EFFECTS OF HORIZONTAL CONCENTRATION IN THE CATTLE PROCUREMENT MARKET OF THE U.S. BEEF PACKING INDUSTRY: PRICE VS.QUANTITY COMPETITION.

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CHAPTER I.

INTRODUCTION.

Recently market economies have undergone various types of merger waves, and welfare effects of these mergers have been widely investigated in the industrial organization literature (Schroeter, 1988; Azzam and Schroeter, 1995; Azzam, 1997; Sexton, 2000; Paul, 2001; Lopez et al., 2002). Horizontal mergers can restrict their outputs and increase their prices and profits through their increased concentration. The increased output price is expected to result in the welfare loss to consumers. However, the merged firms can also improve production and marketing efficiencies through scale economies, and as a result, a part of the welfare loss can be offset by the improved efficiencies of merged firms (Dockner and Gaunersdorfer, 2002).

Controversy related to the size of welfare losses associated with market power has persisted since Arnold Harberger (1954) first produced estimates of welfare loss in U.S. manufacturing industries due to the horizontal merger (Dickson and Yu (1989). According to Sexton and Lavorie (2001), in highly concentrated industries, a positive (negative) correlation between concentration and selling (purchasing) price exists. This correlation has been found rather consistently across many studies of food-processor oligopoly and oligopsony power and food-retailer oligopoly power. The U.S. beef-packing industry is one of those which have undergone maximum level of food manufacturer and retailer concentration. There was an escalation of the four-firm concentration ratio (CR4) from 30% in 1978 to 86% in 1994 in the beef packing industry. Azzam and Schroeter (1995) states that within the past two decades, beef packing in the U.S. has experienced a trend toward fewer and larger plants, increased consolidation among larger firms, and heightened concentration. Previous studies by Muth (1996), who analyzed oligopoly power and Muth and Wohlgenant (1999), who analyzed oligopsony power, failed to find any evidence of market power. Azzam (1997) and Morrison Paul (1999, 2000) argued that market power played a very minor role and cost economies and technological change are the important factors driving the beef-packing sector. These previous studies indicate that the potential economy-wide welfare loss depends on four parameters: the price elasticity of demand, the elasticity of marginal cost, seller concentration and the conjectural variation elasticity. Conjectural variation elasticity is a measure of cooperation among firms within an industry. Salant and Shaffer (1983) examined the profitability of mergers in a Cournot model and concluded that mergers were unprofitable unless they involved at least eighty percent of the firms in the industry. Deneckere and Davidson (1983) extended Salant and Shaffer (1983) by showing that when firms produce differentiated products and compete for prices instead of quantities, a merger becomes profitable. Azzam and Schroeter (1995) also extended Salant et al. (1983) estimating welfare impacts of mergers in the beef packing industry on consumers, producers, and eventually total economy. The authors investigated cost reductions necessary to neutralize consumer and producer surplus losses under alternative assumptions about supply and demand conditions, and post consolidation structure and conduct. They concluded that the estimated cost savings necessary to neutralize the anticompetitive effects of consolidation in the beef-packing industry were about half of the actual cost savings from scale economies. Azzam (1997) 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 most previous empirical studies of imperfectly competitive markets on beef-packing industry have assumed that all firms within the industry supply a homogeneous product and use quantity as a strategic variable thus primarily giving importance to Cournot conjecture. In this case, there is only one demand function and one common price generated in the market. However, most imperfectly competitive industries are characterized by multiple differentiated products that compete with each other based on price as the strategic variable rather than quantity. Hence, a separate market demand function and unique price exist for each quality, and the brands are incomplete substitutes for each other. In such cases, a product-differentiated oligopoly model with price as the strategic variable, or a generalized Bertrand model is applicable.

A comparison of the two benchmark models of price and quantity competition has been undertaken in the literature. Hathaway and Rickard (1979) examined a duopoly market with general demand and cost functions. They found that at least one firm's price is higher in Cournot equilibrium than in Bertrand equilibrium under duopoly. Singh and Vives (1984) further showed that in a duopoly situation, both firms' prices are higher and outputs are lower in quantity competition than in price competition. The studies conducted concerning the comparison of welfare between price and quantity competition is predominantly analytical and not supported by empirical evidence. Moreover, most previous studies have used annual data with few observations. These types of data have the potential to cause convergence problems during model estimation and/or mask seasonal variations in prices and quantities. These limitations may have dictated the results in previous studies.

