stated in a presentation made at a conference in December 2009, *The Economics of Structural Change and Competition in the Food System*, sponsored by the Farm Foundation and other professional agricultural economics organizations.

The basis for my conference presentation and this paper is an article I published, "A Review of Causes for and Consequences of Economic Concentration in the U.S. Meatpacking Industry," in an online journal, *Current Agriculture, Food & Resource Issues* in 2002, http://caes.usask.ca/cafri/search/archive/2002-ward3-1.pdf. This paper is an updated, modified version of the review article though the author cannot claim it is an exhaustive, comprehensive review of the relevant literature.

Issue Background

Nearly 20 years ago, the author ran across a statement which provides a perspective for the issues of concentration, consolidation, pricing, and competition in meatpacking. *"This squall between the packers and the producers of this country ought to have blown over forty years ago, but we still have it on our hands...."* Senator John B. Kendrick of Wyoming, 1919. Senator Kendrick no doubt knew that some of these same issues existed since the 1880s. Shortly after his comment, the Supreme Court issued the Packers' Consent Decree in 1920 and Congress passed landmark regulatory legislation, the Packers and Stockyards Act of 1921, which created the Packers and Stockyards Administration (PSA), later reorganized and renamed the Grain Inspection, Packers and Stockyards Administration (GIPSA), within the U.S. Department of Agriculture (USDA).

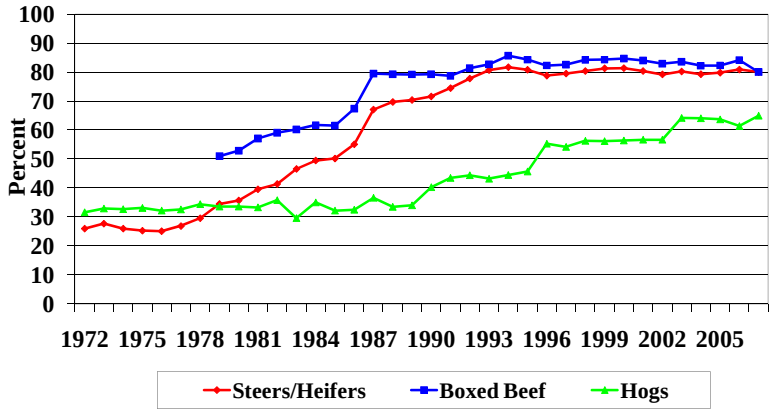
The consent decree and formation of a regulatory agency in USDA may have quieted the waters for a time but many of the same issues surfaced not too many years later. Results of a study published in a reputable economics journal, which the author first saw 20 years ago, contained the following summarization statement. *"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." (Nicholls 1940).

One could trace what might be referred to as the modern era controversy to the late 1960s when Iowa Beef Processors began to be a major force in the meatpacking industry. Their technological innovation of boxed beef combined with questionable and admittedly illegal market penetration tactics into retail markets had a major effect on market structure and economics of the meatpacking industry.

Clear and continuing changes in the structure of the U.S. meatpacking industry have significantly increased economic concentration since the mid-1970s. Figure 1 shows the reported four-firm concentration in steer and heifer slaughter, boxed beef production, and hog slaughter since 1972 based on GIPSA data (Grain Inspection, Packers and Stockyards Administration 2008). These concentration levels will be addressed in more detail later in the paper. Concentration levels are high by many economists' standards, above levels considered by some economists to elicit non-competitive behavior and result in adverse economic performance. However, several civil antitrust lawsuits have been filed against the largest meatpacking firms with no major antitrust decisions against those largest firms, and there have been no significant Federal government antitrust cases brought against the largest meatpacking firms over the period coincident with the period of major structural changes.

Figure 1. National four-firm concentration in steer and heifer slaughtering, boxed beef production, and hog slaughtering, 1972-2007



Source: GIPSA, USDA

Before addressing the concentration data in more detail, let me review the rapid structural changes which occurred in U.S. meatpacking. What economic factors caused the rapid changes and increased concentration?

Structural Changes and Causes

Structural changes in the beef industry preceded similar changes in the pork industry. This review of structural changes focuses on steer and heifer slaughtering-fabricating and hog slaughtering.

In 1976, there were 145 steer and heifer slaughtering plants with annual slaughter of 50,000 head or more (GIPSA 2008 and previous annual reports). These plants slaughtered 22.4 million cattle. Plants with annual slaughter exceeding one-half million steers and heifers annually numbered 5 and accounted for 14.8% of slaughter by all firms in the over 50,000 head per year category. Average slaughter in these largest 5 plants averaged 666,800 head.

Comparable data for 2006, the last year data were reported, show major changes. The number of plants in the category of 50,000 head or more per year had declined to 36 but slaughter in these plants increased to 26.0 million head. Fourteen plants each slaughtered one million or more cattle in 2006. These 14 accounted for 70.2% of total steer and heifer slaughter in the 50,000 head or more size group. Average slaughter per plant in the largest plants nearly doubled from 1976. Annual slaughter in the 14 largest plants averaged 1,302,643 head. The same trend is evident also for boxed beef processing plants.

Not only did *plant* size increase, growth and consolidation resulted in larger beefpacking *firms* as well. There can be little argument that concentration in fed cattle slaughter and boxed beef production is high by economists' standards. In 1976 for steer and heifer slaughter, the four largest firms accounted for 25.1% of total steer and heifer slaughter (a CR4 of 25.1) according to GIPSA data (Figure 1). By 2007, the four largest firms accounted for 80% of total steer and heifer slaughter as well as 80% of boxed beef production. It should be noted that the four largest firms in 1976 were not the same as the four largest firms in 2007. Mergers and acquisitions were largely responsible for the difference in leading firms.

Porkpacking followed a trend similar to beefpacking but changes were not as dramatic. In 1976, there were 141 plants with annual slaughter of 50,000 or more hogs (GIPSA 2008 and previous annual reports). These plants slaughtered 66.0 million hogs and 12 of the plants had an annual slaughter exceeding one million head. Those 12 plants accounted for 28.5% of the total for plants with 50,000 or more hogs slaughtered per year. Average slaughter per plant in the 12 largest plants was 1,569,000 hogs.

The number of plants slaughtering 50,000 or more hogs annually declined to 77 by 2006 but annual slaughter increased to 103.5 million hogs. The number of plants slaughtering one million or more hogs annually increased to 28 and their share of total slaughter in the 50,000 head or more size group increased to 89.9%. Average slaughter for the 28 largest plants increased to 3,325,964 hogs.

As in the beef industry, growth and consolidation led to larger porkpacking firms also. The four largest hog slaughtering firms in 1976 had a combined market share (CR4) of 32.9%. Note the CR4 for hog slaughter two decades ago exceeded that for steer and heifer slaughter. Since then, the CR4 for hog slaughter has not increased as rapidly as it has for steer and heifer slaughter.

However, the CR4 for hog slaughter reached 65.0 in 2006. Again, the largest firms in hog slaughtering in 2007 were not the same as two decades earlier.

The sharp trend toward fewer and larger plants was driven by the enhanced economic efficiency and cost management associated with operating larger firms. MacDonald and Ollinger (2005) cite technology combined with a sharp reduction in packer costs as contributing factors for consolidation in beefpacking. Meatpacking is a margin business. Firms buy livestock at a small range around the market average price. Meatpackers do not control the market average price, i.e., the result of price determination, because they neither control supply nor demand; but packers can influence prices paid around that average price level, i.e., the result of price discovery. They sell meat and byproducts at a small range around the market average wholesale price. Again, they do not control the market average wholesale price but can influence prices received around that average price level. Thus, if gross margins are about the same for all firms, the firm with the lowest costs experiences the largest net margin or profit. Therefore, meatpacking firms search for ways to control costs per unit of output as a means of controlling net margins. As a result, one of the driving forces in meatpacking is the need to be a low-cost slaughterer and processor. And one way to achieve lower costs per unit is to operate larger, more efficient plants at near-capacity levels of utilization. The 1980s saw consolidation of packers and plant closings and reopening to control labor costs, a point clearly shown by MacDonald and Ollinger.

Studies in the 1960s (Logan and King 1965), 1980s (Sersland as reported in Ward 1988; Duewer and Nelson 1991), and more recently (Paul 2001; MacDonald et al. 2000) have found economies of size in cattle slaughtering and fabricating. MacDonald et al. compared their findings with those reported in two previous studies (see Ward 1993 for a detailed comparison of those studies). Sersland used survey data in 1985 for hypothetical plants and operating conditions from beefpacker management while Duewer and Nelson combined economic engineering and simulation with data for 1988. Both were essentially cross-section estimates, whereas the MacDonald et al. study was a time series analysis of Census of Manufactures data for 1963-92. The MacDonald et al. findings showed a slightly greater degree of size economies. A cost index comparison for a slaughter-fabrication plant at an annual output of 175,000 head for the three studies was 116.9, 111.2, and 130.7 for the Sersland, Duewer and Nelson, and MacDonald et al. estimates, respectively. For a 1,350,000 head plant, comparable index values were 81.3, 84.4, and 78.6. Thus, results were quite consistent and confirming of significant economies of size. Paul estimated cost functions with monthly, plant-level cost and revenue data for the 43 largest beefpacking plants in 1992-93. Results for cost economies were very robust. She found significant economies of size, consistent with earlier work.

Research also found economies of size in hog slaughtering (MacDonald and Ollinger 2000). MacDonald and Ollinger examined time series Census of Manufactures data for 1963-92. They compare their findings with one previous study that used cross-sectional survey data for 1996-97 (Hayenga 1998). Assuming reported average cost per head by Hayenga for large plants was indexed at 100, the estimate by MacDonald and Ollinger was 111.7 for a plant slaughtering four million hogs annually. Hayenga assumed full capacity plant utilization, whereas MacDonald and Ollinger used data from actual plant utilization. Less than full capacity utilization leads to

higher average costs compared with operating plants at full capacity (discussed further below).

Size economies research confirms that firms operate larger beefpacking and porkpacking *plants* in order to be competitive. The consistent finding of economies of size is quite robust across a variety of approaches (i.e., economic engineering, simulation, and statistical cost analysis) and data (i.e., both cross-sectional and time series). While the magnitude of estimated economies differs, the overall finding is consistent.

Plant utilization also significantly affects operating costs. Having a larger plant pays dividends in terms of potentially achieving lower costs per head. However, to realize that potential advantage over smaller plants, larger plants must operate at high levels of utilization. A larger plant at lower levels of plant utilization may in fact have higher costs per unit than a smaller plant operated at near-capacity utilization. Research has shown that larger plants operate at higher plant utilization than smaller plants (Ward 1990; Barkley and Schroeder 1996). Thus, larger plants have lower costs per unit than smaller plants both because they are larger and because they are operated at higher utilization. Paul (2001) concluded that larger, more diversified plants (i.e., in terms of processing operations) were more efficient when operated under higher rates of utilization. The importance of high plant utilization appeared in early economies of size studies (Sersland as reported in Ward 1988; Duewer and Nelson 1991) and has been found in subsequent work (Anderson and Trapp 1999; Kambhampaty et al.1996; Paul 2001). The estimated extent varies, but the overall finding is consistent.

Economies of size lead to dynamic structural changes. An example is given here for beefpacking but would apply equally to porkpacking. When a firm expands a plant, say from one-half million cattle per year to one million cattle per year, either by expanding the plant or operating the plant at two shifts per day, the plant experiences lower per-head operating costs. Also, one-half million cattle previously slaughtered by other plants are now slaughtered in a single plant (*ceteris paribus*). Plants losing slaughter volume to the larger plant experience higher costs per unit because their plant utilization decreases. The result over time is that smaller plants experience higher costs and less profit, go out of business, and concentration in meatpacking increases. Evidence of this dynamic element was found in a study by Anderson et al. (1998) of plants exiting the meatpacking industry over the 1991-93 period. Plant-level variables in their model, i.e., plant capacity, age, and extent of horizontal or vertical integration significantly affected the likelihood of plants exiting the industry. Smaller or fringe competitors were more likely to exit already-concentrated markets. Smaller plants exit at higher rates than larger plants, due to smaller plants being less cost competitive.

Market structure changes and increased concentration involved both internal growth and firm consolidation. Firms expanded existing plants as well as purchased closed plants and expanded them before reopening them. There were several plant closings in the early-to-mid 1980s to break union contracts. As indicated, some were expanded and later reopened by the same firm or another firm with much lower costs (MacDonald and Ollinger 2005). Some closed plants, especially smaller ones or ones not well located relative to expanding supplies of livestock, were never reopened.

Consolidation involved firms purchasing individual plants or entire firms. The industry evolved away from the old-line meatpacking names, e.g., Swift, Armour, Wilson, Cudahy to IBP, Excel, Swift Independent and later to JBS, Tyson, Cargill. Thus, concentration increased both from internal growth by larger firms as well as mergers and acquisitions involving the largest firms (Marion and Kim 1991).

The drive to operate larger, more efficient *plants*, capitalizing on economies of size, does not explain by itself the increase in *firm* size, such as via mergers and acquisitions. One factor leading to consolidation is economies of scope. There are several aspects of economies of scope that are relevant to meatpacking. First is the extent of processing activities within a single plant. These may involve slaughtering, fabricating, and hide and byproducts processing. Paul (2001) found evidence that larger and more diversified plants (i.e., in terms of processing operations) have greater technological economies than smaller plants.

A second aspect of scope economies involves firms with more than a single plant, i.e., multiplant firms. Presumably, multiplant firms operate at lower costs per unit than a single-plant firm (assuming plants in both firms are a comparable size). Historically, these economies have been due to spreading overhead and administrative costs across several plants. Ward (1988) argues that multiplant firms have advantages in procuring livestock for one of several plants. Increasing pressures related to food safety suggest another advantage to multiplant firms. Instances can be cited where single-plant firms experienced a food-safety crisis that led to the firm's eventual demise.

Third, there may be economies of scope available to firms that handle both beef and pork relative to firms that specialize in one or the other. These multispecies economies, also inclusive of poultry, may occur in marketing byproducts as well as meat distribution and sales to wholesale and retail buyers. While it is generally believed that economies of scope exist in meatpacking, little research to date has estimated their extent.

Ngugen and Ollinger (2006) found that acquired plants in three meat and poultry industries over the 1977-82 and 1982-87 periods were highly productive before their acquisition. In addition, they found that mergers also improved the productivity of the acquiring firms. However, productivity gains were less for the largest firms, suggesting there is a limit to productivity gains from mergers and acquisitions.

Lawsuits and Regulatory Implications

To some producers and others, market power, oligopsonistic behavior, and price discovery were issues in the 1970s even though four-firm concentration in steer and heifer slaughtering was still in the 20s. A series of lawsuits were filed and later consolidated in the mid-1970s. They were sometimes referred to as the Meat Price Investigators Association (MPIA) case or the Bray case. They were class action antitrust lawsuits filed by producers and others against the four largest grocery retailers, four largest beefpackers, and the leading private market reporting firm. The MPIA case was filed in 1975 when the four-firm concentration in steer and heifer slaughtering was 25.3. The lawsuit dragged out for several years, finally being dismissed in the early 1980s.

Another significant lawsuit was filed in 1985 by Monfort of Colorado, then one of the largest beefpacking firms, against Cargill, another large competitor of Monfort. Cargill agreed to purchase a competing beefpacker to both firms, Spencer Foods. Monfort deemed the acquisition anticompetitve both to itself and to the industry, but the courts ruled in favor of Cargill and allowed the merger to proceed. The Monfort case was filed when four-firm concentration in steer and heifer slaughtering was 50.2. This outcome had a quick and lasting impact as it opened the door to several other mergers and acquisitions in a short time period. The result was a series of mergers and acquisitions in 1987 alone, involving some of the largest meatpacking firms, which increased the four-firm concentration ratio in steer and heifer slaughter by 12 percentage points, from 55.1 to 67.1.

A final, more recent lawsuit also has affected the regulatory environment. By the mid-90s, the four-firm concentration ratio in steer and heifer slaughtering was around 80. Producers filed a lawsuit against IBP in 1996, known initially as the Pickett v IBP case and later the Pickett v Tyson Fresh Meats after Tyson purchased IBP in 2001. A jury in Federal court ruled in favor of the plaintiffs in 2004 and assessed damages of $1.28 billion. However, shortly thereafter, the trial judge set aside the jury ruling and entered a summary judgment in favor of Tyson which was later upheld by an Appellate court.

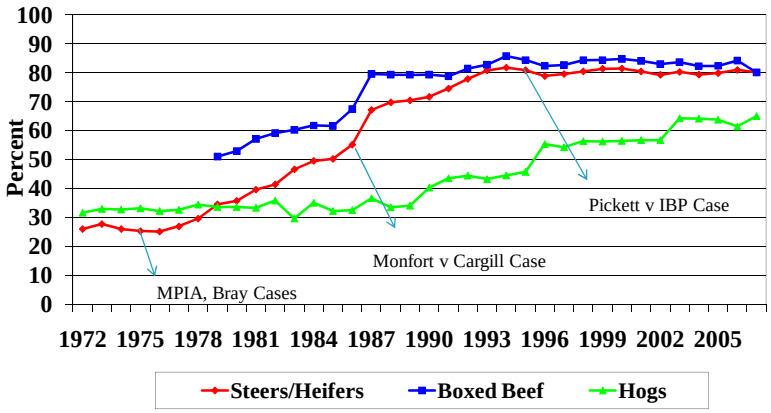
The three lawsuits mentioned here are relevant for a couple reasons. Figure 2 shows the concentration ratios in Figure 1 but with the filing dates of the three lawsuits identified in the figure. Note the difference in concentration level at the three times. Producers and competitors have been concerned about concentration and competition for many years, but to date there has apparently been insufficient evidence presented in court to rule in favor of those concerns.

Regulatory agencies, notably GIPSA and the Department of Justice (DOJ) have been routinely criticized for not halting the trend in concentration. Civil court rulings suggest insufficient, conclusive evidence has been presented for the courts to rule successfully in favor of producers or smaller competing firms. For public regulatory agencies, taxpayer costs of litigation are weighed against the probability of a positive outcome for the regulatory body. A dilemma GIPSA and Department of Justice (DOJ) face is determining what can be done to halt the trend toward increased concentration given the civil court history and apparent lack of conclusive evidence for a successful litigation outcome.

Pricing Behavior Changes

Another clear trend concomitant with increasing plant size, firm size, and buyer concentration is increased packer procurement of livestock by non-cash-price means, both in beef and pork (Ward et al. 2001). A survey of the 22 largest porkpacking firms in 1992 prophetically concluded that production and marketing contracts with pork producers would expand rapidly in the next decade (Hayenga and Kimle 1992). In 1993, the largest porkpackers procured 87% of their hogs through

Figure 2. Significant lawsuits by producers and competitors amidst the rapid rise in national four-firm concentration



Source: GIPSA, USDA

cash market arrangements and the remaining 13% via various types of contracts (Hayenga et al. 1996). A survey of the largest porkpackers regarding hog purchases in January 2001 was compared to previous surveys for 1999 and 2000. Over those three years, spot or cash market purchases declined from 35.8% to 25.7% to 17.3%, respectively (Ward et al. 2001). Thus, the shift from cash market procurement to contracting and vertical integration (packer ownership of hogs) occurred very abruptly.

The trend away from cash market procurement by packers has been more gradual in the beef industry than in the pork industry (Ward et al. 2001). The first year GIPSA collected data on contracting by the four largest beefpacking firms (1988), forward contracts and marketing agreements accounted for 15.8% of steer and heifer slaughter. Since then, the highest level of contracting by the four largest firms was 36.5% for the most recent reporting year (2007) (GIPSA 2008). Packer ownership of fed cattle over the same period increased modestly from 4.7 to 7.0% of steer and heifer procurement.

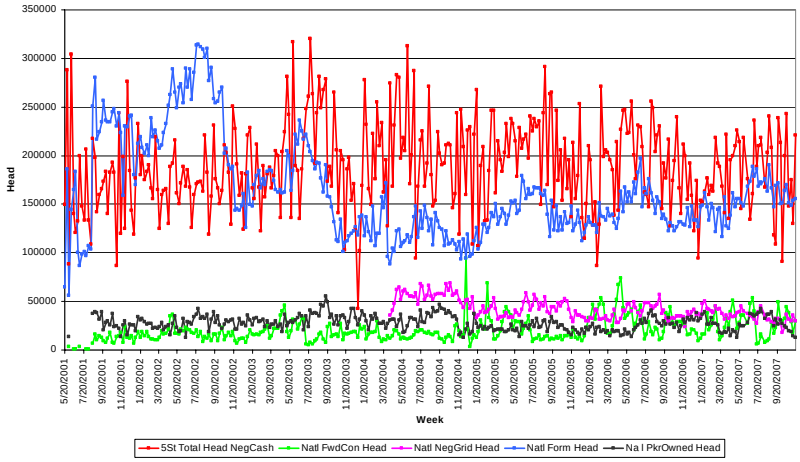
Considerably more and better data are available on packer procurement methods as a result of the Livestock Mandatory Reporting Act. Beginning with its implementation in April 2001, data are now available on weekly prices and volumes of livestock procurement by alternative marketing methods (Ward 2008). Alternative marketing arrangements for fed cattle include negotiated cash trades, negotiated grids (with the base price resulting from buyer-seller negotiation) formula priced trades (typically with the base price tied to a cash market quote or plant average cost), forward contracts (typically with price tied to the futures market or future market basis), and packer owned transactions (for which no price is reported since they are typically internal transfers from one division of the packing firm to another). Alternative

marketing arrangements for hogs include negotiated cash trades, swine market formula priced trades (typically with the base price tied to a cash market quote), other market formula trades (typically with price tied to the futures market), and other purchase methods (which may include window or ledger contracts and cost of production contracts).

The percentage of fed cattle purchased by packers by alternative methods has changed as follows over the 2002-2008 period since the new data have been reported (Ward 2008): negotiated cash 43.8% to 44.4%, negotiated grid pricing 11.0% (for 2004 when reporting began) to 7.1%, formula agreements 48.9% to 38.1%, forward contracts 3.0% to 8.2%, and packer owned 6.2% to 5.7%. Thus, there has been no major trend toward away from the cash market and toward alternative marketing arrangements. Figure 3 shows the variability in weekly fed cattle procurement by alternative procurement methods.

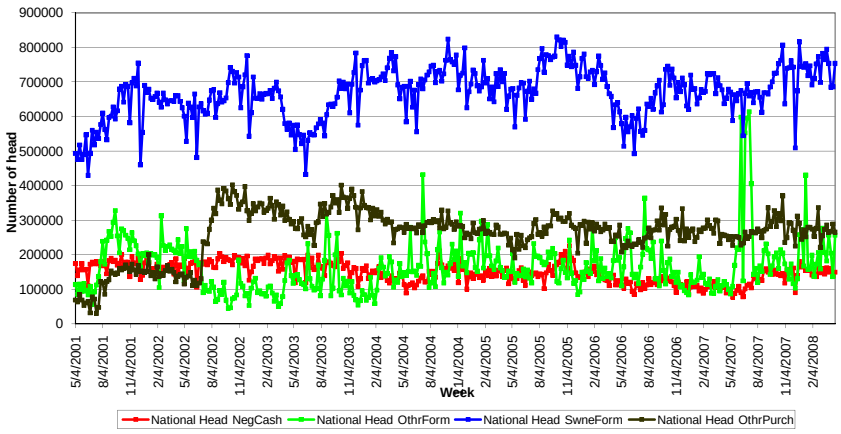
The story for hogs is considerably different. The percentage of hogs purchased by packers by alternative methods has changed as follows over the 2002-2008 period (Ward 2008): negotiated cash 15.5% to 10.3%, swine market formula contracts 55.8% to 55.3%, other market formula contracts 17.8% to 15.8%, and other purchase methods 11.3% to 20.7%. Thus, there has been a trend away from the cash market and toward other purchase methods. Figure 4 shows the variability in weekly hog procurement by alternative procurement methods.

Figure 3. Weekly fed cattle pricing methods by packers since mandatory price reporting, 2001-2008



Source: AMS, USDA

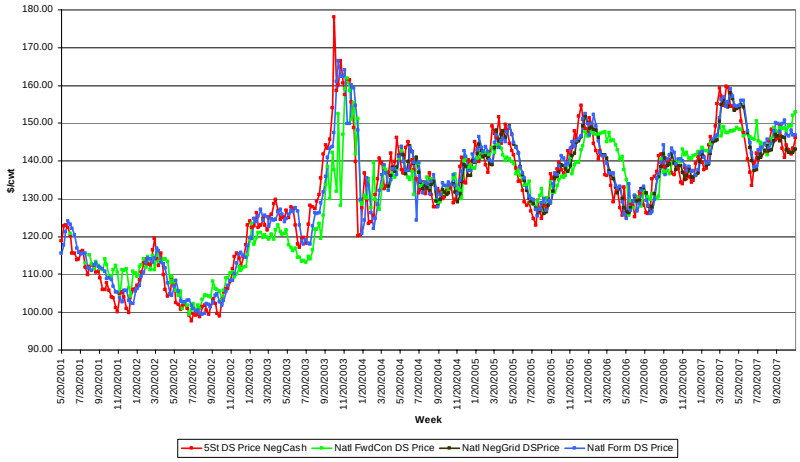
Figure 4. Weekly hog pricing methods by packers since mandatory price reporting, 2001-2008



Source: AMS, USDA

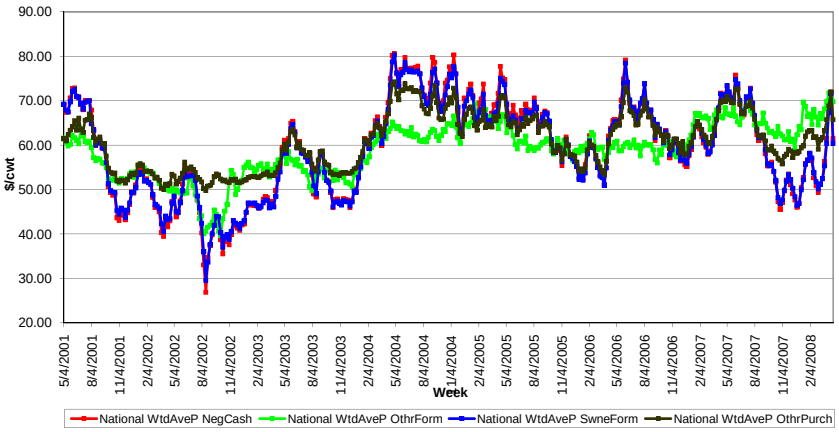
Just as the extent of packer procurement of livestock by alternative methods is important, so is the relationship among prices by alternative methods. Ward (2008) goes into more detail on these price relationships. However, Figures 5 and 6 show the weekly prices for fed cattle and hogs, respectively, by procurement method.

Figure 5. Comparison of fed cattle prices by alternative procurement methods since mandatory price reporting, 2001-2008



Source: AMS, USDA

Figure 6. Comparison of hog prices by alternative procurement methods since mandatory price reporting, 2001-2008



Source: AMS, USDA

Prices for fed cattle track relatively closely for negotiated cash, negotiated grid, and formula agreements but forward contracts do not track the others as closely. The mechanics related to each method and the timing of reported prices for forward contracts explains many of the differences over time, but not necessarily for any given week (Ward 2008).

For hogs, negotiated cash and swine market formula prices track closely, whereas other market formula contracts and other purchase method prices do not. Again, the mechanics of each method help explain why some pricing methods track more closely than others (Ward 2008).

Market and Firm Behavior and Performance Evidence

Agricultural economists have conducted considerable research over the past two-to-three decades on the behavior and performance of livestock and meat markets. Research that addresses market behavior (i.e., leading firms or the market as a whole) is linked directly or indirectly to market performance. Similarly, studies that attempt to measure market performance are implicitly or explicitly tied to market behavior. Thus, here a number of studies are reviewed that pertain to both behavior and performance. Studies are grouped into four interrelated, indistinct categories. Because an individual study frequently crosses category boundaries, one could argue with my choice of discussing them in a given section. Generally, research is discussed in chronological order based on the publication date.

Several studies, especially earlier ones, measure price impacts indirectly from market structure characteristics, without knowing anything about specific conduct or behavior. Examples include using such structural characteristics as number of buyers, bidders, procurement method, and buyer concentration to estimate their effects on prices or margins. This approach tends to be

associated with Bain's (1968) structure-conduct-performance paradigm, which provides a conceptual basis for much antitrust legislation. In recent years, an alternative approach estimating firm conjectures or the conjectural variation approach, has increased in popularity. These studies, estimating conjectures regarding buyer or seller behavior which lead directly to performance measures or outcomes, are sometimes categorized as "new empirical industrial organization" (NEIO) research. Many economists consider the conjectural variation approach superior to the previous, indirect method of measuring price impacts from structural and behavioral changes. However, other economists note shortcomings of this approach and question its presumed superiority (discussed further below). Table 1 (at the end of the paper) identifies and provides a skeletal summary of the research reviewed here.

Price and Market Structure Characteristics

Several, mostly older, studies examine the relationship between prices paid for livestock by meatpackers and various structural characteristics of the marketplace for the respective livestock species. These studies generally adhere to the underlying relationship in traditional industrial organization economics that structural characteristics are causally related to performance outcomes. All research reviewed in this section estimate price-dependent econometric models, which typically hold constant many factors that influence prices, such as supply, demand, quality, quantity, time, and place variables. Thus, the focus of the models and of this review is on the relationship between price and variables related to market structure, e.g., number of bids, number of bidders or buyers (i.e., plants and/or firms), institutional considerations such as marketing/procurement methods, and buyer concentration.

Ward (1981) used transaction data from 1979 to empirically estimate the process packers described in pricing fed cattle. He found a positive significant relationship between prices paid and either number of bids received or number of buyers bidding on each sale lot. Using the same data, he found that prices differed significantly between the smallest buyer and at least one larger buyer in half of the local markets he defined (Ward 1982). Overall, larger buyers did not pay significantly lower prices than smaller rivals.

Annual data for several states in two years (1972 and 1977) were used to relate prices paid by packers and market structure variables, especially state-level concentration (Menkhaus, St. Clair, and Ahmaddaud 1981). Results were consistent regarding the concentration variable. For both years, increased concentration was associated with significantly lower prices. They concluded that the concern over concentration in beefpacking is warranted. It might be noted that concentration in steer and heifer slaughter for the U.S. during the two years they considered was 26% in 1972 and 27% in 1977.

Transaction data from 1979-82 were used to assess the importance and impact of competition on slaughter lamb prices (Ward 1984). In alternative model specifications, he found that prices varied among packers, and the largest buyer based on market share of purchases paid significantly lower prices than the smallest buyer. Prices increased significantly as number of bidders increased and price differences for the teleauction increased in its favor relatively to a larger reference market as number of bidders increased.

Another way to view potential competition is the number of plants in a market area. Discussion above noted the numerous instances of plant closings and less frequent plant openings. Hayenga, Deiter, and Montoya (1986) examined the price impacts from closing and opening hog slaughtering plants in the Corn Belt region. Six plant closings during 1978-81 were studied, along with reopening two of the plants in 1983. Using weekly data, transitory price declines lastly two weeks or more were found for four of the six plant closings and one of the two plant openings. Hayenga, Deiter, and Montoya concluded that concerns about adverse price impacts from plant closings may not be warranted. Adverse effects, when found, were temporary in nature until the market adjusted to the plant closing.

The development of a pilot electronic market for slaughter hogs in 1980 enabled capturing transaction data to examine the relationship between prices paid and increased buyer competition (Rhodus, Baldwin and Henderson 1989). They compared prices observed in HAMS (Hog Accelerated Marketing System) with reference markets for slaughter hogs. Prices received by producers marketing hogs through HAMS were higher relative to traditional hog markets during the1979-81 period. The authors concluded that the electronic market enhanced prices to producers due to increased buyer competition.

Four-firm concentration in lamb slaughtering exceeded that for steer and heifer slaughtering and hog slaughtering until the early 1990s (GIPSA 2008). Thereafter, concentration in steer and heifer slaughtering has exceeded concentration in lamb slaughtering. Concentration in lambpacking has been of concern to many producers and others as well. Menkhaus, Whipple, and Ward (1990) used annual data for four states over the 1972-85 period to examine the effect number of lambpacking plants had on priced paid for slaughter lambs. Results were inconclusive. Evidence was found that prices received by lamb producers in states with only one plant were significantly lower than in states with more than one plant. However, there was no significant difference in prices received in states with 2-5 plants compared with states having more than five plants. They conclude that concerns are justified regarding non-competitive behavior when number of plants declines to a single plant.

A series of mergers in 1987, as noted above, changed the buyer landscape for fed cattle in the southern plains region and created what was called the “big three” packers. Ward (1992) collected transaction data in 1989 similar to that collected ten years earlier to determine whether buyer consolidation affected prices paid for fed cattle. Price differences were found among buyers and prices were positively and significantly association with number of buyers bidding on fed cattle. Both findings paralleled earlier work discussed above. Ward also grouped the three largest buyers into a single variable 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. However, when examined independently, not all of the three largest packers paid lower prices than their competitors.

Marion and Geithman (1995) used pooled cross-section time-series data to study the price-concentration relationship in 13 regional fed cattle markets over the 1971-86 period. They concluded that buyer concentration had a negative, significant effect on fed cattle prices during

the study period. They estimated several model specifications, used alternative estimation methods, and divided the data into various time periods. Their results regarding the effects of concentration on fed cattle prices were mixed. When they estimated the effects for 1971-78 vs. 1979-86, they found that the concentration effect was negative in both periods but more severe in the latter period, which coincided with higher regional concentration. However, when estimating the model for the entire period, the significance of the concentration variable disappeared. They included a variable in some models for the change in concentration and found a positive, significant effect on fed cattle prices. They explain the positive relationship as larger buyers paying higher prices for fed cattle as they increased their market share.

Ward and Hornung (2005) used weekly data for one year prior to and one year following a planned hog slaughter opening in Manitoba, Canada, and an unexpected fed cattle slaughtering plant closing in Kansas. Price difference and partial adjustment models generally confirmed hog prices in the region increased when the Manitoba plant opened. Ninety-five percent of the increase occurred between 3 and 14 weeks. Results for the plant closing differed from expectations and some previous research. The plant closing did not result in consistently lower fed cattle prices in Kansas relative to other markets. In essence, excess plant capacity in nearby, competing plants was able to absorb the fed cattle which would have been slaughtered in the closed plant. The combined results suggest overall market structure characteristics need to be considered when anticipating market effects from plant openings and closings.

Results of another hog plant closing were more consistent with conventional speculation. Raper, Cheney, and Punjabi (2006) examined effects from closing a large plant in Michigan. Prior to the plant closing, Michigan producers had a comparative price advantage relative to eastern Corn Belt producers. However, using monthly data, Raper, Cheney, and Punjabi found that prices dropped in Michigan relative to eastern Corn Belt prices when the plant closed and the price advantage Michigan producers enjoyed before the plant closing disappeared.

Price and Pre-committed Livestock Supplies

Perhaps more contentious than the effects of concentration *per se* on livestock prices has been the effect of pre-committed livestock supplies on livestock prices. Pre-committed supplies were initially referred to in the beef industry and in the agricultural economics literature as captive supplies but have more recently been referred to as alternative marketing arrangements or AMAs. Pre-committed supplies refer to vertical integration of livestock by packers, especially packer ownership of livestock, and various forms of contract coordination between livestock feeders or finishers and packers. Several of the studies reviewed in this section also estimate price effects from pre-committed supplies using econometric models similar to those reviewed in the previous section. However, the focus of these models is on the relationship between prices and pre-committed supplies.

Elam estimated the effects deliveries of pre-committed supplies had on monthly average, fed cattle prices in the U.S. and in selected individual states (Texas, Kansas, Colorado, and Nebraska). 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,

U.S. fed cattle prices declined by $0.03-$0.09/cwt., while for individual states results ranged from not significant to minus $0.37/cwt.

Schroeder et al. (1993) collected transaction data from feedlots in southwestern Kansas during May-November 1990 to examine the relationship between forward contracting (including marketing agreements) and transaction prices for fed cattle. They used two measures of forward contracts. One was contract deliveries as a percentage of the weekly total. The other was each packer's share of contract deliveries for each week. Results indicated a negative relationship between forward contracting and fed cattle prices, ranging from $0.15 to $0.31/cwt. over the six-month data period. Impacts also varied for two-month sub-periods and for individual packers. Price impacts were not significant for some packers and time periods. Related to the previous section, Schroeder et al. found a significant positive relationship between number of bids and prices paid by packers. Also consistent with previous work, they found that prices paid by packers were significantly different over the data period.

Early work estimating price effects from pre-committed supplies lacked a strong theoretical framework identifying the motive(s) for beefpacking firms pre-purchasing cattle supplies. Azzam (1996) developed a conceptual framework for arguing the monopsony-inefficiency motive for integration by beefpackers to capture fed cattle supplies. He estimated the model empirically with aggregated, quarterly data for 1978-93. While the estimate of vertical integration from the model exceeded the level believed to exist, the model provides plausible but not conclusive evidence of the monopsony-inefficiency motive. However, he notes the monopsony hypothesis in the model should be interpreted cautiously.

Azzam (1998) further developed a conceptual model for estimating price effects from pre-committed supplies, without incorporating a backward integration motive. He found that price effects depend on a complex combination of several variables, among them the respective fraction of cash-market and pre-committed procurement supplies. His model suggests that non-competitive conduct is not a necessary condition for negative effects on cash prices from pre-committed (i.e., captive) purchases. Thus, Azzam argued that previous work suggesting the inverse relationship between fed cattle prices and pre-committed supplies is due to non-competitive behavior is not defensible.

The most extensive, detailed data to study price impacts from pre-committed supplies at the time, were made available in a Congressionally mandated study on meatpacking concentration. Ward, Koontz, and Schroeder (1998) estimated price impacts with alternative approaches. They examined the interdependent nature of delivering cattle from three types of pre-committed inventories and purchasing fed cattle in the cash market. And they modeled the impact on transaction prices caused by the size of pre-committed supply inventories from which future deliveries could be made. Transaction data were collected from the 43 largest steer and heifer slaughtering plants, owned by 25 firms, for a one year period, April 1992-April 1993. They found that increasing deliveries of cattle from two of the three types of captive supply inventories were associated with lower transaction prices for fed cattle. A 1% increase in captive supply deliveries, measured in percentages, 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. Simultaneity was found between cash market transaction prices and percentage deliveries of forward contracted and marketing agreement cattle. Coefficients on individual captive supply inventory variables had mixed signs while the coefficient on the total captive supplies variable was not significant. A 1,000 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; an $0.18/cwt. decline for the packer fed inventory; and a $0.02/cwt. decline for marketing agreement inventory. Related to the previous section, Ward, Koontz, and Schroeder found a positive and significant relationship between plant utilization and prices paid by packers, though the magnitude was small. Significant price differences were found among plants and firms. There was a tendency for plants paying highest prices to be larger or located close to the primary cattle feeding area of Texas, Oklahoma, Kansas, Colorado, and Nebraska.

Love and Burton (1999) developed a strategic rationale for backward integration by packers into livestock production or feeding. Their model included various forms of pre-committed supplies, i.e., 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 in their model for pre-committed purchases. Love and Burton argue their results are consistent with previous research. For example, the GIPSA concentration study found:

- beefpackers paid higher prices for marketing agreement purchases than cash market purchases (Ward, Koontz, and Schroeder 1998);
- higher rates of capacity utilization were associated with higher fed cattle prices (Ward, Koontz, and Schroeder 1998);
- higher rates of capacity utilization were associated with higher rates of pre-committed supply usage (Barkley and Schroeder 1996; Capps et al.1999); and
- larger beefpacking plants paid higher prices than smaller plants (Ward, Koontz, and Schroeder 1998).

These results were predicted by the Love and Burton model. They conclude that use of pre-committed supplies by beefpackers can be a potential source of market power. However, they note that market power exertion may not be the prime motive for vertical integration.

Zhang and Sexton (2000) employ a spatial model to illustrate how meatpackers can use pre-committed supplies strategically to influence cash market prices. Their model hinges on the importance of space to processors, i.e., relative shipping costs to product value. As the importance of space increases, the more likely meatpacking plants will create a geographic buffer between them which reduces competition in the cash market.

Most of the studies cited to this point estimate impacts of pre-committed supplies, while some are more theoretical or conceptual in nature. A point which needs to be made is that there are economic motives for buyers and sellers to employ pre-committed supply methods in marketing and procurement. Ward et al. (2001) report results of a survey of porkpackers and beefpackers regarding their motives for using pre-committed supply methods to improve coordination of the supply chain. Porkpacker respondents indicated their two highest rated motives were to secure more consistent quality of hogs and secure high quality hogs. Beefpacker respondents also rated highest the need to secure more consistent quality cattle and to secure higher quality cattle.

Schroeter and Azzam (2003) used transaction data provided by GIPSA to examine the relationship between cash-market prices and pre-committed supplies. Data were from four plants in the Texas panhandle region for the period, February 1995-May 1996. Schroeter and Azzam distinguish between market-level and plant-level components of the broader relationship between cash-market prices and pre-committed supplies. They provide a conceptual framework and estimate a plant-level model. The researchers conclude packers tend to pay lower cash-market prices relative to the regional average when anticipated near-term deliveries of pre-committed supply cattle are high relative to total slaughter volume and to rivals' reliance on pre-committed supplies. However, again the magnitude of this impact is small, estimated to be $0.02/cwt. lower than the regional market average price. Packers with a relatively high reliance on pre-committed supplies tend to pay slightly lower prices than packers whose reliance on pre-committed supplies is lower.

With the same data, Schroeter and Azzam (2004) build on institutional characteristics of marketing agreements and forward contracts to test the effect on pre-committed supply deliveries from prior-week changes in cash-market prices. For example, cattle feeders typically have discretion over the number of cattle delivered weekly in marketing agreements but packers have discretion over the day(s) deliveries occur. Schroeder and Azzam found that expected price changes significantly affect marketing agreement deliveries but had less importance for forward contracts.

Figure 3 shows that formula pricing of fed cattle accounted for about 38% of fed cattle purchases over the 2001-2008 period. Most such contracts are priced by a formula tied to the cash market, either a quoted price for a specified region and time or a plant average price where the cattle will be slaughtered. Prices tied to a specified quoted price may be called top-of-the-market contracts because sale prices are tied to a "market top" or highest reported cash price for a given time, often the preceding day or week. Xia and Sexton (2004) develop a theoretical model to examine top-of-the-market-pricing (TOMP). They found that such formula pricing had anticompetitive implications when these contracts are exclusive and the same set of buyers operate both in the contract and cash markets. Xia and Sexton note that contracts may be individually rational for sellers but harmful for cattle feeders as a group.

Crespi and Sexton (2004) use Texas panhandle transaction data from the same study as Schroeter and Azzam (2003, 2004) to study bid shading in the price discovery process, which they liken to a first-price auction. For their empirical analysis, they develop a set of packer bid functions to simulate highest losing bids, which were unavailable to them in the data set on actual transactions. They found simulated bids were significantly higher than actual sale prices for each of the four packing plants in 80-86% of the transactions. They found that some buyers systematically did not bid for some lots of cattle, many lots of cattle were sold with just a single bid, and there was little switching by feedlots between packers buying their cattle.

Also using the Texas panhandle transaction data, just as Crespi and Sexton (2004), Hunnicutt, Bailey, and Crook (2004) examined the stability of feedlot selling behavior. They found consistent, stable buyer-seller relationships, which they attribute in part to buyer and seller efforts to reduce transaction costs. Feedlots were found to frequently deal with a single packer

both for contracted cattle and cash market cattle.

Congress mandated a study of alternative marketing arrangements (AMAs) in 2003. The study was similar to but broader than the Congressionally mandated concentration study of 1996. Muth et al. (2008) focused on the price differences and price risk differences across AMAs for fed cattle. They used transactions from 29 of the largest beefpacking plants from October 2002 through March 2005. These 29 plants were owned by 10 firms. Data included 591,000 sale lots averaging 100 cattle per lot, or an estimated 85% of fed cattle slaughtered during the study period. They found auction transactions were $0.11/cwt. higher than direct trade cattle, the most common marketing method, but variability, a measure of price risk, was highest for auction-priced cattle. Forward contract prices were lowest but price risk was the second highest. Direct trade, marketing agreement, and packer owned trades were within $0.01/cwt. of each other. Compared to direct trade transactions, price risk was lower for packer owned and marketing agreement cattle.

Most research on pre-committed supplies focuses on fed cattle. The Congressionally funded AMA study also included research on hogs. Vukina, Shin, and Zheng (2009) argue the importance of testing for complementarities in procurement for AMAs, especially in light of legislative proposals in Congress to alter or eliminate some AMAs. Researchers had access to 1.6 million transactions (sale lots) from 29 porkpacking plants owned by 15 firms for the period October 2002 to March 2005. They also had monthly profit and loss statements from 18 plants owned by 6 firms. They confirmed economies of plant size in porkpacking but indicated their estimated economies were less than the output of some of the largest plants. They found the efficient scale of operations were narrowly clustered around 44 to 47 million pounds of carcass weight per month. Regarding estimated plant performance from using AMAs, they found plant performance improved for various combinations of AMAs relative to plants using only cash market purchases. In addition, they found that packers which used a portfolio of marketing arrangements, on average paid lower prices for hogs than packers that used the cash market only.

Concentration and Margins

Marketing margins have been a topic of research interest in the agricultural economics profession for a long time. One point of interest is whether or not market structure characteristics affect marketing margins, i.e., farm-wholesale, wholesale-retail, or farm-retail. The basis for these studies is the presumed linkage between market structure and economic performance. Structural characteristics may allow firms to behave in a manner leading to lower input prices, higher output prices, or a combination of both. In any of those cases, marketing margins would widen (*ceteris paribus*).

Schroeter and Azzam (1990) extend the conjectural variation approach from Schroeter (1988) to meatpacking firms processing more than one livestock species, i.e., beef and pork. Specifically, they estimate the degree of monopoly/monopsony power in farm-retail price spreads. They estimate their model with quarterly data for the period 1976-86. They found evidence of monopoly/monopsony conduct and estimated that nearly half of farm-retail price spreads for beef and pork (55% and 37%, respectively) can be attributed to monopoly/monopsony distortions. It should be noted that Schroeter and Azzam assumed fully-integrated meatpacking

firms and ignore all vertical relationships in the industry. They also note data limitations in estimating the model.

Schroeter and Azzam (1991) develop a conceptual framework to decompose marketing margins into components, including oligopsony and oligopoly price distortions. They empirically apply the model to the porkpacking industry with weekly data for 1972-88. Note that during this period, four-firm concentration in hog slaughter ranged from 31.6 in 1972 to 33.5 in 1988 according to GIPSA data. They found that oligosony and oligopoly price distortions were not significant for the period studied, but also were not zero. In testing for differences in sub-periods (i.e., 1980s compared with 1970s), Schroeter and Azzam found evidence for less concern about oligopsony and oligopoly price distortions in the latter period than the earlier period, despite increased regional concentration in hog slaughter.

Brester and Musick (1995) used monthly data for 1980-92 to study the effect concentration in lambpacking had on farm-wholesale and farm-retail marketing margins. Results showed that increases in lambpacking concentration had small, positive effects on marketing margins, both farm-wholesale and farm-retail. However, Brester and Musick do not conclude that lambpacking firms used market power to lower slaughter lamb prices or raise retail prices, since the widening margins may be associated with increased costs of processing as the industry converted from carcass to boxed lamb processing and distribution.

One objective of an Economic Research Service study was to estimate the effect concentration has had on farm-wholesale and wholesale-retail marketing margins in the beef industry (Matthews, Jr. et al. 1999). They estimate an asymmetric price adjustment model to determine whether or not price spreads change at the same rate when prices are decreasing as when prices are increasing. They examined monthly data for 1979-96 and for the sub-period 1992-96. Using the Herfindahl-Hirshman Index (HHI) as the measure of concentration in beefpacking, they included it in the asymmetric price adjustment model. For the entire period, there was no significant effect on marketing margins from increasing concentration. However, for the sub-period, there was a positive, significant effect. Thus, increased concentration was associated with higher fed cattle prices and lower farm-wholesale marketing margins. While unexpected based on the hypothesis of non-competitive behavior, the positive effect was small. Matthews, Jr. et al. hypothesize that gains experienced from capitalizing on economies of size may be shared with cattle feeders, consistent with previous research (Ward, Koontz, and Schroeder 1998).

Ward and Stevens (2000) approach the question of concentration impacts on marketing margins by examining price linkages from the producer-to-retail level in the beef chain. Data were monthly observations over the 1974-94 period. They found that increased beefpacker concentration did not translate into a weakening of the price linkage between producers and packers or between packers and wholesale (i.e., purveyors-processors). They found evidence that most of the pricing behavior change occurred at the retail level, not the packer level. They further note that concentration has not adversely influenced the speed of price transmission in the beef chain. They conclude that increased beefpacker concentration had little aggregate effects on price linkages between producers and packers.

Oligopoly and Oligopsony Market Power

Several studies reviewed in this section reflect the increased preference for the conjectural variation approach. The intent is to measure directly the effect behavior has on performance, i.e. the existence of oligopoly/oligopsony (or monopoly/monopsony) price distortions and evidence of market power. However, other studies use alternative approaches as is noted.

Schroeter (1988) was the first to apply the conjectural variation approach to beefpacking. He developed a conceptual framework and applied it to annual data for the 1951-83 period. He found significant conjectural elasticity estimates for 28 of the 33 years. Monopoly and monopsony price distortions were relatively modest according to Schroeter, about 3% and 1%, respectively. There was little evidence the degree of monopoly or monopsony distortion had increased during the later years of the study, when beefpacking concentration was beginning to increase sharply.

Azzam and Pagoulatos (1990) modify the conjectural variation approach to allow different conjectures for input and output markets. They estimate the model with annual, Census of Manufactures data for the meatpacking industry for the years 1959-82. Recall that during this period, concentration in meatpacking was relatively low compared with later years. Azzam and Pagoulatos found non-competitive behavior in both the output and input markets. Further analysis revealed the extent of oligopsony power was significantly higher than that for oligopsony power.

One limitation of conjectural variation studies reviewed to date is the extent of data aggregation. Azzam and Schroeder (1991) recognize this problem especially as it relates to the input market for beefpacking where markets were believed to be more regional or local in nature. They develop a model to estimate oligopsony price distortions in 13 regional, fed cattle procurement markets. They calibrate the model to approximate the distortion across markets in 1986 then used simulation to determine the price distortion estimates for varying levels of regional beefpacking concentration and behavior. Subjecting the model to sensitivity analysis, they compare their results with previous research using econometric modeling. Azzam and Schroeder 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 (Ward 1981; Menkhaus, St. Clair, and Ahmaddaud 1981; Marion and Geithman 1995). They conclude that their results indicate less danger of falling fed cattle prices, i.e. oligopsony price distortion, as a result of increasing buyer concentration than had been found in previous research.

Limitations of the conjectural variation approach are noted by Koontz, Garcia, and Hudson (1993). They argue that conjectural variations say nothing about optimal pricing strategies of firms and that often data used are highly aggregated. They study non-competitive behavior in short-run pricing of fed cattle by beefpacking firms. Non-cooperative game theory is used to explain possible tacit collusion among rival packers. They show that in order for collusive behavior to be optimal, rival firms follow a dual strategy. Firms will follow a cooperative pricing strategy at times and pay sub-competitive prices; while at other times, they follow a non-cooperative strategy and pay competitive prices. Daily fed cattle prices from four regional

markets for two time periods were used in the empirical estimation. Times chosen were two periods of relative structural stability in the beef industry, 1980-82 and 1984-86. They found evidence of oligopsony behavior consistent with trigger pricing strategies in all regions and both time periods. Their estimated conjectures 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.

Stiegert, Azzam, and Brorsen (1993) constructed a system of demand and supply equations in an imperfect market setting to examine pricing implications when fed cattle supplies are anticipated or unanticipated. They recognize that beefpacking firms are quantity-driven. Economies of size and utilization affect costs, which in turn directly affect profitability. Therefore, fed cattle supplies are critically important in measuring market behavior and its impacts. They use quarterly data for 1972-86. Their results suggest beefpacking firms follow average cost rather than marginal cost pricing, consistent with Ward's (1988) hypothesis and other research. Fed cattle were priced below marginal value in 31 of 59 quarters. The markdown during periods of anticipated supply were consistent with average cost pricing. Packer response to unanticipated supplies suggested that pricing response is dependent on the size of the supply shock. Small shocks tend to be associated with average cost pricing. They conclude that decreasing buyer concentration is unlikely to result in improved (i.e., higher) fed cattle prices.

Economies of size suggest increased efficiencies have occurred over time in meatpacking as structural changes have taken place. Several studies also have found oligopoly or oligopsony price distortions associated with the same structural changes which have led to increased concentration in meatpacking. Azzam and Schroeter (1995) address the tradeoffs in efficiency gains and oligopsony losses. They develop their model for the beefpacking industry in general, and then specifically for regional fed cattle procurement. They use a baseline period which corresponds in their estimation to the 1986-88 period, then use sensitivity analysis to consider impacts from further structural changes (i.e., increases in regional concentration but lower processing costs) and increased olipgopsony pricing. Overall they found 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 anti-competitive effects from a 50% increase in beefpacking concentration. Their estimate of actual cost savings was 4%. Thus, they conclude structural changes have been welfare enhancing in the beefpacking industry.

Concomitant with structural changes in the meatpacking industry has been the decreased consumer demand for red meats (Purcell 2000). Weliwita and Azzam (1996) consider declining demand's impacts on beefpacking behavior. They argue that an oligopoly or oligopsony will behave as a cartel and become more competitive with an unexpected decline in output demand. In a game theory framework, firms will not distinguish between declining demand and rivals cheating, thus inducing a punishment period. Weliwita and Azzam test for cooperative pricing behavior after unexpected declines in beef demand. They develop the conceptual model and apply it to quarterly data for 1978-93. 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, within the range of those found in previous research.

Driscoll, Kambhampaty, and Purcell (1997) test for short-run profit maximizing behavior of beefpacking firms. They argue that if profit maximization is not followed, then estimates of conjectural elasticities are biased. They devise a nonparametric test for profit maximization and apply it to weekly data from 15 plants in two regions for a one-year period in 1992-93. They apply the test to weekly, plant-level data, then merge data into four levels of aggregation, ultimately to monthly, firm-level data. They found that plants and firms did not appear to follow profit-maximizing behavior, both for weekly and monthly data. Plants regularly operated at production levels below those needed to achieve static profit maximization. Results are consistent with hypothesized behavior proposed by Ward (1988), that meatpacking firms use average cost pricing and may be profit satisficers. Driscoll, Kambhampaty, and Purcell found very little evidence of oligopolistic or oligopsonistic behavior when profit maximization was assumed, consistent with small price distortions found in previous research. They argue that use of conjectural variations is inappropriate when short-term, static profit maximization is assumed. However, they do not rule out profit maximizing behavior over several periods.

One assumption commonly, and arguably incorrectly, made in conjectural variation studies is fixed proportions technology according to Muth and Wohlgenant (1999). They develop a model relaxing this assumption in favor of variable proportions or substitutability among the non-specialized inputs. They contend their approach requires less data in the empirical estimation process and apply the model to annual data for 1967-93. They found negligible oligopsony price distortion, contrary to previous models using fixed proportions.

Koontz and Garcia (1997) extend the Koontz, Garcia, and Hudson (1993) non-cooperative game to measure the competitiveness of beefpacking firms across regional fed cattle markets. Multi-plant firms encounter each other in multiple markets. The Koontz and Garcia model enables accounting for firm behavior in all relevant markets. They use daily data from eight regional fed cattle markets for the periods 1980-82 and 1984-86. 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 was the finding that the extent of oligopsony was small and that the effect was greater in the earlier period than the latter period, despite regional concentration being higher in the latter period. Overall, Koontz and Garcia conclude that oligopsony behavior in fed cattle procurement is non-constant over time and space.

While oligopsony and oligopoly price distortions have been found in some studies, Schroeter, Azzam, and Zhang (2000) explore the oligopoly question in relation to the retail market. Specifically, they develop a model 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 1990-94, they conclude the data best fit a model of oligopsony behavior by retailers. They found that meatpackers were price-takers with little or no evidence of oligopoly behavior.

Paul (2001) estimated oligopoly and oligopsony power with monthly, plant-level cost and

revenue data for the 43 largest beefpacking plants for a one-year period in 1992-93, data collected as part of the Congressionally mandated concentration study. She also estimated cost functions and found results both for cost economies and market power to be very robust. Her findings confirmed significant economies of size, as discussed above. In addition, she found little evidence of price-depressing, oligopsonistic effects for fed cattle. Her findings are consistent with previous research on tradeoffs between cost efficiency gains and oligopsony losses (Azzam and Schroeter 1995).

The data Crespi and Sexton (2004) used to study bid shading in the price discovery process was also used to estimate the extent of markdown prices (Crespi and Sexton 2005). Recall data were based on Texas panhandle transactions from four plants for the period, February 1995-May 1996. Their empirical model estimates the magnitude of bid shading based on winning bid probabilities. They use censored regression to estimate losing bids and use those estimates in conjunction with known winning bids to develop the winning bid probabilities. Markdown pricing based on the Lerner index ranged from 5-10%, with an index for all plants of 6.5%. In terms of dollars, estimated markdown ranged from $3.40/cwt to $6.92/cwt and averaged $4.51/cwt. These markdown estimates were larger than most previous research which was generally 3% or less. Two points should be noted. First, results depend critically on the accuracy of computing losing bids and the authors assumed all packers bid on all lots of cattle, an assumption they and others found not to be the case (Crespi and Sexton 2004; Hunnicutt, Bailey, and Crook 2004). No consideration was given to long-term buyer-seller relationships. Ward (2007) found in an experimental setting designed to capture highest losing bids that buyer-seller relationships matter, just as Hunnicutt, Bailey, and Crook found. Few transactions involved bids from more than 2 packers and multiple pen purchases were common, indicating packers often bid on pooled lots, thereby reducing transaction costs. Crespi and Sexton estimated average losing bids were 2.6% below actual transaction prices. In the Ward (2007) experiment, observed average losing bids were 0.5% below actual transaction prices. Results in the experimental model cannot be assumed to accurately predict the real-world market but caution must be used in accepting estimates with real-world data when assumptions are questionably appropriate.

Game theory was used with experimental data by Carlberg, Hogan, and Ward (2009) in an extension of previous game theory research (Koontz, Garcia, and Hudson 1993; Koontz and Garcia 1997). The model estimated the percentage of collusive and reversionary periods as well as the degree of market power packers exerted during each period. Experimental data from three semester-long classes were used. The first semester was a class in which no specific experiment was employed. During the second semester, a marketing agreement was imposed on the experimental market between the largest packer and the two largest cattle feedlots. In the third semester, an experiment was imposed which altered market participants' access to publicly reported data in the experimental market. For two of the three semester-long periods, the dual-regime model was found, indicating the presence of trigger strategy behavior. The market conduct parameter was considerably higher for the collusive regime than the reversionary regime in all three semesters. Thus, this research found evidence in the experimental market of packer market power in fed cattle procurement. The authors conclude such research needs to be conducted with industry data.

Zheng and Vukina (2009) use structural econometrics to test whether the use of AMAs by porkpackers is the source of market power on cash market hog prices. Data came from the same Congressionally mandated study of AMAs as in Vukina, Shin, and Zheng (2009). AMAs were combined and compared with cash market prices for hogs. As expected, the AMA price was closely related to the cash market price. Packer market power increased with an increase in AMA volume, similar to previous research for fed cattle. Higher pre-committed supplies mean less need to purchase cash market hogs and packers can negotiate better (lower) prices. Researchers found evidence of market power but the part of market power attributed to AMA volume was not statistically significant. Thus, they conclude the origin of market power is likely related to traditional oligopsony concentration issues. Percentage markup in the pork market was 6.7% and percentage markdown in the hog market was 1.1%., which the authors indicate were both in the range of previous research.

Summary of the Evidence

Table 1 summarizes the research reviewed in this paper. Research varies widely in terms of data, i.e., data unit aggregation (transactions to annual observations), collection length (one month to decades), and spatial aggregation (local market to the entire U.S.), as well as methodological approach, i.e., numerous econometric models, simulation, game theory, etc.

Azzam and Anderson (1996) conducted an extensive review of competition in meatpacking. In their summary, they offer criticisms both of the structure-conduct-performance approach and conjectural variation approach. They concluded that the body of empirical evidence was insufficient to persuasively argue the meatpacking industry was not competitive. Sexton (2000) reports on more recent critiques of the conjectural variation approach. Despite its weaknesses, he concludes that market power estimates in meatpacking (i.e., the focus of much of the conjectural variation literature) are modest and structural changes on balance are probably beneficial from an efficiency viewpoint. Note his conclusion in 2000 was before subsequent research on TOMP and bid shading research he did with others.

In this author's opinion, research shows a dynamic, bi-directional linkage between structure, conduct, and performance. This exhibits itself from research measuring indirectly the linkage between structure and performance as well from research measuring directly the linkage between behavior and performance. In both cases, economic performance carries implications for future market structure and behavior.

Both the structure-conduct-performance approach and the conjectural variation approach share a related weakness. In the Bainsian structure-conduct-performance approach, excessive emphasis is placed on a single structural characteristic, i.e., the concentration ratio or HHI, as a predictor of conduct and performance. In the conjectural variation approach, emphasis shifts to a single conduct variable, i.e., the conjectural variation coefficient, as a descriptor of conduct and predictor of performance. In either case, relatively little emphasis is placed on the "how," especially the competitive dynamics of rivals' reactions.

Besides the "how" of exercising market power, another issue of importance emerges. Most of

the research on price impacts and market power estimates leads to questions of the form, "How large is large?" or "How small is small?" Price distortions of 3% or less were found in most studies. These fall well short of regulatory agency standards related to merger impacts and non-competitive behavior, i.e. often assuming a 5% price impact rule (U.S. Department of Justice and Federal Trade Commission). However, the courts and regulatory agencies have not defined specifically how much market power is "significant" and for how long a firm or firms must maintain significant market power (Carlton and Perloff 1994).

From a related vantage point, seemingly small impacts on a $/cwt basis may make a substantial difference to livestock producers and rival meatpacking firms operating at the margin of remaining viable or being forced to exit an industry. In relatively low-profit businesses, "small" degrees of market power can have significant profit implications. Even "small" $/cwt or percentage impacts represent large, total dollar sums, especially summed over long time periods. To some, these large dollar sums provide clear targets for antitrust lawsuits, conclusive evidence of lax antitrust enforcement, and undeniable grounds for corrective legislation.

Conclusions

Having spoken to numerous producer and processor groups over the past 35 years, followed structural changes in meatpacking during that time, conducted some of the relevant research, and reviewed others' research pertinent to the issue, a question is posed to me frequently. What should be done or what can be done to reverse the trend? Some people of course want to do nothing and allow the market to function unencumbered by external regulations and constraints. Other people literally want to turn back the clock. They would administratively alter the market structure where problems seemingly occur, i.e., break up large meatpacking firms initially, and restrict presumably problematic behavior, i.e., eliminate contracting and vertical integration (packer ownership of livestock). Some people want to treat agriculture as a unique sector of society and create laws and regulations applicable to agriculture alone, regardless whether or not they apply to other sectors of the economy. Relatively little thought is given in many cases to public and private costs, or to public and private benefits, of these alternatives, especially since they are codependent with the rest of the economy.

From the review written here, the author identifies these conclusions.

- From a long historical perspective, names of meatpacking firms change but many of the same allegations of meatpacker abuse continue.
- Evidence of structural changes is clear. Meatpacking firms have increased greatly in size through internal growth and from mergers and consolidations. The result has been fewer and larger plants, fewer and larger firms, and much higher levels of concentration.
- Structural changes stem in large part from economies of size in meatpacking and the emphasis on reducing costs to be competitive with rival firms. Research on economies of size is quite consistent and robust.
- Evidence of behavioral changes is clear also. Meatpacking firms no longer rely solely on the cash market for livestock purchases. These changes are in response to livestock owners in some cases as well as the need to improved coordination and reduce costs to be competitive with rival firms and competing meats.
- No clear evidence from civil antitrust cases points to actions regulatory agencies could or

should have taken to reverse the trends in structural or behavioral changes.

- Relatively consistent research on pre-committed supplies suggests use of alternative marketing arrangements by packers is associated with lower cash market prices for livestock though the magnitude of lower prices is quite small. Further, some research fails to connect this finding to abusive use of pre-committed supplies.
- Research on oligopoly/oligopsony power is mixed. Game theory research provides evidence packer behavior is consistent with a trigger pricing strategy. Where market power has been found, whether oligopoly power or oligopsony power, the market power magnitude is relatively small in most cases and seemingly within an "acceptable" public policy level. But there are exceptions, and the larger magnitude exceeds the "acceptable" public policy level.

In total, research findings do not consistently and convincingly identify serious problems, though many studies point to small or potential problems and raise several issues. Determining the need for legislative or regulatory reform is difficult, as is identifying what the reform measures should be that would be corrective, without being disruptive and injecting unintended, negative consequences.

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Table 1. Summary of Relevant Research on Market Structure and Conduct Impacts