Industrialization and Consolidation in the U.S. Food Sector: Implications for Competition and Welfare

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Food processing, distribution, and retailing activities account for the majority of retail food and beverage costs for all major U.S. commodity groups, and the share of costs attributable to these marketing activities is rising over time. Consider, for example, the U.S. Department of Agriculture's "market basket" of food products. The farm share of the market basket remained stable at about 40% from 1960 to 1980 but declined rapidly since then, to 30% in 1990 and 22.2% in 1998. Given its expanding importance, behavior in the marketing sector has an increasingly important effect on the welfare of both consumers and farmers.

Much has been written recently about the evolution of the food processing and distribution sector toward ever higher levels of food manufacturer and retailer concentration and increasing vertical coordination across market stages. In some cases the changes have been sudden and dramatic, as a few examples illustrate:

- The top twenty food manufacturers accounted for over 50% of food-processing value added in 1995, more than double the corresponding share in 1954.
- Rapid escalation in the four-firm concentration ratio (CR4) occurred in key industries:
  - beef packing—from 30% in 1978 to 86% in 1994,
  - malt beverages—from 40% in 1967 to 90% in 1992,
  - wheat milling—from 30% in 1969 to 77% in 1995,
  - pasta manufacturing—from 34% in 1967 to 78% in 1992.
- The top six supermarket retailers now control 50% of supermarket sales, versus 32% in 1992. Concentration in local grocery markets is, of course, much higher.

Good sources for information on recent developments in food-market structure include Barkema, Drabenstott, and Welch; U.S. Department of Agriculture (1996b), and Rogers. My objective is not to add to this literature, but, rather, to consider what we have learned as a profession about the rapid consolidation in food processing and distribution. What are its implications for market power, economic efficiency, and the distribution of economic welfare among producers, consumers, and marketers?

Historical Context of Industrial-organization Work in Agriculture

I specifically upon the application of modern industrial-organization (IO) concepts to study the food-marketing sector. Industrial-organization research has a rather long, if not well-known, history within agricultural economics, dating back at least to work in 1933 by Cassels, who provided a lucid classification of market structures and who presented a framework for investigating market behavior which conforms closely with what later became known as the structure-conduct-performance (SCP) paradigm. The first analytical treatise on industrial organization in agriculture was published in 1941 by Nicholls, who presented a sophisticated analysis rich in agricultural applications of

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Waugh Lecture.

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Cournot and Bertrand models of oligopoly-oligopsony, bilateral monopoly, product differentiation, and price discrimination. At about this same time, Hoffman published an influential monograph that documented the growth of firms and increasing concentration in each of the major agricultural sectors. Hoffman framed the policy issue in terms of balancing the efficiency virtues of large-scale operations against the problems of monopolistic control. Some sixty years later, the same issue confronts us, perhaps with greater urgency.

Hoffman's and Nicholls' work did not generate much interest in an IO approach to agricultural market analysis. Rather, interest shifted to what proved eventually to be the rather unfruitful concept of workable or effective competition (Clark). Workable competition was based on an inherently normative concept—the belief that most markets could not meet the stringent requirements of perfect competition—and adherents sought instead to identify desirable economic outcomes that were practically attainable (Sosnick).

The study of workable competition proceeded contemporaneously and in intellectual harmony with the development of the SCP framework. The SCP paradigm was grounded in a loose economic theory, which posited that structural characteristics of an industry (degree of buyer-seller concentration, extent of product differentiation, and conditions of entry) determine the conduct of firms in the industry (price and output policies, product development and promotion policies, and behavior toward rivals), which, in turn, determines the market performance (price-cost margin, production efficiency, relative expenditures on advertising and promotion, product character, and progressivity). This approach was introduced in agricultural economics in 1961 in an influential article by Clodius and Mueller. It became the dominant paradigm for conducting IO analyses in agriculture for the ensuing twenty-five years.[1]

A particularly influential set of ten agricultural industry studies with a strong SCP influence was published in 1966 under the auspices of the National Commission on Food Marketing. The Commission's summary report argued that, even at this time, concentration had reached undesirably high levels in various segments of the food system, especially in grocery manufacturing, and that spending for advertising and sales promotion had attained excessive levels. The Commission rejected the notion that growth in concentration was necessitated by economies of size, asserting that "firms tend to grow, especially by merger and acquisition well beyond the size needed to attain full operating efficiency (p. 106)." What might the members of the Commission conclude if they witnessed today's food-marketing landscape?

A Model Framework to Study Industrial-Organization Issues in Agriculture

The so-called "new" IO refers to both conceptual and empirical approaches. The conceptual advances were primarily a product of progress in analysis of noncooperative games, beginning with Nash's concept of equilibrium, and later its extension to dynamic games through the concept of subgame perfection (Selton) and then to games of uncertainty through development of solution concepts such as sequential equilibrium (Kreps and Wilson) and perfect Bayesian equilibrium (Fudenberg and Tirole).

Many interesting problems in agricultural marketing can be represented rather simply as a game with two stages. Stage 2 is when production, pricing, and consumption take place simultaneously, and players receive payoffs. If production is assumed to be homogeneous (i.e., no product differentiation), then a firm's strategic variable in stage 2 will be its output choice and Cournot's equilibrium will be utilized. If product differentiation, whether achieved through brand recognition, quality differences, or spatial dispersion, is an issue, firms in stage 1 will generally be modelled as price setters and Bertrand's equilibrium will be utilized.[2]

Stage 1 is usually the primary focus in two-stage game models, and what transpires

[1] Key early references on application of SCP models to agricultural markets include Collins and Preston and Imel, Behr, and Helmberger. More contemporary classic works in the SCP tradition include Connor et al. and Marion.

[2] If Bertrand (price-setting) competition was utilized with homogeneous products, the equilibrium price would be set at the level of the marginal costs of the highest cost seller who produced a positive output, making the concept rather uninteresting and uniformative for such games. Cournot (quantity-setting) competition could be utilized in models with product differentiation but usually the mathematics favor Bertrand competition, and it is also natural to think of price as the strategic variable in differentiated product settings. A priori choice of a solution concept in almost all models of production is, however, a legitimate criticism of such models.

in stage 1 depends upon the researcher's objective. For example, my work with various colleagues has involved the decision by a coalition of consumers to enter the market as a cooperative and an incumbent's response to that entry if it occurs (Sexton and Sexton), the decision of beef packers whether to offer "captive supply" contracts, and feedlot operators' decisions whether or not to accept such contracts (Zhang and Sexton 2000a), a marketing board's decision as to expenditure on generic advertising (Zhang and Sexton 2000b), and spatially dispersed processors' decision to adopt either an FOB or a delivered pricing strategy (Zhang and Sexton 2001). In the two-stage game framework, stage 1 decisions are made in rational anticipation of their impact on the stage 2 equilibrium.

Stage 2: A Basic Framework

A key consequence of the industrialization of agriculture is the possibility of both buyer and seller market power and also market power manifest at multiple stages of the market chain (e.g., by both processors and retailers). Here I will set forth a simple but relatively flexible model of an integrated food-marketing sector that accommodates both oligopoly power in selling the finished product to consumers and oligopsony power in procuring the agricultural commodity from farmers. Models that focus only on oligopoly power or on oligopsony power run the risk of (a) understating the extent of the market-power distortion and/or (b) erroneously attributing distortions to the wrong form of market power. The model extends readily to accommodate market power at multiple stages of the market channel. See Sexton and Zhang for details.

Consider an industry where an integrated processing-retailing sector procures a primary agricultural product from farmers, performs processing functions, and then sells a homogeneous final product to consumers at retail. For simplicity, I will generally refer to the integrated marketing firms as "processors." Consumers' inverse demand for the retail product is

$$(1) \qquad P^r = D(Q^r|X)$$

where Q^r is the market quantity of the retail product, P^r is the market price, and X denotes demand-shift variables. Variables in X fall into two categories. One is truly exogenous variables, such as consumer income and prices of related goods. The other is demand-influencing variables that are under the processing firms' or the industry's collective control at a prior point in time. Examples include expenditures on generic or brand advertising or investments in product quality. Choices as to these variables can be studied in stage 1 in the two-stage framework, based upon players' recognition of the impact of their choices on the subsequent stage 2 competition. In stage 2, however, the stage 1 choices are fixed and are exogenous.

In most applications it remains appropriate to assume that farmers are price takers in their output market. Inverse farm supply may then be expressed as

$$(2) \qquad P^f = S(Q^f|Y)$$

where P^f is the price received at the farm, Q^f is the total volume of farm shipments, and Y represents supply-shift variables. Similar to the role of X in retail demand, Y will normally contain truly exogenous variables such as prices for inputs into farm production, but it might also contain variables that are under processing firms', the industry's, or the government's control at a prior point in time. Agricultural research is a good example. It might be funded by government, a producer-funded industry board, or even imperfectly competitive processors (Zhang).[3] Choices as to elements of Y can also be studied in stage 1, with recognition of their impact on stage 2 behavior.

I usually represent the marketing sector in a particularly simple way that enables the research to focus most directly on the implications of alternative forms of competition in the processing-retailing sector. Key assumptions are (a) a fixed number, N, of identical processing-retailing firms, (b) fixed proportions in converting the farm commodity into the finished product, and (c) constant returns to scale in processing. Obviously no industry is depicted accurately through these assumptions, but that is not the point. The key dimension is that the simplifying assumptions

[3] Competitive processors would generally not have incentive to fund farm production research, but as Huang and Sexton, and Alston, Sexton, and Zhang (1997) show, imperfectly competitive processors may capture a large share of the benefits from farm-sector research and, thus, have an incentive to fund such research. However, Zhang shows that processor expenditures will often be crowded out by collective expenditures funded by government or an industry board.

must not bias the analysis of competition in any particular direction, and the aforementioned assumptions generally meet that criterion.

Given the above assumptions, I can depict a representative processing-retailing firm's variable cost function as

$$(3) \qquad C = c(V)q + S(Q^f|Y)q$$

where q is the output of the representative firm, and $Q = Q^r = Q^f = Nq$, where N is the number of processing-retailing firms.[4] Per-unit processing costs are $c(\cdot)$. The cost-shift variables in V can be given the same general interpretation as the variables in X and Y, and can also be the object of choice in stage 1 if desired.

The representative processor-retailer's profit function can be expressed as

$$(4) \qquad \Pi = D(Q|X)q - [S(Q|Y) + c(V)]q.$$

Maximization of (4) with respect to q yields a first-order condition that can be written in elasticity form as

$$(5) \qquad P^r\left(1 - \frac{\xi}{\eta}\right) = P^f\left(1 + \frac{\theta}{\epsilon}\right) + c$$

where η and ϵ, respectively, are the retail price elasticity of demand and the farm price elasticity of supply, and ξ and θ are market conduct parameters (sometimes called conjectural elasticities) that measure the extent of processor-retailer market power. Specifically, $\xi \in [0, 1]$ measures departures from competition in selling the finished product at retail, with $\xi = 0$ denoting perfect competition, $\xi = 1$ denoting pure monopoly or a perfect seller cartel, and $\xi \in (0, 1)$ denoting various degrees of oligopoly power, with higher values of ξ denoting greater departures from competition. $\theta \in [0, 1]$ plays a similar role in terms of procurement of the farm product. Values of 0 and 1 denote, respectively, perfect competition and pure monopsony and increasing values of θ in the interval $(0, 1)$ denote greater levels of oligopsony power. See Zhang and Sexton (2000b) and Sexton and Zhang for details.

Given the assumptions of the model, equation (5) represents an industry equilibrium condition that can be solved jointly with equations (1) and (2) to determine the equilibrium values for the endogenous variables P^r, P^f, and $Q^r = Q^f$ as functions of η, ϵ, ξ, θ, $f = 1 - c$ and the exogenous variables X, Y, and V.[5] To obtain an explicit solution, functional forms must be assumed for the retail demand and farm supply functions in (1) and (2), respectively. In prior work (Alston, Sexton, and Zhang (1997); Sexton and Zhang; and Zhang and Sexton (2000b)), we have usually chosen simple linear or double log representations for (1) and (2).[6] Given a set of values for X, Y, and V, which essentially fix the demand, supply, and unit processing cost intercepts in the linear model, and by taking advantage of the data normalizations that are available, these studies show that the stage 2 equilibrium in the base model can be expressed solely in terms of five market parameters: η and ϵ, the market demand and supply elasticities, ξ and θ, the oligopoly and oligopsony power parameters, and f, the farm sector share of final product revenues under perfect competition.[7] In most applications, and η and ϵ generally appear only in the ratio form $\phi = \eta/\epsilon$, thereby reducing the relevant parameter choices to four.

A principal virtue of this approach to modelling imperfect competition in agricultural markets is that it can represent any market configuration ranging from perfect competition to pure monopoly and/or monopsony. It also allows for the presence of both oligopoly and oligopsony power, while maintaining considerable simplicity, as manifest by equilibrium values depending upon only four or five parameters in addition to whatever elements of X, Y, or V are under consideration. This simplicity enables an analysis to focus on other decisions of interest that would be depicted in the game's first stage.

Stage 1

Let payoffs to a representative processor, consumers, and farm producers be

[4] The assumption that $Q^r = Q^f$ is made at no additional cost of generality, given the assumption of fixed proportions in converting the farm product to a finished product.

[5] Cournot's equilibrium is an important special case of the model. Given the assumptions of the model, Cournot's equilibrium is represented by $\xi = \theta = 1/n$, where n is the number of processing firms.

[6] Alston, Sexton, and Zhang (1999), however, set forth a "generalized linear model," which intoduces one additional parameter in the demand and supply curves and is able to depict strictly convex or concave demand and supply functions and nest as special cases linear, quadratic, and square root demand and supply functions.

[7] We choose monetary units so that the final product price under perfect competition is 1.0. Then $f = 1 - c$ is the farm share of product revenue under perfect competition.

represented, respectively, by the processor's profit, Π, consumers' surplus (CS), and producers' surplus (PS). Each of these payoff measures is a function of equilibrium prices and output from stage 2, which, in turn, are functions of ϕ, ξ, θ, and f and the exogenous variables X, Y, and V,

$$\Pi = \Pi^*(X, Y, V, \phi, \xi, \theta, f)$$
$$\text{CS} = \text{CS}^*(X, Y, V, \phi, \xi, \theta, f)$$
$$\text{PS} = \text{PS}^*(X, Y, V, \phi, \xi, \theta, f).$$

The asterisk denotes that these payoff functions embody the equilibrium behavior emerging from stage 2. Suppose, for example, that we are interested in the expenditure of funds, Y, to support farm-production research. Then the payoffs facing the market participants in stage 1 are $\Pi^*(Y|\phi, \xi, \theta, f)$, $\text{CS}^*(Y|\phi, \xi, \theta, f)$, and $\text{PS}^*(Y|\phi, \xi, \theta, f)$.

How to proceed at this point depends upon the structure of the problem under investigation. For example, in the context of farm-production research, three possibilities present themselves readily: First, is that the research is funded by an industry-marketing board supported by a producer tax, in which case the logical objective in stage 1 is the selection of Y to maximize $\text{PS}^*(Y|\phi, \xi, \theta, f)$. The presence of imperfect competition in the market will distort the optimal research expenditure from its level under imperfect competition. A second possibility is that the research is funded publicly, in which case an appropriate stage 1 objective might be the maximization with respect to choice of Y of the sum of CS, PS, and Π. Finally, imperfectly competitive processors may voluntarily fund farm-sector research as a way to reduce input costs. In this case, the objective of each processor i would be to choose Y_i to maximize $\Pi_i^*(Y_i|\phi, \xi, \theta, f)$. This latter scenario is the most complicated of the three considered because it involves the simultaneous choice of research investment by multiple decision makers and implementation of Nash equilibrium as a solution concept.

Empirical Implementation

A well-structured conceptual analysis developed along these or similar lines can generate a host of useful insights about imperfectly competitive agricultural markets, as I will later illustrate. The basic stage 2 framework is also readily amenable to empirical analysis, including estimation of η, ϵ, ξ, θ, and tests of market power, if suitable data are available. The basic model consists of equations (1)–(3), and (5). In most applications, consumer demand and farm-product supply are expressed in simple linear or logarithmic forms. The processing cost function, $c(V)$, is expressed as a flexible function, typically a generalized Leontief, and the associated conditional demand functions for the inputs represented in V are derived via Shephard's lemma and estimated jointly with the system. In such an estimation, primary interest focuses upon the conduct parameters, ξ and θ, contained in (5). Because estimation of the full system often proves intractable, a common alternative is to avoid estimation of the consumer demand and farm-supply functions and to use extraneous estimates for the necessary elasticity values, η and ϵ.

An empirical analysis structured along these lines represents an example of what has been called the new empirical industrial organization (NEIO) because the estimation is based on a formal structural model of the market and also because the focus of such studies is typically a single industry rather than a cross-section of industries as was common with studies in the SCP tradition. This genre of empirical study was first applied in an agricultural market setting in 1988 by Schroeter.[8]

Evaluation of the Empirical Work on Imperfect Competition in Agricultural Markets

What have we learned about market power in food processing and distribution? I will first summarize the implications of the collected empirical research and then will make some evaluative comments. A more detailed discussion is available in Sexton and Lavoie. First, in highly concentrated industries, a positive (negative) correlation between concentration and selling (purchasing) price exists. This correlation has been found rather consistently across many SCP studies of food-processor oligopoly and oligopsony power and food-retailer oligopoly power.

[8] A related conceptual framework relies on a production function rather than on the cost function framework to depict the processing technology. Gollop and Roberts' analysis of U.S. coffee roasting represents a first application of this approach, and Azzam and Pagoulatos' investigation of U.S. meat packing extends the approach to investigate both oligopoly and oligopsony power.

The NEIO studies of processor behavior have generally found some statistical evidence of market power, although the measured departures from competition have mostly been small, with point estimates of θ or ξ often being less than 0.2 (the market-power equivalent of that produced in a five firm symmetric Cournot equilibrium). Because these studies have naturally been conducted in industries where structural conditions suggest the possible presence of market power, these results on the whole suggest that market power has, in the past, not been a very important factor in the food-processing sector.

The extant empirical work does, however, have a number of limitations. I will discuss some issues pertaining to the empirical analysis of market power in the food-marketing sector by referencing work done on the U.S. beef-packing industry. This choice is not intended to single out the beef-sector studies for particular criticism. Rather, because the U.S. beef-packing sector has been the subject of more empirical studies of market power than any other industry in the world, it represents an excellent case study on the evaluation of market power.

The extensive focus on the beef-marketing channel owes to the stunning increase in concentration in the sector that occurred during the past twenty-twenty-five years. The rise in concentration in beef packing was fueled by technological change and declining demand. During the 1960s the boxed-beef technology was introduced, wherein carcasses were processed into individual cuts, packed, and shipped from the same plant where slaughter took place. This capital-intensive technology resulted in expanded economies of size in the industry. In addition, declining consumption of red meats led to excess capacity, triggering a wave of mergers and acquisitions during the 1970s and 1980s (Purcell). From 1978–94, the CR4 rose from 30 to 86%. It is even higher today.

Congress in 1992 commissioned the U.S. Department of Agriculture to investigate the effects of concentration in the industry. This study alone resulted in seven technical reports which are summarized in U.S. Department of Agriculture (1996a).[9] Studies of the beef-packing sector conducted within the SCP framework (e.g., Menkhaus, St. Clair, and Ahmaddaud; Marion and Geithman) found a negative relationship between concentration (generally measured as the CR4) and the price paid to ranchers, and a positive correlation between feedlot size and price received, suggesting possible countervailing power. Using transactions price data to examine the determinants of fed cattle prices, Ward (1981, 1992) found that feedlot prices are positively correlated with the number of buyers bidding for the purchase.

In his early application of the NEIO framework to the U.S. beef market, Schroeter rejected price-taking behavior but found that distortions from competitive pricing were modest in magnitude—on the order of 3% in output sales and 1% in input purchases. Azzam and Pagoulatos studied meat packing as an aggregate industry. Through their production function formulation (see footnote 8), they were able to obtain point estimates of conjectural elasticities of both oligopoly power ($\xi = 0.223$) and oligopsony power ($\theta = 0.178$). Schroeter and Azzam developed a multiproduct model of the meat-packing industry, treating pork and beef as separate products, but not allowing oligopoly and oligopsony conjectures to differ. This study also rejected price-taking behavior, although the estimated $\theta = \xi$ parameters were small in magnitude. Azzam (1992) rejected price-taking behavior by U.S. beef packers in farm product purchases but not in processed product sales. Koontz and Garcia also found statistically significant but modest levels of packer oligopsony power.

However, in contrast to the majority of prior studies Muth, who analyzed oligopoly power, and Muth and Wohlgenant (1999a), who analyzed oligopsony power, failed to find any evidence of market power. They attributed the different results to the prior authors' assumption of a fixed proportions and constant returns processing technology. Most recently Azzam (1997) and also Morrison Paul (1999, 2000) argued that technological change and cost economies are the most important factors driving the beef-packing sector, and that market power played a relatively minor role.

The most well-known critiques of empirical research on market power are criticisms of the SCP studies into the profit-concentration relationship. These include the Demsetz critique of the interpretation of profit-structure studies and Fisher and McGowan's critique

[9] Among the technical reports is a detailed survey of research on the competitiveness of the U.S. meat-packing industry by Azzam and Anderson.

of the use of accounting data to infer market power. Although responses to these critiques can and have been made, the drift of the SCP literature has been away from studies of profits and to the analysis of price-structure relationships within a single industry. The aforementioned SCP studies of cattle pricing are examples of this trend, and in my view such work provides convincing evidence as to the price effects of consolidation in the food chain.[10]

Perhaps due to their more recent vintage, there has been less formal criticism of the NEIO studies. One aspect that was discussed critically was the conceptual underpinnings of market-power parameters such as ξ and θ. In the context of their formal interpretation as "conjectural variations," ξ and θ are used to attempt to model a dynamic phenomenon (i.e., action and reaction) within a static framework. However, recent practice has been to specify first-order conditions such as (5) without any direct reference to θ or ξ representing conjectural variations. They are simply empirical indices or "conduct parameters" that measure the departure of a given market from competitive outcomes. Recent work by Corts, however, casts doubt upon estimation of ξ and/or θ under this interpretation. Corts shows that empirical estimates of ξ or θ are generally incapable of measuring the underlying market power in an industry unless, in fact, the data used in the estimation represent equilibria from a market in which the firms do behave in accord with a conjectural variations model.

Two additional general criticisms can be levelled against empirical work on the food and beverage industries conducted within the NEIO framework. The first is the range of "maintained hypotheses" that is present in most works. A prominent example is the reliance in essentially all of the studies upon particular *ex ante* choices of functional forms and explanatory variables for market demand and/or supply and processor technology. A second key example involves implicit assumptions, usually perfect competition, in the production stages that are not the immediate objects of study.

As a result of the maintained hypotheses in structural NEIO models, the researcher is always testing a joint hypothesis—whatever is intended to be tested plus the maintained hypotheses of functional form, competition at other market stages, etc. This criticism applies, of course, not just to studies of market power and is the launching point for nonparametric analyses of demand, production, and market power.[11]

The problem of maintained functional form is mitigated partially when the researcher utilizes flexible functional forms. In NEIO studies, the processing technology is often represented by such functions, but retail or wholesale demand and/or farm supply are usually represented by simple linear or double log functions, or else the needed elasticities are obtained from extraneous estimates. Because the demand and/or supply estimation is often not the researcher's primary focus, specification of these functions may not receive the same attention as other aspects of the work, but the consequence can easily be biased estimates of market power.[12] Herrmann and Sexton provide an illustration where rather minor variations in the specification of the demand function for German banana imports result in quite different conclusions as to importer oligopoly power.

Two important issues present themselves regarding specification of the processing-marketing cost function. First is the issue of technical change. Most applications of the NEIO models proceed with annual data at the industry level. To obtain sufficient observations, these applications may study thirty or more years of industry data, during which time significant technical change will almost inevitably have occurred. Indeed, as in the case of beef, technological change may be a

[10] Nonetheless, a modified version of the Demsetz critique was levelled against the SCP studies of price based on a quality argument. According to this reasoning, the most successful firms provide the best quality products and related service, thereby receiving price premiums or paying discounted prices and attaining large market shares. For example, in the context of the beef-sector studies, it might be argued that large buyers offer better service than small buyers (e.g., prompt and reliable payment, secure market outlet, technical assistance) thereby enabling them to pay lower prices. A similar argument can be constructed for why large sellers may earn price premiums.

[11] See Ashenfelter and Sullivan and Love and Shumway for applications of the nonparametric approach to examining oligopoly power and oligopsony power, respectively.

[12] A simple example can illustrate this point. Suppose we are investigating oligopoly power only in a homogeneous product industry. The relative price (P) marginal cost (MC) gap can be expressed as $(P - MC)/P = \xi/\eta$. Estimation results at a given data point reveal the $(P - MC)/P$ expression to be 0.25, i.e., a 25% markup above marginal costs. Suppose the estimated or assumed demand elasticity at that observation was $\hat{\eta} = 2.0$. Then, oligopoly power equivalent to $\xi = 0.5$ (i.e., a Cournot duopoly) is indicated by the data. Suppose, however, that demand elasticity at the data point is, in fact, only $\eta = 1.2$. Then the data indicate market power equivalent $\xi = 0.3$.

driving force behind the market consolidation that has inspired concerns about market power.

Most NEIO studies have addressed technological change, if at all, through very simple means such as time trends. Incorporating more sophisticated methods is not necessarily straightforward because of data limitations and convergence problems in the highly nonlinear empirical models. Failure to estimate processing costs accurately can bias estimates of market power in ways similar to the problems caused by failure to generate good estimates of demand or supply elasticities (see footnote 12). Morrison Paul's recent work on beef packing is a good example of careful specification of costs and technological change and led her to conclude that technological change and not market power was the primary force driving the industry.

A second issue with respect to the cost-function estimation that arises mainly in agricultural applications concerns the elasticity of substitution, σ, between the farm input and other inputs in producing a finished product. Most authors have assumed that no such substitution exists, but Muth and Muth and Wohlgenant (1999a, 1999b) attributed several authors' empirical finding of market power in the beef industry in part to their failure to allow for substitution in their model frameworks. (See footnote 14 for a perspective on this issue.)

The tendency of the NEIO studies of the food industry is to investigate oligopoly or oligopsony power at one stage of the market, typically the processing sector, while maintaining implicitly an assumption of perfect competition at other stages of the market.[13] Although there may sometimes be good economic rationale for this decision, often there is not because any structural bases for concern about oligopoly power usually imply parallel concerns about oligopsony power and vice versa. In addition, the consolidation of agricultural markets involves both the manufacturing and retailing sectors, so market power at successive stages in the market channel is often a relevant issue. How does an erroneous assumption about competition on one side of the market affect inferences about market power on the other side of the market?

Consider, for example, the wholesale-farm price spread for beef. A point of obvious interest in the beef-packing industry has been the interplay between the efficiency gains in the sector due to the advent of the boxed-beef technology and the economies of size from consolidation of packing plants, and the possible losses from oligopsony power caused by the consolidation.

Azzam (1997) recently analyzed the farm-wholesale price spread for beef and concluded that the positive efficiency impacts from consolidation dominated a small negative impact due to oligopsony power. However, the wholesale beef price is determined by interactions between beef packers and food retailers, and the case could certainly be made that this relationship might be characterized by packer oligopoly or by retailer oligopsony. If either is true, it means that a model that seeks to explain the price spread solely in terms of input prices, technological changes, and oligopsony power is misspecified. Indeed, recent work by Schroeter, Azzam, and Zhang addressed precisely the question of bilateral market power in the wholesale beef market and concluded that the data most supported a hypothesis of retailer oligopsony power. If the wholesale price is depressed by retailer market power, then the extent of packer oligopsony power over producers is probably understated.

More research is needed on the implications of the various maintained hypotheses for our ability to draw inferences about market power. Additional Monte Carlo studies along the lines of Hyde and Perloff and Raper, Love, and Shumway could help to answer these questions.

A second general criticism of the NEIO studies has been their architects' failure in many cases to think carefully about the markets they intend to analyze before conducting the actual analysis. Antitrust actions that evolve around market power begin with definitions of the relevant market, both in geographic and product form dimensions. Only when these issues are settled does the action proceed to assess the actual exercise of market power. This sequence is fundamental to studying market power. Of what relevance is it to ask whether a firm or a group of firms exercise market power without having

[13] An alternative approach is to assume that market power is identical in both the farm-product and the finished-product markets, i.e., $\xi = \theta$ [Schroeter and Schroeter and Azzam]. Because of likely differences in the relevant geographic and product markets for the farm product versus the finished product, this practice also has limitations. Azzam and Pagoulatos and Wann and Sexton present two alternative approaches that allow ξ and θ to differ within a vertical market.

first answered what are the relevant geographic and product markets within which the firms operate? Most NEIO applications in agriculture treated market definition issues superficially at best. The work on the beef channel provides examples of the problem. Some applications studied meat packing in aggregate. Others focused on specific meats. If all meat is a relevant product market, then beef alone is not. Despite evidence that cattle are seldom shipped more than 300 miles, various studies investigated packer oligopsony power using data aggregated to the national level, without questioning whether the relevant geographic markets are regional in scope.

A factor contributing to poorly defined product or geographic markets is that many NEIO and aggregate SCP studies used data collected for reasons other than economic analysis such as the U.S. standard industrial classification (SIC) data. Data at the level of aggregation in the four-digit SIC codes often contain a variety of products which are mostly linked through a common agricultural input, not by end use. For example, SIC 2015 is poultry and egg processing, and Bhuyan and Lopez (1997) found moderate oligopoly power ($\xi = 0.289$) in this category for the period 1972–87. Five-digit SIC categories within SIC 2015 include young chickens, turkeys, other poultry, and liquid, dried, and frozen eggs. Other examples of empirical analyses of market power that clearly failed to define relevant markets include Holloway and more recently Reed and Clark (2000), where processed fruits and vegetables, fresh fruit, fresh vegetables, and dairy were among the "markets" studied. As these examples indicate, in most cases the problem is working with data that imply an overly broad definition of the market. My conjecture is that in working with data that are too aggregate and markets that are too broad we bias analyses against findings of market power.[14]

What Do We Know About the Effects of Market Power in Food Processing and Distribution?

A plausible conclusion to draw from the empirical work conducted to date is that market power by food manufacturers and/or retailers is an issue in the more concentrated markets, but that the exercise of market power is not extreme. In the notation of this paper, measured values for ξ and θ are small, mostly 0.2 or less. However, many of these conclusions were based on data sets that end around 1990 or earlier and commence in the 1960s or 1970s. Thus, arguably most of the extant empirical work misses the rapid consolidation of recent years that continues to the present and may well understate the extent of market power present today. Also unclear is how and in what direction the limitations discussed in the prior section influenced results.

Given this state of knowledge, let me offer and provide evidence in support of a number of loose propositions concerning the efficiency and the distributional impacts of market power in the food chain:

- Efficiency (deadweight) losses from market power are small and are exceeded in most cases by efficiency gains from consolidation.
- Distributional losses to producers and consumers from market power vastly exceed the pure efficiency losses, both on an absolute and a percentage basis.
- Producers and consumers on balance have been harmed by the increasing concentration in the food-marketing sector, i.e., the gains from enhanced efficiency of marketing have not offset the distributional losses from market power.
- Market power in processing and distribution reduces incentives to undertake

[14] The issue of substitution in processing between the farm input and other inputs in best considered in the context of the appropriate product definition for market-power analysis. The studies cited most commonly in support of substitution, Wohlgenant and Goodwin and Brester, both rely on highly aggregative product categories. Wohlgenant studies the same product categories as utilized by Holloway and Reed and Clark, whereas Goodwin and Brester analyze all food and kindred products as a single product category. The "substitution" these authors appear to have in mind is allocation of a particular farm commodity among different final product uses. For example, Wohlgenant writes, "The food-marketing sector produces a plethora of products (for at-home and away-from-home consumption) from any given raw material, so opportunities for substitution between marketing services and raw food quantities appear to exist." (p. 242) For example an outcome from higher cattle prices is likely an increase in the relative allocation of beef to restaurants and less for at-home consumption because higher cattle prices will effect the cost of beef in restaurants relatively less than the cost of beef consumed at home. Certainly a pound of beef consumed in a restaurant contains more "marketing services" than a pound consumed at home, a fact which may be viewed as substitution of marketing inputs for raw beef in response to changing relative prices. However, it is not at all clear that beef at home and beef in restaurants are in the same product market from an antitrust perspective. In general, the more aggregate the product categories, the more likely that substitution will appear to take place, but the less likely it is that the category constitutes a relevant product market.

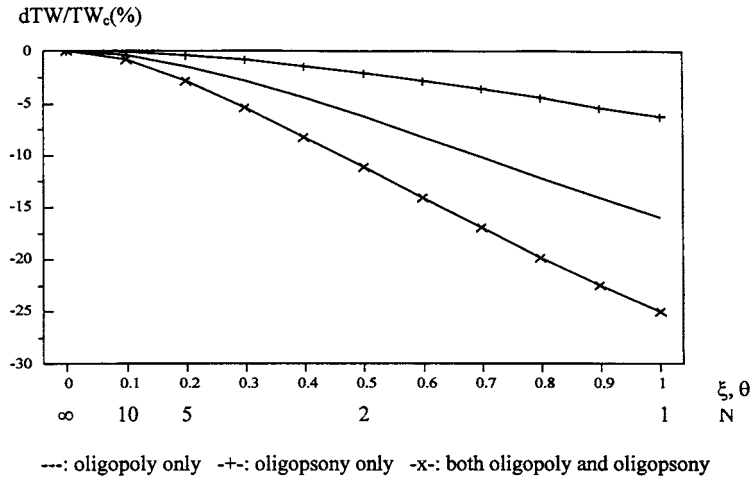

Figure 1. The effect of market power on total welfare

demand-expanding or cost-reducing activities at the producer level, and these effects represent additional welfare losses from market power.

Welfare losses from market power in the food and tobacco sector have been studied rather extensively, most recently by Bhuyan and Lopez (1995) and Peterson and Connor. However, work to date has focussed on food manufacturers' market power as sellers of a finished product, ignoring impacts of possible manufacturer oligopsony power and also of retailer market power.

The modest exercise of market power anywhere in the market channel of a magnitude suggested by the prevailing empirical work does not generate much efficiency or deadweight loss. Rather, the effects are primarily distributional, transferring surplus to the market agent possessing the power. Figure 1 illustrates the percentage reduction in market surplus from the competitive level for alternative magnitudes of oligopoly power, oligopsony power, and joint oligopoly-oligopsony power, based on a linear version of the market model summarized in equations (1), (2), (4), and (5).[15] The percentage reduction in total welfare (TW) relative to competition is only 0.4% for $\theta = 0.2$ and $\xi = 0$ (oligopsony only), 1.4% for $\xi = 0.2$ and $\theta = 0$ (oligopoly only), and 2.8% for $\theta = \xi = 0.2$ (joint oligopoly-oligopsony).[16] The effect of oligopoly power in the market is more severe than oligopsony power, *ceteris paribus*, because the farm product represents only a portion of the final product value.[17] However, the welfare loss increases at an increasing rate as a function of the market power as figure 1 illustrates, so efficiency losses can be large in more severe cases. For example, $\theta = \xi = 0.5$ causes a deadweight loss of 11.1%.

Figure 2 presents information on the impacts of market power on consumer and producer welfare (given $\eta = \epsilon$ in the base simulation, the relative impacts on consumers and producers are the same). Even modest market power as manifest by $\theta = \xi = 0.2$ reduces consumers' and producers' welfare by 31% relative to competition. Either oligopoly or oligopsony power is harmful to both producers and consumers because each's welfare is a monotone function of output, and either form of market power diminishes output. Figure 3 illustrates the distribution of income among producers, marketers, and consumers for alternative magnitudes of joint oligopoly and oligopsony power. For the base simulation depicted in the figures, the distribution of welfare under perfect competition is two-thirds to consumers, one-third to producers, and none to marketers, given the constant returns marketing technology assumed in (3). The distribution for $\theta = \xi = 0.2$ is 48% to consumers,

[15] The simulation results presented here assume that $\phi = 1$(*i.e.*, $\eta = \epsilon$) and $f = 0.5$ a 50% farm share under perfect competition. See Sexton and Zhang for a more detailed discussion.

[16] Figures 1–7 feature dual horizontal axes. The first axis depicts values for ξ and/or θ, while the second axis depicts values for N, the number of marketing firms. This axis depicts the magnitude of market power if one assumes Cournot competition.

[17] However, as (5) makes clear, the distortion from market power is always determined jointly by the market-power parameter and the elasticity of the demand curve, in the case of oligopoly power, or the elasticity of the supply curve, in the case of oligopsony power. Thus, if farm supply is sufficiently inelastic relative to consumer demand, oligopsony power can generate larger distortions than oligopoly power. This case does not arise in the simulations discussed here because $\eta = \epsilon$.

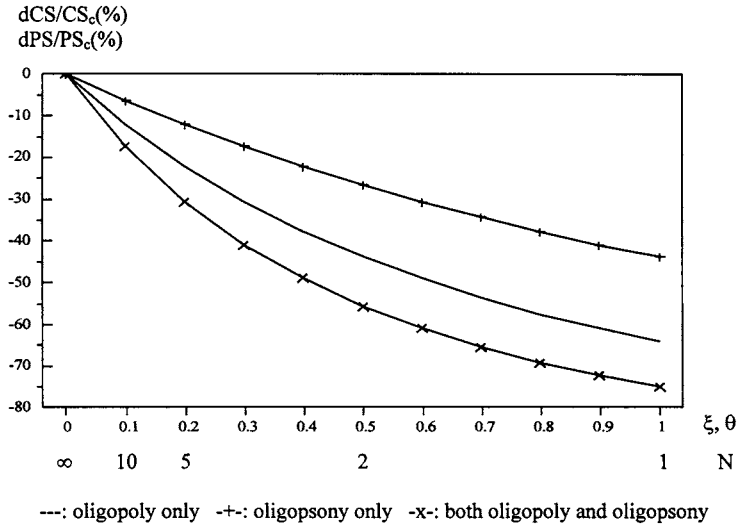

Figure 2. The effect of market power on consumer and producer welfare

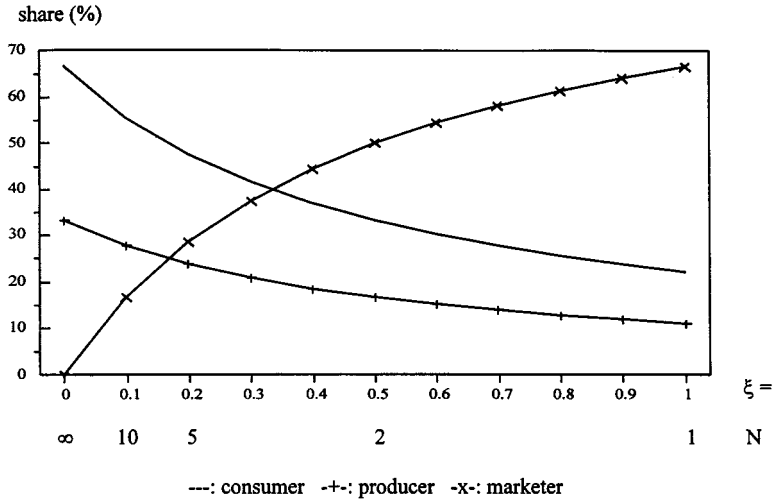

Figure 3. The effect of market power on distribution of welfare

24% to producers, and 29% to marketers. When $\theta = \xi = 0.5$, marketers capture fully half of the market surplus, relegating consumers and producers to shares of one-third and one-sixth, respectively.

Worth emphasizing is that the preceding results all pertain to market power exercised at a single stage (e.g., processing) of the market channel. Successive market power causes additional efficiency losses and transfers from producers and consumers to the marketing sector. One example from the analysis by Sexton and Zhang illustrates the point. Modest successive oligopoly power (i.e., both processors and retailers exercise oligopoly power) combined with processor oligopsony power, as depicted by conduct parameters equal to 0.2, reduces both consumer and producer surplus by nearly half (46%) relative to the competitive outcome. The marketing sector in this setting captures 42% of the total benefits from production and sale of the commodity, relegating producers and consumers to shares of 19 and 39%, respectively.

The Market-Power and Cost-Efficiency Trade-off

Building upon a theme articulated originally by Williamson, several food industry analysts noted that the consolidation of the food-marketing sector likely has important and positive efficiency implications. Enhanced efficiency portends higher welfare. Thus, the

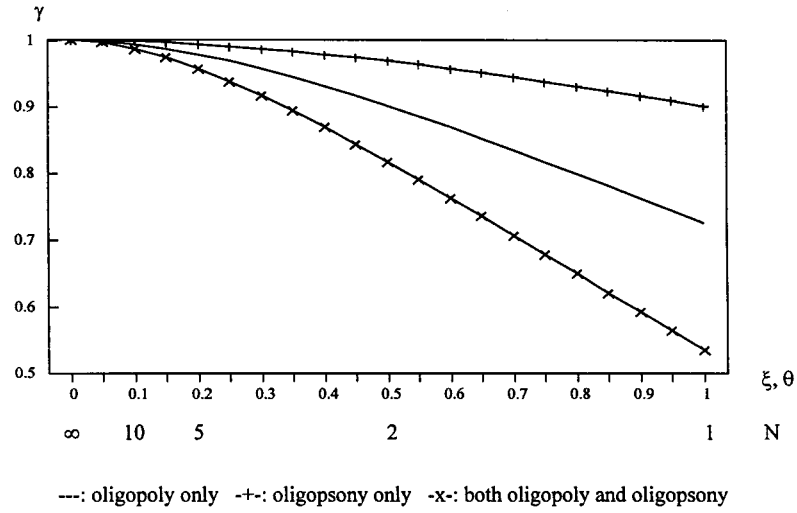

Figure 4. Welfare-neutral efficiency and market power

market-power cost of consolidation may be worth it if the efficiency gains are sufficiently large.[18]

This point was explicated nicely through the recent work of Azzam and Schroeter, Azzam (1997), and Morrison Paul (1999, 2000) on the U.S. beef sector. Azzam and Schroeter used a simulation framework, not unlike the model summarized in this paper, to conclude that the cost savings from consolidation in beef packing have likely dominated the efficiency losses due to increased market power. Subsequent empirical work by Azzam and Morrison-Paul tends to support this conclusion. These papers, however, focused exclusively on the possible oligopsony power implications of consolidation in beef packing.

The trade-off between market power and production efficiency can be explored rather easily within the framework of the stage 2 model developed here. Rewrite the marketing technology as

$$(3') \quad C = \gamma c(V)q + S(Q^f|Y)q$$

where $\gamma \in [0, 1]$ is a cost efficiency parameter that is set to 1.0 under perfect competition. We can now think of the trade-off between efficiency and market power as the percentage cost reduction, measured in terms of γ, that must be achieved for a given increase in market power to maintain welfare.

Figure 4 illustrates this trade-off for the base simulation model. Figure 4 confirms Azzam and Schroeter's basic point, as it pertains to modest levels of market power. For example, consolidation that moves an industry from a competitive outcome to a loose oligopsony as manifest by $\theta = 0.2$, need generate only a 0.59% reduction in marketing costs to maintain total welfare. However, as noted, oligopsony is less pernicious than oligopoly in its welfare impacts. The cost savings needed to maintain welfare given a move from $\xi = 0$ to $\xi = 0.2$ is 2.1%, and welfare-neutral consolidation that causes both oligopoly and oligopsony power such that $\xi = \theta = 0.2$ must produce cost savings of 4.26%. Figure 4 illustrates in the context of the linear model that $d^2\gamma/d\xi^2 < 0$ and $d^2\gamma/d\theta^2 < 0$, i.e., the cost savings necessary to counterbalance a given expansion in market-power increase at an increasing rate.

What about the trade-off between market power and cost efficiency as it pertains to producer and consumer welfare? Because both consumer and producer surplus are monotonic in output, the necessary condition to preserve consumer and producer welfare at the competitive level is the same: $\Delta Q = 0$. Figures 5–7 depict this condition for oligopsony, oligopoly, and joint oligopoly-oligopsony, respectively, and compare it to the trade-off needed to maintain total welfare.

[18] The existence of efficiency gains from consolidation should not, however, be taken for granted. A traditional argument, e.g., Parker and Connor, is that concentration and market power reduce the imperative to achieve economic efficiency and can result in less efficient outcomes than attainable under competition.

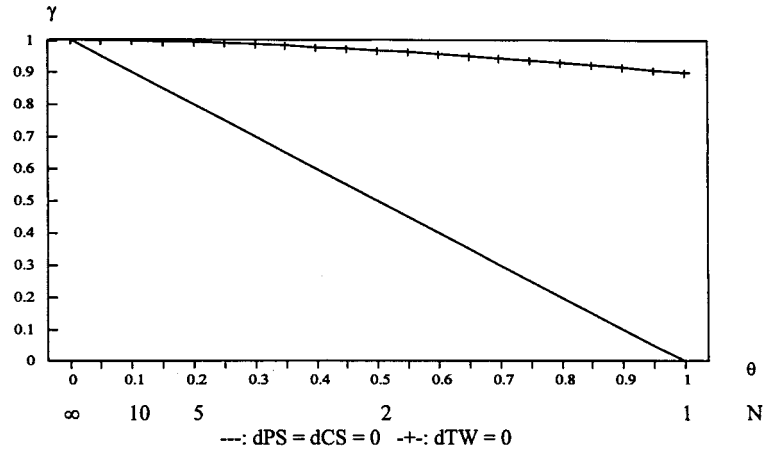

Figure 5. Producer and consumer welfare-neutral efficiency and oligopsony power

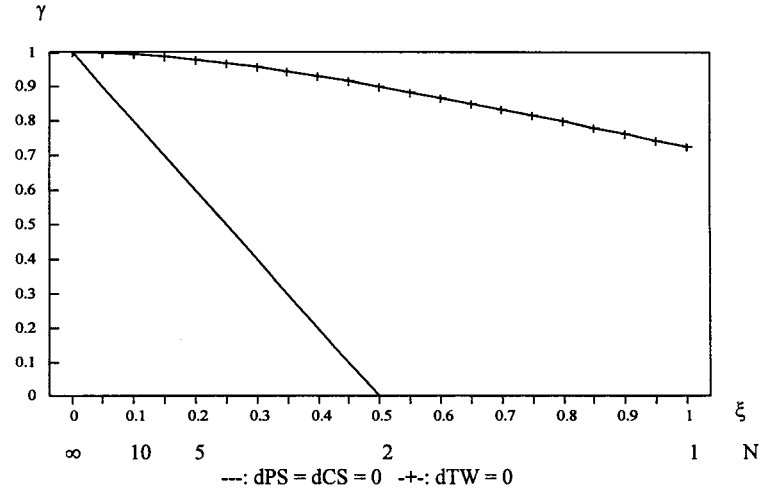

Figure 6. Producer and consumer welfare-neutral efficiency and oligopoly power

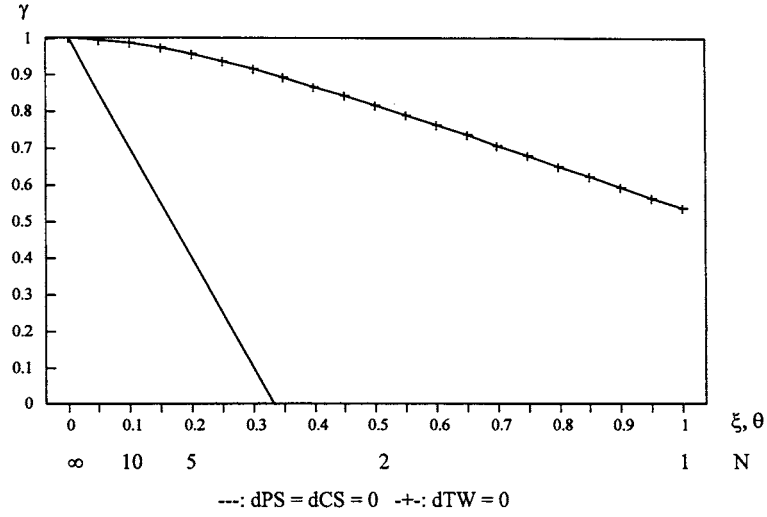

Figure 7. Producer and consumer welfare-neutral efficiency and joint oligopoly-oligopsony power

For the base simulation model, the efficiency-welfare trade-offs are linear:

$$\left.\frac{d\gamma}{d\theta}\right|_{\Delta CS=0} = -1, \qquad \left.\frac{d\gamma}{d\xi}\right|_{\Delta CS=0} = -2,$$
$$\left.\frac{d\gamma}{d\theta = \xi}\right|_{\Delta CS=0} = -3.$$

Thus, the manifestation of oligopsony such that $\theta = 0.2$ requires a 20% reduction in marketing costs, $\xi = 0.2$ requires a 40% reduction, and so forth, if consumer and producer welfare is to be preserved. Cost efficiencies of this magnitude as a consequence of consolidation are not likely to be attainable, or even theoretically possible for extreme cases of market power, as figures 5–7 illustrate. Although these results apply directly only to the linear version and base parameter values of the stage 2 market model, they are probably quite representative.

How Market Power Distorts Incentives to Undertake Market-Expanding Activities

Either oligopoly or oligopsony power reduces production of the primary farm commodity and, thus, also reduces the farm price. An additional set of distortions is introduced at the level of stage 1 of the two-stage model framework set forth here. Because processor or retailer market power transfers surplus from farmers, incentives at the farm level to undertake investments in demand expansion, such as advertising, or cost reduction, such as adoption of new technologies, are attenuated. By the same token, the transfer of surplus to the marketing sector gives marketing firms an incentive to undertake similar investments that would not exist if the industry were competitive.

Alston, Sexton, and Zhang (1997, 1999) examined the distribution of benefits from publicly funded farm-sector research under imperfect competition. Whereas a competitive, constant-returns processing sector would capture none of the benefits, an imperfectly competitive marketing sector may capture the lion's share of the benefits, as well as reducing the magnitude of the total benefits from the research. Using the U.S. beef sector as an application, Alston, Sexton, and Zhang estimated, based on the rather modest levels of market power found by Azzam and Pagoulatos, that the processing sector would capture 30% of the benefits from a research-induced parallel shift in farm supply, with farmers and consumers, respectively, capturing 11% and 59% of the benefits. The estimated reduction in total research benefits relative to perfect competition was 3.2%, consistent with the general proposition that overall efficiency effects from moderate market power are small.

The aforementioned work treats the expenditure of public funds on research as exogenous. However, when producers provide the revenue to fund investments, the presence of imperfect competition in the marketing sector will distort not only the distribution of benefits but also producers' incentives to undertake such expenditures. Zhang and Sexton (2000b) examined this issue in the context of producers' incentives to undertake a market-expanding investment in generic advertising funded through a per-unit check off. Any combination of processor oligopoly and/or oligopsony power reduces the optimal producer-funded advertising expenditure relative to the competitive outcome.

A perhaps surprising result from the linear model is that oligopsony power reduces the optimal advertising expenditure more than oligopoly power does. This happens because a parallel advertising-induced shift of a linear demand makes the demand more elastic and, thus, reduces the oligopoly distortion. For a linear model and base parameter values as indicated in footnote 15, modest market power as represented by $\xi = \theta = 0.2$ reduced the optimal generic advertising expenditure by 16% and reduced producer benefits from advertising by 30% relative to the competitive outcome, while more extreme market power represented by $\xi = \theta = 0.5$ reduced the optimal expenditure by 30.4% and producer benefits by 54%. Application to the beef sector using the Azzam and Pagoulatos market-power estimates indicates that optimal advertising is 16.5% lower than if the industry were competitive, producer benefits are 31% lower than under competition, and packers capture 55% of the combined producer-marketer benefits that are generated.

These types of distortions from imperfect competition are not captured in traditional welfare analyses. Because the marketing sector captures a share of the benefits from these market-expanding activities, the expectation might be that processor investments in, e.g., farm sector research and development and commodity advertising would offset any reductions in farm-level expenditures. However, activities that expand markets generally

rather than benefit a single firm are subject to free-riding, both in respect to expenditures by other processors and also by government or an industry board. Thus, as Zhang's work in the context of farm research expenditures demonstrates, unless the marketing sector is highly concentrated so as to limit the free-riding problem, processor expenditures are unlikely to fully replace the reduced producer expenditures. The more likely outcome is that processors will invest in proprietary research and/or brand advertising intended to expand individual shares of the market, but perhaps not the market itself.

Concluding Comments

Economists are often guided in their thinking by economic efficiency, as defined in a relatively narrow, partial equilibrium sense. I suspect most of us have satisfied ourselves that the developments in food markets, in terms of both horizontal and vertical consolidation, are efficient in this traditional sense. I would tend to agree. Vertical coordination has apparently been effective at increasing product quality in the food chain and transmitting consumers' preferences through the chain, resulting in more variety and higher quality foods at retail than ever before. Horizontal consolidation reflects economies of modern processing technologies and product marketing.

The market power created in the process appears, based on the extant literature, to be rather modest, and probably "worth it" from an efficiency calculus. However, this narrow analysis misses much. As shown here, even modest market power might have important redistributive consequences. For example, what are the implications of this redistribution for the future of farming in some regions and for the vitality of rural communities?

Despite these concerns, it is not clear what can or should be done. The current practice of antitrust enforcement in the United States is far from the activist policy advocated by the pioneers of industrial-organization analysis in agriculture such as Hoffman. Compare, for example, the subdued tone and modest recommendations contained in the recent report by the U.S. Department of Agriculture Advisory Committee on Agricultural Concentration (U.S. Department of Agriculture, 1996b) with the activist recommendations issued thirty years earlier in a similar report by the National Commission on Food Marketing. Although markets are generally much more concentrated now than thirty years ago, the Advisory Committee's main recommendation is for enhanced disclosure and improved reporting of information, and the Committee distances itself from recommendations that would "ultimately stunt opportunities for growth within the industry" (p. 15), or "slow or prevent the industry's need to adapt to a changing market place" (p. 15).[19]

The main body of U.S. antitrust law is now about 100 years old and may well be rather ineffective in addressing the imbalance of power in today's agricultural sector. The special tools that government has given U.S. farmers via the Capper-Volstead Act and the Agricultural Marketing Agreement Act to take collective actions and to regulate their own affairs through cooperatives, bargaining, or marketing orders seem not to be used especially well these days either. Reasons are probably several, including processor-handlers' general antipathy toward these institutions, and their ability, through various means, to sway producers. Another factor in several industries, such as the produce sector, is active rivalry at the production stage. Other producers are viewed nowadays as competitors, not compatriots, and the goal is to compete against them, not cooperate with them.

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[19] Ironically, mandatory disclosure of terms of trade such as price can have anticompetitive consequences, presumably not what the Committee intended. In markets such as live cattle where prices are set through buyer bidding, mandatory disclosure of bids is an excellent device to reinforce bidder cartels.

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