The motivation of this study was to conduct a market power - cost efficiency effect analysis for price competition as well, compare the effects with quantity competition and check whether the results from previous studies on quantity competition that market power effect is superseded by cost efficiency effect is reversed under alternative assumptions of market structure. Singh and Vives (1984) suggested that price competition is welfare enhancing compared to quantity competition. We went on to examine whether this actually holds good for the beef packing industry. Moreover, a similar kind of analysis was conducted for input price as the effect of processor's increased concentration on the price which the farmers actually receive for their inputs is worth analyzing.

Our objective is to compare effects of horizontal mergers in the U.S. beef packing industry under quantity and price competitions. Our study develops separate models for price and quantity competitions that include a measure of industrial concentration, namely Herfindahl index. Azzam and Schroeter, (1995), Azzam (1997), and Lopez, Azzam, and Liron-Espana (2002); derived a Cournot type model for homogeneous product and estimated market power and cost efficiency effects of industry concentration on output prices. We extend these earlier studies by considering a model with differentiated products and deriving the market power and cost efficiency effects of industry concentration on output as well as input prices for both Cournot and Bertrand conjectures. We focus on the concentration in the oligopsonistic or buying side of the processors since the food processing industry is more likely to fit the oligopsonistic profile, given the geographic nature of their input markets. The raw-materials are supplied by numerous price-taking producers and given the difficulties in transportation due to their bulk nature and perishability, each producer is likely to face only a small number of processing firms as prospective buyers. We apply this model to weekly data for U.S. beef packing industry. This enabled us to empirically investigate the comparison of welfare loss due to market power under quantity and price competition. We further extend our work by calculating the welfare loss to individual participants such as farmers, consumers and processors for both types of model.

The conceptual framework is presented in Chapter II. In this chapter we present the market power and cost efficiency effect analysis on the output price for both the models under the assumption of homogeneous product and differentiated product. For the differentiated product case we extend our analysis to the effects of consolidation on the input price as well. Empirical framework and data sources are presented in Chapter III. Chapter IV presents findings of the study and an interpretation. Chapter V encompasses a welfare analysis of each participant under price competition and quantity competition. Chapter VI provides a brief summary, conclusions, recommendations, and limitations of the study, and suggestions for future researches.

CHAPTER II.

CONCEPTUAL FRAMEWORK.

Theoretical Model for Homogeneous Products.

We consider a food processing industry involving the combination of a single raw material input with other inputs into a competitively-sold processed good for our basic theoretical framework.

Following Dickson and Yu (1989), we assume the processor demand and raw material input supply functions take the constant elasticity forms

(1) $$Q^d = A/P^{\eta}, \qquad \eta < 0,$$

where Q^d, A, P and η stand for output demanded, a demand shifter, price and the negative of price elasticity of industry demand

and

(2) $$Q^s = BW^{\varepsilon}, \qquad \varepsilon > 0,$$

where Q^s, B, W and ε represent quantity produced, a cost shifter, raw material input price and the marginal cost elasticity. For numerical convenience competitive price and raw material input price are set at \$1 per unit and output is set at 100 units. Thus from equations (1) and (2) the demand shifter A and cost shifter B are set at 100.

Oligopoly output Q_0, will be less than competitive output, 100 units, implying that there might be a welfare loss under competition. To evaluate this oligopoly output we first evaluate oligopoly price P_0 using the following expression for the Lerner Index (L) from Clarke and Davies (1982).

(3) $$L = \frac{(P_0 - MC_0)}{P_0} = \frac{H + \delta(1 - H)}{\eta}.$$

Where MC_0 is the industry marginal cost at Q_0; H is the Herfindahl Index of seller concentration; and δ is the conjectural variation elasticity. Here, δ measures the proportional change in the output (for Cournot) and price (for Bertrand) of rivals expected by a typical firm in response to a proportional change in its own output (for Cournot) or price (for Bertrand). According to Brander and Zhang (1990) for Cournot, Bertrand and monopoly equilibrium, conjectural variation is equal to 0, -1, and 1 respectively for homogenous product. The Bertrand model requires, in the homogeneous product case, that price equals marginal cost which is equivalent to the competitive case. The Cournot competition implies that under the assumption of constant market share, if any one firm decides to increase its output by one unit it does so under the assumption that its competitors won't change their output. Under price competition, the industry output is fixed when any one participant decides to decrease its charged price by one unit; it assumes that its competitors will increase their charged price by one unit as well. This is so because once a competitor decides to lower his price his motive is to increase his market share, if his conjecture is not as stated above, then the constant industry output assumption fails to hold. Substituting $MC_0 = \left(\frac{Q_0}{100}\right)^{1/\varepsilon}$ in equation (3) gives

$$\frac{P_0 - (1/100)^{1/\varepsilon} Q_0^{\ 1/\varepsilon}}{P_0} = \frac{H + \delta(1-H)}{\eta} \text{ and therefore}$$

(4)
$$P_0 = \frac{\eta (1/100)^{1/\varepsilon} Q_0^{\ 1/\varepsilon}}{\eta - [H + \delta(1-H)]} .$$

Substituting for P_0 using equation (4) in the market demand curve we get,[1]

(5)
$$Q_0 = 100\left[1 - \frac{H + \delta(1-H)}{\eta}\right]^{\eta\varepsilon/(\varepsilon+\eta)} .$$

The conjectural variation elasticity will be zero for the Bertrand competition or the Perfectly Competitive case and will lie anywhere within zero and one for Cournot competition (Sexton, 2000).

Differentiating equation (4) w.r.t. H we find the price effect on the output price to be

$$\frac{\partial P_0}{\partial H} = \frac{\eta (1/100)^{1/\varepsilon} Q_0^{\ 1/\varepsilon} (1-\delta)}{[\eta - [H + \delta(1-H)]]^2} .$$

Under Price competition for homogeneous products, the conjectural variation elasticity is zero, which yields that for Bertrand conjecture, $\frac{\partial P_0}{\partial H} = \frac{(1/100)^{1/\varepsilon} Q_0^{\ 1/\varepsilon}}{\eta}$. Whereas for quantity competition, the conjectural variation elasticity lies between zero and one, which yields greater price effect as the resulting expression is likely to have a bigger numerator and a smaller denominator.

The Model for Differentiated Products.

In this section we develop two separate differentiated product models for price competition and quantity competition. Most imperfectly competitive industries are characterized by multiple differentiated products that compete with each other based on price as the strategic variable rather than quantity. Hence, a separate market demand function and unique price exist for each brand, and the brands are incomplete substitutes for each other. In such cases, a product-differentiated oligopoly model with price as the strategic variable, or a generalized Bertrand model is applicable. Infact a differentiated product model is more applicable for the U.S. beef packing industry.

We consider an industry where there are a few processors each selling a differentiated quality but buys more than one type of raw input to produce this differentiated product. We assume that there are J processors and six raw input alternatives in the industry. Each processor has access to the available set of raw inputs. Although every processor has access to all the raw inputs, they do not necessarily purchase all of them. They purchase only a few from the given set. Moreover, we consider fixed proportions technology, thus the quantity of final output produced by the processor equals the sum of the quantity of inputs he purchases from the farmers i.e. $Q_f = \sum q_i$. Even though we can model both selling and the procurement markets, our focus lies on the buying side and we consider that there exists imperfect competition in the processor's procurement market.

Let Θ represent the set of raw inputs associated with a certain segment of the beef industry. There are F firms, each buying some subset Θ_f, of this segment. Let Θ_{-f} be the subset of raw inputs not associated with firm f. Therefore, $\Theta = \Theta_f \cup \Theta_{-f}$[2]. We assume that there are 6 raw inputs in Θ. The profit of firm f is:

$$(6) \qquad max\pi_f = \{P_f\{Q_f(p(q)) - mc_f(Q_f(p(q))\}\}Q_f(p(q)) - \sum_{i \in \Theta}^{6} p_i(q_i)q_i - c^f,$$

where P_f is the price of brand *f*, mc_f is the marginal cost of brand *f*, Q_f is the output of *f*-th processor, q_i is the demand as well as farm supply at the equilibrium of *i*-th input, p_i is the farm price of ith input, and c^f are fixed costs of production. The demand for brand *f* depend on own price, the price of other brands in the industry, and price of farm inputs purchased: $Q_f = Q_f(P_1, \ldots\ldots, P_J)$. In maximizing the profit, the firms simultaneously choose the prices they are willing to pay for the raw inputs required to produce their brands and the average price reactions of other processors who buy the raw inputs not part of their portfolio: $p_{j \in \Theta_f} = h(p_{k \in \Theta_{-f}}, p_{i \in \Theta_f})$, where *h* is an unknown function. This is followed by the derivation of pricing equations for price competition and quantity competition.

Case I: Price Competition.

<u>Analysis of the effects of price competition on output price (retail price).</u>

Differentiating equation (6) with respect to P_f leads to:

$$(7) \qquad \frac{\partial \pi}{\partial P_f} = Q_f + (P_f - mc_f)\left[\frac{\partial Q_f}{\partial P_f}\right] - \sum_{i \in \Theta}^{6} p_i(q_i)\left[\frac{\partial q_i}{\partial P_f} + \sum_{k \neq i, k \in \Theta} \frac{\partial q_i}{\partial P_k} \cdot \frac{\partial P_k}{\partial P_f}\right] = 0.$$

Dividing equation (7) throughout by $\sum_{f=1}^{J} Q_f$ yields,

(8)

$$\frac{Q_f}{\sum_{f=1}^{J} Q_f} + \frac{(P_f - mc_f)}{\sum_{f=1}^{J} Q_f}\left[\frac{\partial Q_f}{\partial P_f}\frac{P_f}{Q_f}\frac{Q_f}{P_f}\right]$$

$$-\sum_{i\in\Theta}^{6} p_i(q_i)\frac{1}{\sum_{f=1}^{J} Q_f}\left[\frac{\partial q_i}{\partial P_f}\frac{P_f}{q_i}\frac{q_i}{P_f} + \sum_{k\neq i,k\in\Theta}\frac{\partial q_i}{\partial P_k}\frac{P_k}{q_i}\frac{q_i}{P_k}.\frac{\partial P_k}{\partial P_f}\frac{P_f}{P_k}\frac{P_k}{P_f}\right] = 0.$$

Replacing $\frac{Q_f}{\sum_{f=1}^{J} Q_f} = s_f$, the share of firm *f* in the total output, $\frac{\partial Q_f}{\partial P_f}\frac{P_f}{Q_f} = \eta_{ii}$, the own price elasticity of demand of brand or quality *f*, $\frac{\partial q_i}{\partial P_f}\frac{P_f}{q_i} = \varepsilon_{ii}$, supply elasticity of farm supply in terms of output price, $\frac{\partial P_k}{\partial P_f}\frac{P_f}{P_k} = \theta_{ki}$, conjectural elasticity of price competition arising from the oligopsony power of processors into equation (8) we get,

(9) $$s_f + (P_f - mc_f)\left[\eta_{ii}\frac{s_f}{P_f}\right] - \sum_{i\in\Theta}^{6} p_i(q_i)\frac{\sum q_i}{\sum_{f=1}^{J} Q_f}\left[\frac{\varepsilon_{ii}}{P_f} + \sum_{k\neq i,k\in\Theta}\frac{\varepsilon_{ik}.\theta_{ki}}{P_f}\right] = 0.$$

Multiplying equation (9) throughout by P_f results in,

$$s_f P_f + (P_f - mc_f)\left[\eta_{ii} s_f\right] - \sum_{i\in\Theta}^{6} s_f p_i(q_i)\left[\varepsilon_{ii} + \sum_{k\neq i,k\in\Theta}\varepsilon_{ik}.\theta_{ki}\right] = 0\text{, or,}$$

(10) $$s_f P_f + P_f\eta_{ii}s_f - mc_f\eta_{ii}s_f = \sum_{i\in\Theta}^{6} s_f p_i(q_i)\left[\varepsilon_{ii} + \sum_{k\neq i,k\in\Theta}\varepsilon_{ik}.\theta_{ki}\right].$$

Using the expression $\sum s_f^2 = H$, Herfindahl index and after some manipulation of equation (10) yields,

(11) $$P_f = \frac{1}{s_f(1+\eta_{ii})} H \sum_{i\in\Theta}^{J} \left[\frac{p_i \left(\varepsilon_{ii} + \sum_{k\neq i, k\in\Theta} \varepsilon_{ik} . \theta_{ki} \right)}{s_f} \right] + \frac{mc_f \eta_{ii}}{(1+\eta_{ii})}.$$

Replacing the marginal cost for the Leontief cost function[3],

$mc_f = \sum_l \sum_m \alpha_{lm} (v_l v_m)^{1/2} - 2H \sum_f^J Q_f \sum_m \beta_l v_l$, in equation (11) we get,

(12) $$P_f = \frac{1}{s_f(1+\eta_{ii})} H \sum_{i\in\Theta}^{6} \left[\frac{p_i \left(\varepsilon_{ii} + \sum_{k\neq i, k\in\Theta} \varepsilon_{ik} . \theta_{ki} \right)}{s_f} \right] + \frac{\eta_{ii} \sum_l \sum_m \alpha_{lm} (v_l v_m)^{1/2} - \frac{-2H \sum_f^J Q_f \sum_m \beta_l v_l}{(1+\eta_{ii})}}{(1+\eta_{ii})},$$

where Q_f is the f-th processor's output, v a price vector of non-farm inputs such as labor and capital, and α_{lm}, and β_l are parameters to be estimated.

Differentiating equation (12) w.r.t H yields,

(13) $$\frac{\partial P_f}{\partial H} = \frac{1}{s_f(1+\eta_{ii})} \sum_{i\in\Theta}^{6} \left[\frac{p_i \left[\varepsilon_{ii} + \sum_{k\neq i, k\in\Theta} \varepsilon_{ik} . \theta_{ki} \right]}{s_f} \right] - \frac{\eta_{ii} (2 \sum_f^J Q_f \sum_m \beta_l v_l)}{(1+\eta_{ii})},$$

where, $\frac{1}{s_f(1+\eta_{ii})} \sum_{i\in\Theta}^{6} \left[\frac{p_i \left[\varepsilon_{ii} + \sum_{k\neq i, k\in\Theta} \varepsilon_{ik} . \theta_{ki} \right]}{s_f} \right] = MP^B$ is the market power effect and

$\frac{\eta_{ii} (2 \sum_f^J Q_f \sum_m \beta_l v_l)}{(1+\eta_{ii})} = CE^B$ is the cost efficiency effect on output price.

Analysis of the effects of price competition on input price (farm price).

Differentiating equation (6) with respect to p_i leads to:

$$\frac{\partial \pi}{\partial p_i} = (P_f - mc_f)\left[\frac{\partial Q_f}{\partial p_i} Q_f + \frac{\partial Q_f}{\partial p_i}\right] - \sum_{i \in \Theta}^{6} p_i(q_i)\left[\frac{\partial q_i}{\partial p_i} + \sum_{k \neq i, k \in \Theta} \frac{\partial q_i}{\partial p_k} \cdot \frac{\partial p_k}{\partial p_i}\right] = 0$$

$$= (P_f - mc_f)\left[\frac{\partial Q_f}{\partial p_i}(Q_f + 1)\right] - \sum_{i \in \Theta}^{6} p_i(q_i)\left[\frac{\partial q_i}{\partial p_i}\frac{p_i}{q_i}\frac{q_i}{p_i} + \sum_{k \neq i, k \in \Theta} \frac{\partial q_i}{\partial p_k} \cdot \frac{p_k}{q_i} \cdot \frac{q_i}{p_k}\frac{\partial p_k}{\partial p_i} \cdot \frac{p_i}{p_k}\frac{p_k}{p_i}\right]$$

$$= (P_f - mc_f)\left[\frac{\partial Q_f}{\partial p_i}\frac{p_i}{Q_f}\frac{Q_f}{p_i}(Q_f + 1)\right]$$

$$- \sum_{i \in \Theta}^{6} p_i(q_i)\left[\frac{\partial q_i}{\partial p_i}\frac{p_i}{q_i}\frac{q_i}{p_i} + \sum_{k \neq i, k \in \Theta} \frac{\partial q_i}{\partial p_k} \cdot \frac{p_k}{q_i} \cdot \frac{q_i}{p_k}\frac{\partial p_k}{\partial p_i} \cdot \frac{p_i}{p_k}\frac{p_k}{p_i}\right].$$

We assume for simplicity that the farmers operate in a competitive market.

Let $\frac{\partial Q_f}{\partial p_i}\frac{p_i}{Q_f} = \eta_{ii}^f$, be the price elasticity of demand in terms of input price, $\frac{\partial q_i}{\partial p_i}\frac{p_i}{q_i} =$ ε_{ii}^f , be the own price elasticity of supply, $\frac{\partial q_i}{\partial p_k} \cdot \frac{p_k}{q_i} . = \varepsilon_{ik}^f$, be the cross price elasticity of supply, $\frac{\partial p_k}{\partial p_i} \cdot \frac{p_i}{p_k} = \theta_{ki}^f$, be the processor's conjectural variation elasticity.

Therefore,

$$(P_f - mc_f)\left[\eta_{ii}^f \frac{Q_f}{p_i}(Q_f + 1)\right] = \sum_{i\in\Theta}^{6} p_i(q_i)\left[\varepsilon_{ii}^f \frac{q_i}{p_i} + \sum_{k\neq i,k\in\Theta} \varepsilon_{ik}^f . \frac{q_i}{p_k}\theta_{ki}^f \frac{p_k}{p_i}\right]$$

$$or,(P_f - mc_f)\left[\eta_{ii}^f \frac{Q_f}{p_i}(Q_f + 1)\right] = \sum_{i\in\Theta}^{6} p_i(q_i)\varepsilon_{ii}^f \frac{q_i}{p_i} + \sum_{k\neq i,k\in\Theta} \varepsilon_{ik}^f . \theta_{ki}^f \frac{q_i}{p_i}$$

$$or,(P_f - mc_f)\eta_{ii}^f (Q_f + 1)Q_f - Q_f \sum_{i\in\Theta}^{6} \varepsilon_{ii}^f = \sum_{i\in\Theta}^{6} p_i(q_i) \sum_{k\neq i,k\in\Theta} \varepsilon_{ik}^f . \theta_{ki}^f \frac{q_i}{p_i}$$

Dividing the above equation by $\sum_{f=1}^{J} Q_f$ *gives,*

$$(P_f - mc_f)\frac{(Q_f + 1)}{\sum_{f=1}^{J} Q_f}\eta_{ii}^f - \frac{Q_f \sum_{i\in\Theta}^{6} \varepsilon_{ii}^f}{\sum_{f=1}^{J} Q_f} = \frac{\sum_{i\in\Theta}^{6} p_i(q_i) \sum_{k\neq i,k\in\Theta} \varepsilon_{ik}^f . \theta_{ki}^f \frac{q_i}{p_i}}{\sum_{f=1}^{J} Q_f}$$

$$or,(P_f - mc_f)\left(s_f + \frac{1}{\sum_{f=1}^{J} Q_f}\right)\eta_{ii}^f - s_f \sum_{i\in\Theta}^{6} \varepsilon_{ii}^f = \frac{p_i \sum_{k\neq i,k\in\Theta} \varepsilon_{ik}^f . \theta_{ki}^f \frac{q_i}{p_i}}{\sum_{f=1}^{J} Q_f}$$

$$or,\left[(P_f - mc_f)\sum s_f \eta_{ii}^f + \frac{\eta_{ii}^f}{\sum_{f=1}^{J} Q_f} - s_f \sum_{i\in\Theta}^{6} \varepsilon_{ii}^f\right]\frac{\sum_{f=1}^{J} Q_f}{\sum_{k\neq i,k\in\Theta} \varepsilon_{ik}^f . \theta_{ki}^f \frac{q_i}{p_i}} = p_i .$$

Differentiating the above equation w.r.t. H yields,

(14) $$or,\frac{\partial p_i}{\partial H} = P_f \ \eta_{ii}^f \frac{\sum_{f=1}^{J} Q_f}{\sum_{k\neq i,k\in\Theta} \varepsilon_{ik}^f . \theta_{ki}^f \frac{q_i}{p_i}} - 4H \ \eta_{ii}^f \frac{\sum_{f=1}^{J} Q_{fi}}{\sum_{k\neq i,k\in\Theta} \varepsilon_{ik}^f . \theta_{ki}^f \frac{q_i}{p_i}} \sum_{f=1}^{J} Q_f \ \sum_m \beta_l v_l$$

Here $P_f\ \eta_{ii}^f \dfrac{\sum_{f=1}^{J} Q_f}{\sum_{k\neq i,k\in\Theta} \varepsilon_{ik}^f . \theta_{ki}^f \dfrac{q_i}{p_i}} = MP^{B\,f}$ is the market power effect and

$4H\eta_{ii}^f \dfrac{\sum_{f=1}^{J} Q_f}{\sum_{k\neq i,k\in\Theta} \varepsilon_{ik}^f . \theta_{ki}^f \dfrac{q_i}{p_i}} \sum_{f=1}^{J} Q_f \sum_{m} \beta_l v_l = CE^{B\,f}$ is the cost efficiency effect on input price.

We had assumed a fixed proportions technology, so the price elasticity of demand and price elasticity of supply in terms of output price and input price are assumed to be same.

Case II: Quantity Competition.

<u>Analysis of the effects of quantity competition on output price (retail price).</u>

We maximize the following profit function in order to find the profit maximizing quantity and price under quantity competition,

(15) $$max\pi_f = \{P_f\{Q_f(p(q)) - mc_f(Q_f(p(q)))\}\}Q_f(p(q)) - \sum_{i\in\Theta}^{6} p_i(q_i)q_i - c^f,$$

The first order condition of firm f is:

Differentiating equation (15) w.r.t. Q_f we get,

(16) $$\frac{\partial\pi_f}{\partial Q_f} = (P_f - mc_f) + \frac{\partial P_f}{\partial Q_f} Q_f - \sum_{i\in\Theta}^{6} \left[\frac{\partial p_i}{\partial Q_f} + \sum_{k\neq i,k\in\Theta} \frac{\partial p_i}{\partial Q_k} \frac{\partial Q_k}{\partial Q_f} \right] q_i = 0,$$

(16) $$\frac{\partial\pi_f}{\partial Q_f} = (P_f - mc_f) + \frac{\partial p_i}{\partial Q_f} \frac{Q_f}{P_f} P_f - \sum_{i\in\Theta}^{6} q_i \left[\frac{\partial p_i}{\partial Q_f} \frac{Q_f}{p_i} \frac{p_i}{Q_f} + \sum_{k\neq i,k\in\Theta} \frac{\partial p_i}{\partial Q_k} \frac{Q_k}{p_i} \frac{p_i}{Q_k} \frac{\partial Q_k}{\partial Q_f} \frac{Q_f}{Q_k} \frac{Q_k}{Q_f} \right] = 0.$$

Replacing $\frac{\partial Q_f}{\partial P_f}\frac{P_f}{Q_f} = \eta_{ii}$, the own price elasticity of demand of quality *f*,

$\frac{\partial p_i}{\partial Q_f}\frac{Q_f}{p_i} = \varepsilon_{ii}$, supply elasticity of farm supply,

$\frac{\partial Q_k}{\partial Q_f}\frac{Q_f}{Q_k} = \phi_{ki}$, conjectural elasticity of quantity competition arising from the

oligopsony power of processors into equation (17) we get,

$$(17) \qquad (P_f - mc_f) + \frac{P_f}{\eta_{ii}} - \sum_{i\in\Theta}^{6} q_i \left[\frac{1}{\varepsilon_{ii}}\frac{p_i}{Q_f} + \sum_{k\neq i,k\in\Theta} \frac{p_i}{\varepsilon_{ik}}\frac{\phi_{ki}}{Q_f} \right] = 0 .$$

Using the expression $\sum s_f^2 = H$, Herfindahl Index and after some manipulation of equation (18) results in,

$$(19) \qquad P_f(1+\frac{1}{\eta_{ii}}) = mc_f + \sum_{i\in\Theta}^{6} s_f \left[\frac{p_i}{\varepsilon_{ii}} + \sum_{k\neq i,k\in\Theta} \frac{p_i}{\varepsilon_{ik}}\phi_{ki} \right] \text{ and finally}$$

(20)

$$P_f = \frac{\sum_l \sum_m \alpha_{lm}(v_l v_m)^{1/2} - 2H\sum_f^J Q_f \sum_m \beta_l v_l}{(1+\frac{1}{\eta_{ii}})} + \frac{H\sum_{i=\Theta}^{6}\left[\frac{p_i}{\varepsilon_{ii}s_f} + \sum_{k\neq i,k\in\Theta} \frac{p_i\phi_{ki}}{\varepsilon_{ik}s_f} \right]}{(1+\frac{1}{\eta_{ii}})} .$$

Differentiating equation (19) w.r.t H and substituting expression for marginal cost for Leontief Cost function yields,

$$(21) \qquad \frac{\partial P_f}{\partial H} = \frac{-2Q_f \sum(\beta_l v_l)}{(1+\frac{1}{\eta_{ii}})} + \frac{1}{(1+\frac{1}{\eta_{ii}})}\sum_{i=\Theta}^{6}\left[\frac{p_i}{\varepsilon_{ii}s_f} + \sum_{k\neq i,k\in\Theta} \frac{p_i\phi_{ki}}{\varepsilon_{ik}s_f} \right].$$

Here the market power effect is given by $\frac{1}{(1+\frac{1}{\eta_{ii}})}\sum_{i=\Theta}^{6}\left[\frac{p_i}{\varepsilon_{ii}s_f}+\sum_{k\neq i,k\in\Theta}\frac{p_i\phi_{ki}}{\varepsilon_{ik}s_f}\right]=MP^C$ and the

cost efficiency effect is $\frac{2\sum_{f=1}^{J}Q_f\sum_m\beta_l v_l}{(1+\frac{1}{\eta_{ii}})}=CE^C$ on output price.

Analysis of the effects of quantity competition on input price (farm price)

Differentiating equation (6) with respect to q_i leads to:

$$\frac{\partial\pi}{\partial q_i}=(P_f-mc_f)\left[\frac{\partial Q_f}{\partial p_i}\frac{\partial p_i}{\partial q_i}Q_f+\frac{\partial Q_f}{\partial q_i}\frac{\partial p_i}{\partial q_i}\right]-\sum_{i\in\Theta}^{6}p_i(q_i)+\sum_{k\neq i,k\in\Theta}q_i\frac{\partial p_i}{\partial q_k}.\frac{\partial q_k}{\partial q_i}=0$$
$$=(P_f-mc_f)\left[\frac{\partial Q_f}{\partial p_i}\frac{p_i}{Q_f}\frac{Q_f}{p_i}\frac{\partial p_i}{\partial q_i}\frac{q_i}{p_i}\frac{p_i}{q_i}(Q_f+1)\right]-\sum_{i\in\Theta}^{6}p_i(q_i)+\sum_{k\neq i,k\in\Theta}q_i\frac{\partial p_i}{\partial q_k}.\frac{q_k}{p_i}.\frac{p_i}{q_k}\frac{\partial q_k}{\partial q_i}.\frac{q_i}{q_k}\frac{q_k}{q_i}.$$

. Let $\frac{\partial Q_f}{\partial p_i}\frac{p_i}{Q_f}=\eta_{ii}^f$, be the price elasticity of demand in terms of input price,

$\frac{\partial q_i}{\partial p_i}\frac{p_i}{q_i}=\varepsilon_{ii}^f$, be the own price elasticity of supply, $\frac{\partial q_i}{\partial p_k}.\frac{p_k}{q_i}.=\varepsilon_{ik}^f$, be the cross price

elasticity of supply, $\frac{\partial q_k}{\partial q_i}.\frac{q_i}{q_k}=\phi_{ki}^f=0$, be the processors's conjectural variation

elasticity.

Therefore,

$$p_i=(P_f-mc_f)\eta_{ii}^f\frac{Q_f}{q_i}\varepsilon_{ii}^f(Q_f+1)-\sum_{k\neq i,k\in\Theta}q_i/\varepsilon_{ik}^f.\phi_{ki}^f\frac{p_i}{q_k}\frac{q_k}{q_i}.$$

Dividing the above equation throughout by $\sum_{f=1}^{J}Q_f$ yields,

$$p_i = (P_f - mc_f)\left[s_f \frac{\eta_{ii}^f \varepsilon_{ii}^f}{q_i} \; (s_f + \frac{1}{\sum_{f=1}^{J} