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by

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ABSTRACT

Consolidations in the U.S. beef packing industry have prompted concern within the government and interest among academics over whether packers possess and are able to exercise market power. Economists have generated numerous studies to test for and measure market power in beef packing, but the empirical studies have failed to provide definitive results on the presence of market power and whether any existing market power is exercised. The thesis of this paper is that the standard approach to measuring market power, conjectural variations, is based on a model which may not accurately describe competition between packing firms. I first discuss the institutional factors of beef packing that are not captured by the conjectural variations approach. I then present a theoretical extension of the CV approach which is based on a more realistic description of competition between packing firms. The paper concludes by suggesting alternative techniques for measuring market power.
MARKET POWER IN THE BEEF PACKING INDUSTRY:
IS IT TIME FOR A NEW APPROACH?*

1 Introduction

Consolidations in the U.S. beef packing industry have prompted concern within the government and interest among academics over whether packers possess and are able to exercise market power. Economists have generated numerous studies to test for and measure market power in beef packing, but the empirical studies have failed to provide definitive results on the presence of market power and whether any existing market power is exercised. Most studies (Schroeter (1987), Bhuyan and Lopez (1997), Koontz, Garcia, and Hudson (1993), Schroeter and Azzam (1990)) conclude that some market power may exist either in the primary input market or in the consumer market, but that the degree of market power is small. It therefore remains somewhat of a puzzle whether packers do indeed possess the market power that consolidation suggests they might, and if they do how they are exercising it.

It is reasonable to expect that the numerous studies that appear in the literature would by now have resolved the issue of market power in beef packing, or at least compiled consistent evidence for or against its existence. On the contrary, as we will show below, neither compelling nor consistent evidence has emerged, although numerous studies have been performed. In this paper, we explore possible explanations for these inconsistent results, and sketch a model that could be used to test one of these explanations. Our purpose here is not to definitively test a given model of competition, but to suggest alternative explanations that we hope will lead to theoretical modeling and empirical testing in future studies of the beef packing industry (and in studies of market power in general).

A review of the empirical literature on market power, specifically in beef packing and more generally in agricultural markets reveals that most studies utilize the conjectural variations (CV) approach. CV models, while empirically convenient, are reduced form models of competition in the beef packing industry. That is, they do not describe the competitive process leading to a given quantity/price pair. Instead, they posit a particular competitive process, and attempt to infer the presence of market power using industry quantity/price data. Because the competitive process is assumed, reduced form models do not require strategic variables, timing of actions, and the information structure faced by firms to be fully specified (Fudenberg and Tirole (1987), hereafter F&T). We contend that the focus on market outcomes has overlooked important elements of the competitive process in the beef packing industry. For example, CV models assume that firms are not forward looking, even when it is known to all parties that decisions made in the current period have important consequences for future market conditions. Clearly, a test of market power based on an inaccurate description of competition cannot (except by accident) lead to accurate measures of market power.

A second explanation of the inconclusive results of studies done so far involves the data used in many of these studies. Models of market power (in any industry) describe individual firm behavior. Unfortunately, much of the data available is aggregated to the industry level. Attempting to infer firm behavior using industry data is like trying to judge an individual student's ability based on the class average test score. Second, the ability of market

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power studies to generate robust inferences relies heavily on accurately estimated market conditions - consumer demand, cattle supplies and in-plant processing costs. Inasmuch as market conditions are inaccurately estimated, tests of firm behavior which rely on them will also be inaccurate. Finally, data is often incomplete, forcing the use of various proxies for unobserved prices and quantities. The combined effects of empirical misspecifications and data constraints may reduce the statistical power of all tests of market power. The CV approach is particularly vulnerable to these problems, as it requires a large amount of very detailed data. This weakness of the CV approach may reduce the power of its tests to the point where it is incapable of generating the inferences that are being sought.4

Given these problems, we find it surprising that alternative tests of market power have been rarely used in studies of beef packing. Instead, most new studies rely on some version of the CV model. This might be explained by noting that many constituencies (researchers, industry groups, policy makers) are likely not content with the results of studies done so far, so that additional work is desired. Since CV is a well-known approach to market power, and is based on a widely accepted model of competition, researchers are less willing to develop new approaches. This complacency, even in the face of known weaknesses is easily understood, as alternative measures may be difficult to develop, will have to overcome the natural skepticism of those in the profession, and are sure to have weaknesses of their own. Even so, we believe that problems with the CV approach call for attempts to develop alternative measures of market power.

The following section provides further details of the CV model. Section 3 discusses institutional details of beef packing that suggest a reduced-form approach to market power such as the CV model may not fit the industry very well, and explain why results from the CV model are inconclusive. Section 4 sketches a model that includes one of these institutional details, the fact that packers are forward-looking in their decisions. Section 5 concludes and presents alternative views of market power.

2 The Conjectural Variations Approach

Conjectural variations (CV) models assume that firms base output decisions on the response they expect to get from competitors. Limited response of market outcome to changes an individual firm makes suggests that the market is competitive, while an extensive change in market outcomes suggests the industry under scrutiny is monopolistic/monopsonistic. Because the estimates of competitor response are based within a solid theoretical framework, conclusions derived from the model enable direct predictions of firm behavior. Tests using the CV framework explicitly permit the decision process of a single firm to be affected by the behavior of rival firms. The CV model does not require that the conjectures be specified ex ante, but instead allows empirical data to provide information about the nature of the conjectures. These reasons, along with relative ease of estimation (provided that detailed data is available) make conjectural variations a popular choice for measuring and estimating market power.
A typical empirical study of beef packing using the CV framework assesses the retail-farm price spread - the difference between prices charged to customers and prices paid to producers - to measure market power held by processors. Such studies usually involve constructing an economic model of the oligopoly/oligopsony market structure and generating testable hypotheses regarding the size of the retail-farm price spread.\(^5\) We reproduce the CV model as it appears in Schroeter (1987), a seminal article in the field. For brevity, the details of the model structure are not repeated. The reader is referred to the original publication.

Suppose \( j = 1, ..., N \) firms purchase live cattle and produce a single output, boxed beef. Let \( Q^j \) denote both the quantity of the raw input and quantity of the processed output for firm \( j \). (Input and output units have been chosen to simplify the notation.) The market level quantity of the raw input and processed output is \( Q \). The problem for the \( j^{th} \) firm is to maximize the current period profit, \( pQ^j - w_MQ^j - C(Q_j, w) \), where \( p \) is the price of boxed beef, \( w_M \) is the price of live cattle (the Material input), and \( w \) is the vector of input prices for factors such as labor and machinery used inside the beef packing plant. The cost function, \( C(Q_j, w) \), gives the cost of transforming live cattle into saleable output (boxed beef).

Let \( \theta^j = (\partial Q/\partial Q^j)(Q^j/Q) \) denote the conjectural elasticity for firm \( j \). \( \theta^j \) is the \( j^{th} \) firm’s perceived rate of change of market output (raw input) with respect to the firm’s own output (raw input) choice, expressed as an elasticity. The range of the conjectural elasticity is between zero and one. As \( \theta^j \) tends to zero, the interpretation is that firms ignore the impact of their input and output decisions on rival behavior. This is consistent with a competitive market. As \( \theta^j \) tends to one the firm conjectures that its output is synonymous with market output, so that the firm behaves as a monopolist in the boxed beef market and a monopsonist in the live-cattle input market.

The CV framework can easily be extended to permit distinct conjectures in the raw input and the output market (Schroeter (1987)). Let \( \theta_b^j \) denote the \( j^{th} \) firm’s conjectural elasticity in the raw input (beef) market and let \( \theta_f^j \) denote the \( j^{th} \) firm’s conjectural elasticity in the output (final goods) market. A first order necessary condition for profit maximizing behavior emerges from the CV model;

\[
p(1 + \theta_f^j/\eta) = w_M(1 + \theta_b^j/\epsilon) + C_Q(Q^j, w)
\]

where \( \eta \) and \( \epsilon \) are respectively the retail market demand elasticity and the live cattle market supply elasticity, and \( C_Q(Q^j, w) \) is the marginal in-plant processing cost. The first order conditions encompass a wide range of input-output quantities because of the flexibility in conjectures. If \( \theta_b^j \) and \( \theta_f^j \) are both equal to one, equation 1 coincides with a monopolist’s profit maximizing necessary condition and \( Q^j \) is the monopoly output quantity. If \( \theta_b^j = \theta_f^j = 0 \), equation 1 collapses to the standard first order condition in a competitive market, and \( Q^j \) equals the individual firm’s share of competitive market quantity. The empirical approach is to obtain values of \( \eta \) and \( \epsilon \) estimate and test whether \( \theta_b^j \) and \( \theta_f^j \) are, in fact, statistically distinguishable from zero.
3 Institutional Details

As noted above, reduced form tests such as the CV model take the competitive process as given and use observed price/quantity pairs to measure industry competitiveness. Inasmuch as the competitive process differs from what is assumed, measures of market power will not be accurate. For example, packers may be more interested in assuring a steady supply of live cattle than in manipulating the price paid for those cattle. In this case, the implicit assumptions of the CV approach may not coincide with the strategic setting under which competition actually takes place. In this section, we discuss institutional details that make competition among beef packers different from what the CV model assumes. The details fall into six categories, as listed below.

3.1 Cost Structure of Packing Plants

Market power is measured as the ability of a firm to raise the price of its output above the cost to produce that output, or to reduce the price it pays for its inputs below the value of those inputs to the firm. Thus, measuring market power involves looking for discrepancies between price and marginal cost (on the output side) or between input price and marginal revenue product (on the input side). Differences between input price and marginal revenue product are then attributed to power that packing plants have over feedlots and/or ranchers.

There is an alternative explanation for differences between input price and marginal revenue product, however. As noted by Morrison (1998b) if average cost is falling, large packing plants will have lower processing costs than smaller plants. These lower costs raise the marginal revenue product of each pen of cattle purchased, and thus the plant’s profit. If all packing plants were the same size, this additional profit would be competed away in a higher price for live cattle. All packing plants are not the same size, however, and the smallest competitor in a market receives the smallest profit per unit of cattle purchased (zero, in theory). Although larger packers would be willing to pay a higher price for the cattle they purchase, they should attempt to procure needed supplies at the lower price that smaller competitors must pay to stay in business. In short, it is the cost structure of beef packing combined with size differences between packing plants, not market power, that drives a wedge between input price and marginal revenue product.

This theory has been tested in a series of papers studying both the U.S. and Australian meat packing industries Morrison (1998b), Morrison (1998a), which find that scale economies (falling average cost curves) can explain most of the markup of price over marginal cost (output market power), and of the reduction in input price below marginal revenue product (input market power). Ignoring this institutional detail may cause researchers to wrongly attribute to oligopsonistic behavior reductions in input prices below the value of such inputs.
3.2 Strategic Variables Other than Price

Beef packers may consider variables other than price in attempts to behave non-competitively. The concern here is that the CV model assumes the wrong strategic choice variable for packing firms. Schroeter and Azzam (1991) point out that packing plant size has been steadily increasing since the 1980s, which may lead to "...a breakdown in the industry's oligopolistic discipline." (page 997) This discipline may break down, they say, as plant managers become more interested in ensuring a steady supply of inputs to keep plants operating at optimal capacity. As plants expand, the need to operate at efficient scale may outweigh any benefits obtained from exploiting the market's oligopsony structure. This fact is noted by Purcell (1999) who mentions that packing plants may attempt to "smooth" throughput through the use of captive supplies. Azzam and Park (1993) also suggest that throughput may explain why the beef packing industry appears to be competitive (based on input price measures) even as the market share held by the largest four firms has more than doubled.

3.3 Increasing Use of Captive Supplies

One way that packers may influence the prices they pay for inputs is through captive supplies. Captive supplies may involve contracts between packers and feedlots for delivery of a given number of cattle at a particular date or business arrangements in which a steady supply of cattle is transferred from feedlot to packer. Alternatively, packers can "capture" supply by taking ownership of cattle before they enter the feedlot, and paying the feedlot a given amount for finishing. These contracts remove cattle from the spot market, and therefore might have an effect on spot market prices. As noted in Schroeder, Mintert, and Barkley (1993), rather than attempting to manipulate the prices they pay, packers may use captive supplies to guarantee a steady supply of input, particularly during months in which smaller numbers of cattle are available.

Schroeder et al. (1993) find that the use of contracts reduces the price in spot markets, although the effect is small. Hayenga and O'Brien (1992) find that the use of contracts reduces spot market prices in some states (Texas), increases it in others (Kansas), and has no effect in a third set (Colorado, Kansas, Nebraska). Ward, Koontz, and Schroeder (1998) also find an inverse relationship between use of forward contracts between packers and feedlots and spot market prices, although the relationship is somewhat weak and does not exist for all types of contracts. It appears, then, that captive supplies do not always affect spot market prices, and even when they do, the effect is generally small. This suggests that packers use captive supplies to smooth their input use, rather than to reduce the prices they pay. Even so, ignoring the use of captive supplies may cause market power tests based on input prices only (as in the CV model) to be inaccurate.
3.4 Data Aggregation Problems

As noted in the introduction, the data requirements of the CV model are quite extensive. CV methodology relies on accurate estimates of the output demand and input supply functions in the market. If either of these estimated functions is incorrect, conclusions regarding firm conjectures may also be incorrect.

The data typically available are aggregated retail market prices, prices of retail beef substitutes or other retail demand shifters, farm-gate prices, aggregate market quantity and prices of factors that are used in the in-plant processing of live cattle. Many empirical studies rely on a subset of these prices or a proxy of the prices of in-plant factor inputs. Because data is difficult to come by, and generally aggregated in form, estimates of the demand and supply functions could be easily misspecified. Jones, Purcell, Driscoll, and Peterson (1996) provide a model which demonstrates that tests based on aggregate data almost never correctly infer market power. They demonstrate this result by estimating a model of market power using data simulated by a generating process from known market structure and firm behavior. Using data which comes from known behavior, they show that standard CV estimates perform very poorly. There is no reason to expect that these same estimates will perform well when data comes from unknown behavior.

3.5 The Dynamic Nature of Competition in Beef Packing

The assumption that firms are concerned solely with current period prices and quantities may overly simplify the competitive process in beef packing. This problem is familiar to many authors using the CV approach. Indeed, a large literature exists regarding the "consistency" of conjectures. Basically, the problem is in defining what firms believe about the actions of other firms, especially at price-quantity pairs away from the equilibrium solution. Makowski (1987) points out that the standard interpretation of "conjectures" as describing firm j's optimal reaction (change in quantity, for example) to a change made by firm i is inaccurate. While conjectures do accurately describe j's optimal response to i's action at equilibrium, they do not describe j's optimal response to a change in i's action. The problem is that "conjectures, which are supposed to reflect one firm's beliefs about other firms' strategic responses to its actions, need a temporal story to be legitimate." (Makowski (1987), pg. 47). In standard CV models, no such "temporal story" is provided. Lindh (1992) considers the possibility that firms may behave in non-optimizing fashion in order to "test" rival firms, and discusses how this might affect equilibrium outcomes.

One way around the problem of dynamics is to ignore them, and claim that the analysis is static, looking only at a series of equilibria without describing how such equilibria are reached. This solution is noted in Holt (1985), "A common way of analyzing multiperiod oligopoly models without dynamic interactions in the payoff structure is to compute a Nash equilibrium for each period taken separately." (pg. 314) Schroeter and Azzam (1990) implicitly employ this strategy, in using a CV model to test for market power in beef and pork.
production. They do note that "...we have approximated an inherently dynamic problem with a static model..." (page 1374). The model we sketch below also uses this strategy, although we extend the simple assumptions of the standard CV model to incorporate forward-looking considerations.8

Multi-period considerations have important implications for model building, and for inferences that are drawn from empirical work. For example, the standard CV model implicitly assumes that supply conditions are not affected by packer decisions. This assumption directly contradicts the cattle cycle literature, where changes in current period demand affect not only current period choices, but future period conditions as well. As noted in Rosen, Murphy, and Scheinkman (1994), competition in the beef packing sector involves a forward-looking decision process. The dynamics arise from unavoidable technological constraints on live cattle supplies. A nine-month gestation period, plus a one- to two-year growth lag is required to produce an animal for slaughter. Consequently, ranchers and feeders face an unavoidable lag from the time they receive a price signal to increase production until increased supply is actually realized. A supply response lag means that an increase in current period live cattle demand necessarily affects supply conditions, and \( w_M \), for two to three production periods into the future. In short, packers play a multi-stage game, with decisions at one stage having ramifications for future stages.

In addition to the biological lag that causes decisions to occur over several periods, there may be other implications of ignoring or misrepresenting multi-period competition in beef packing. Given that ranchers/feeders cannot easily relocate their operations and that beef packing plants are fixed in geographic space, each side should recognize that they will engage in future dealings. If either side has the ability to punish the other in future dealings, maximizing current period payoffs may not be in a party’s best interest. Additionally, since there are relatively few large beef packers in the industry each of them can reasonably expect to be competing with the same firms year in and year out. That is, it is reasonable to assume that packers engage in a repeated game, with each other and with cattle suppliers, rather than the one-shot competition posited in the CV model.

If competition in beef packing is repeated, it makes sense to take observations of some economic variable over time as a measure of market power. Most models using this approach look at price movements over time as a measure of collusive behavior.9 This approach moves us away from the one-period nature of CV models, and allows for a more realistic characterization of the competitive setting.

The foundations for this work are the papers of Green and Porter (1984) and Abreu, Pearce, and Stacchetti (1986), who demonstrate that firms may be able to collude by basing their actions on the observed market price in the previous period. Firm strategies involve jointly selling the collusive (monopoly) quantity if the previous period’s prices were high enough. When prices fall below some trigger value, it is presumed that someone cheated on the collusive agreement. Firms then choose the Cournot level of output (which punishes the cheater by reducing its profits). After some period of punishment, the game re-enters the cooperative phase with industry output falling to the monopoly level and firm profits rising.
These theories of repeated competition between oligopolists has been used to model price changes over the business cycle by Rotemberg and Saloner (1986), Bagwell and Staiger (1997), Haltiwanger and Harrington (1991) and Staiger and Wolak (1992) among others. The basic idea is that firms are better able to collude during one part of the business cycle than during the other. This means that collusive prices will rise (fall) as the gains from cheating on the agreement fall (rise) with the business cycle. Empirical support for pro-cyclical prices is provided in Machin and Reenen (1993), who study a panel of 709 large UK firms.

Theories of oligopsony collusion in input prices in beefpacking have been tested by Koontz et al. (1993), Azzam and Park (1993), and Weliwita and Azzam (1996). The results of these studies are mixed - Koontz et al. (1993) find evidence of oligopsonistic price setting practices, Azzam and Park (1993) generate mixed results, finding collusive practices from 1955 through 1977, but a reversion to competitive input pricing from 1978 to 1987, while Weliwita and Azzam (1996) find no oligopsony collusion. The mixed results are somewhat difficult to reconcile, as these studies cover approximately the same periods. They may be due to different observational units (Weliwita and Azzam (1996) uses quarterly national data, Azzam and Park (1993) have annual national observations, and Koontz et al. (1993) have monthly regional observations), or to different model specifications.

Thus, while repeated interaction between packing firms and the possibility of punishment strategies has been considered, no clear consensus regarding the ability of packers to exercise monopsony power emerges. As far as we know, no tests of multi-period competition (forward looking considerations caused by stock dynamics) have yet been done. In the following section, we sketch a model that might be used to test this theory. In future work, we plan to more fully develop and test this model.

4 A Forward-Looking Model of Competition

In this section, we sketch a model of competition in which firms account for the effects of their current period output/input choices on stock levels in future periods. We demonstrate that when forward-looking considerations affect firm decisions, market power measures derived in standard CV models are not accurate.

We take as our starting point the model presented in Kamien, Levhari, and Mirman (1985). For simplicity, we consider two packers \((i = 1, 2)\), each choosing how many cattle \(x^i\) to purchase and process in each production period. Without loss of generality, we assume that live cattle are transformed pound for pound into output (boxed beef). Let \(X = x^1 + x^2\) denote the aggregate live cattle purchases and the output that is supplied in the period. The price of boxed beef is given by the inverse demand function \(p_b = p(X)\). Processing costs that are incurred by each packer in transforming the raw input into output are \(c(x^i)\). Live cattle are purchased from ranchers following the supply function \(w_m = w(X)\). The growth characteristics of cattle stocks \((s)\) are represented by the growth function \(f(s)\), so that \(s_t = f(s_{t-1} - X_{t-1})\). Following the literature on cattle growth in feedlots, we assume
$f'(s) > 0$, and $f''(s) < 0$.

Firm $i$ chooses $x^i$ each period to maximize the present value of the sum of per-period operating profits, $\pi_t(p^i, w^i_m) = p(X_t)x^i - w(X_t)x^i - c(x^i)$, subject to the growth characteristics of the live cattle stock, and the actions of rival firm $j$. This value function is

$$V(s_t) = \sum_{t=1}^{\infty} \beta^t \pi_t(p^i, w^i_m)$$

subject to

$$s_{t+1} = f(s_t - X_t), \quad s_0, X_0 \text{ given}$$

where $\beta = 1/(1 + r)$ and $r$ is the market rate of interest.

As is standard in oligopoly models, we assume that firm $i$ believes that its rival’s quantity is given by $x^j = x^j(x^i, s)$. To ease notation, let $r^j \equiv \frac{dx^j(x^i, s)}{dx^i}$ denote the rate at which firm $j$’s quantity adjusts with $x^i$, and let $R^i \equiv dX/dx^i = 1 + r^j$ denote the rate at which market output adjusts with $x^i$. Finally, let $\varepsilon$ and $\eta$ denote the price elasticity of demand ($-p(X)/Xp'(X)$) and the input cost elasticity of supply ($w(X)/Xw'(X)$) respectively. It is common to express the rate at which market output adjusts with $x^i$ in elasticity form, $\theta^i = \frac{\varepsilon dX}{X dx^i} = \frac{\varepsilon}{X} R^i$; thus $\theta^i$ is the conjectural elasticity parameter for firm $i$.

The output policy will identify each firm’s optimal quantity as a function of the cattle stock, $x^i = x^i(s)$. Because firm $i$ understands that $j$’s quantity decision is also conditional on $s$, firm $i$’s belief about what firm $j$ considers in its choice is $x^j(x^i(s), s)$ at the optimum. The Bellman representation for equation 2 is given by

$$V(s) = \max \left\{ [p(x^i + x^j(x^i, s)) - w(x^i + x^j(x^i, s))] x^i - c(x^i) + \beta V(f(s - X)) \right\} \quad (3)$$

Firm $i$ is assumed to solve this equation each period. Taking the derivative with respect to $x_i$ gives the first-order necessary condition:

$$[p(X) - w(X)] + [p'(X) - w'(X)] R^i x^i - c'(x^i) - \beta V' (f(s - X)) f'(s - X) R^i = 0 \quad (4)$$

In the standard CV model, firms do not take stock dynamics into consideration, and maximize only their current period profit. In that case, the firm’s objective function is given by $[p(x^i + x^j(x^i)) - w(x^i + x^j(x^i))] x^i - c(x^i)$ and the firm’s first order necessary condition is $[p(X) - w(X)] + [p'(X) - w'(X)] R^i x^i - c'(x^i) = 0$.

The CV model measures market power in the output market as the difference between price and marginal costs of production, divided by the price. This measure is known as the
Lerner index, and is given by $L = (p - MC)/p$. This measure ranges from zero (when the market is perfectly competitive so that $p = MC$) to one (when the market is a monopoly, and $MC$ is very small in comparison to output price). In the standard CV model, the Lerner index is thus given by $L^s = -p'(X)R_i^z x^i / p(X)$. This can be decomposed into $-p'(X)X / p(X) \times R_i^z x^i$ or $\theta_i / \varepsilon$. We see, immediately, that unless $\varepsilon$ is estimated correctly, the standard Lerner index will not accurately measure market power.

When stock dynamics are included, we rearrange equation 4 into the Lerner index as follows:

$$L^d = \frac{p(X) - w(X) - w'(X)R_i^z x^i - c'(x^i)}{p(X)} = -\frac{p'(X)R_i^z x^i}{p(X)} + \frac{\Delta}{p(X)}$$

Measuring monopsony power involves calculating the difference between marginal revenue product and input cost. The standard measure is $M = \frac{MRP - w}{w}$. Rearranging the standard first order necessary condition, we see that $M^s = \frac{p(X) + p'(X)R_i^z x^i - c'(x^i) - w(X)}{w(X)} = \frac{w'(X)R_i^z x^i}{w(X)}$. When stock dynamics are included, we rearrange equation 4 to obtain

$$M^d = \frac{w'(X)R_i^z x^i - \beta V'(\cdot)f'(\cdot)R_i^z}{w(X)} = M^s + \frac{\Delta}{w(X)}$$

Notice that both forward-looking indices include the standard measure plus a correction term. These terms represent the consideration firm $i$ gives to the effect of its current period choices on the stock available for slaughter in future periods. They will be zero only under special circumstances. In general, unless firms completely discount future periods ($\beta = 0$), stock levels are unchanging from period to period ($f'(\cdot) = 0$), or the market is competitive ($R_i = \theta_i = 0$) the standard model’s estimate of market power will not be accurate. Under perfect competition forward-looking market power measures are equivalent to the standard measures (both are zero) because firms cannot be assured that they will be the claimants of the returns from investing in the stock.

This sketch demonstrates that standard measures of market power, such as those provided by the CV model, which do not incorporate forward-looking considerations may be biased. It is an empirical matter to determine whether or not such bias exists, and its sign.

5 Conclusions

Consolidations since the 1970s have generated much interest in potential market power in the beef packing industry. Many studies have attempted to measure market power, but most have
resulted in findings of no or very limited ability of packers to exploit feeders/ranchers and consumers. Because these findings are surprising, especially in the face of greatly increased packer concentration, studies continue to be performed.

We suggest that economists step back from the methods, in particular reduced-form modeling approaches, currently used to measure market power. We identify six institutional details that create problems for the most common method of estimating market power (conjectural variations). If cost economies exist in beef packing, as Morrison (1998b) suggests, then marginal revenue product may be greater than input price in more efficient plants. This divergence is not due to market power, but to the technology underlying beef packing. Captive supplies may also reduce the price of live cattle on the spot market, although not necessarily the overall (average) price that packing firms pay for cattle. Schroeder et al. (1993), Hayenga and O'Brien (1992) and Ward et al. (1998) provide some evidence of a negative relationship between spot market prices and the use of captive supplies. Strategic variables other than price may be important to packers, as noted by Schroeter and Azzam (1991). Data aggregation problems may also dramatically affect the reliability of market power measures generated within the CV model, as shown by Jones et al. (1996). Finally, competition between packing firms is both repeated and forward looking. Tests that exploit the repeated nature of competition by examining the possibility of oligopsony collusion among packers include Koonz et al. (1993), Azzam and Park (1993), and Weliwita and Azzam (1996). These papers generate mixed evidence on collusion between packers. In this paper, we sketch a model to demonstrate that ignoring forward-looking stock concerns may lead to bias in measures of market power. In future work, we intend to test this model to determine whether such bias exists, and if so whether standard measures over- or underestimate market power.

Possibly the most promising direction for discovering alternative and more powerful tests of market power in beef packing is the development of extensive form game-theoretic models. As suggested by Fudenberg and Tirole (1987) this approach "forces economists to clearly specify the strategic variables, their timing, and the information structure faced by firms." (page 176). For example, a model that analyzes throughput rates with packing firm payoff functions that capture the value of reduced throughput variability, in a repeated competition setting, would better characterize key features of the beef packing industry. It remains for researchers to develop extensive form models that capture other elements of packer competition, and from these models to generate empirical specifications to test for market power in beef packing. We hope that this paper helps initiate these efforts.

(Chapter head:)*

References


Morrison, C. J. (1998b). *Cost economies and market power: The case of the u.s. meatpacking industry.* (unpublished manuscript, University of California at Davis)


Notes

1There are several reasons to be concerned about the existence of market power. The most important are the economic welfare implications. First, in markets with price-making firms, dead weight losses arise that reduce total economic welfare. A second effect that may have important political implications, particularly in agriculture, is wealth redistribution that may result as beef packers exercise control over input prices.

2Studies of market power in beef packing which do not use the conjectural variations approach include Koontz et al. (1993), Azzam and Park (1993) and Weliwita and Azzam (1996). These studies examine the possibility of collusive pricing among beef packing firms, and find (generally) that no such collusion exists.

3See Corts (1999) for a discussion of this problem.
Jones et al. (1996) present a simulation model that dramatically illustrates these problems. In this paper, market power predictions of the standard conjectural variations model are almost never accurate.

See, for example Schroeter (1987).

See Ward et al. (1998) for a description of the various ways packers contract with feedlots.

See, for example, Bresnahan (1981), Makowski (1987) and Lindh (1992). Holt (1985) finds that the consistent-conjectures hypothesis is rejected in an experimental setting.

The literature on 'consistent', 'rational' and 'reasonable' conjectures suggests that trying to use a static model to describe dynamic competition is doomed to failure. In turn, this suggests that all studies relying on conjectural variations fundamentally misrepresent the competitive process.

Alternatively, one might wish to look at throughput and how it changes over time. As far as we know, this approach has not been used to test for collusive behavior in the beef packing industry.

The results generalize to competition between more than two packers.

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Abstract

Consolidations in the U.S. beef packing industry have prompted concern within the government and interest among academics over whether packers possess and are able to exercise market power. Economists have generated numerous studies to test for and measure market power in beef packing, but the empirical studies have failed to provide definitive results on the presence of market power and whether any existing market power is exercised. The thesis of this paper is that the standard approach to measuring market power, conjectural variations, is based on a model which may not accurately describe competition between packing firms. I first discuss the institutional factors of beef packing that are not captured by the conjectural variations approach. I then present a theoretical extension of the CV approach which is based on a more realistic description of competition between packing firms. The paper concludes by suggesting alternative techniques for measuring market power.

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1 Introduction

Consolidations in the U.S. beef packing industry have prompted concern within the government and interest among academics over whether packers possess and are able to exercise market power. Economists have generated numerous studies to test for and measure market power in beef packing, but the empirical studies have failed to provide definitive results on the presence of market power and whether any existing market power is exercised. Most studies (Schroeter (1987), Bhuyan and Lopez (1997), Koontz, Garcia, and Hudson (1993), Schroeter and Azzam (1990)) conclude that some market power may exist either in the primary input market or in the consumer market, but that the degree of market power is small. It therefore remains somewhat of a puzzle whether packers do indeed possess the market power that consolidation suggests they might, and if they do how they are exercising it.1

It is reasonable to expect that the numerous studies that appear in the literature would by now have resolved the issue of market power in beef packing, or at least compiled consistent evidence for or against its existence. On the contrary, as we will show below, neither compelling nor consistent evidence has emerged, although numerous studies have been performed. In this paper, we explore possible explanations for these inconsistent results, and sketch a model that could be used to test one of these explanations. Our purpose here is not to definitively test a given model of competition, but to suggest alternative explanations that we hope will lead to theoretical modeling and empirical testing in future studies of the beef packing industry (and in studies of market power in general).

A review of the empirical literature on market power, specifically in beef packing and more generally in agricultural markets reveals that most studies utilize the conjectural variations (CV) approach.2 CV models, while empirically convenient, are reduced form models of competition in the beef packing industry. That is, they do not describe the competitive process leading to a given quantity/price pair. Instead, they posit a particular competitive process, and attempt to infer the presence of market power using industry quantity/price data. Because the competitive process is assumed, reduced form models do not require strategic variables, timing of actions, and the information structure faced by firms to be fully specified (Fudenberg and Tirole (1987), hereafter F&T). We contend that the focus on market outcomes has overlooked important elements of the competitive process in the beef packing industry. For example, CV models assume that firms are not forward looking, even when it is known to all parties that decisions made in the current period have important consequences for future market conditions. Clearly, a test of market power based on an inaccurate description of competition cannot (except by accident) lead to accurate measures of market power.3

A second explanation of the inconclusive results of studies done so far involves the data used in many of these studies. Models of market power (in any industry) describe individual firm behavior. Unfortunately, much of the data available is aggregated to the industry level. Attempting to infer firm behavior using industry data is like trying to judge an individual student’s ability based on the class average test score. Second, the ability of market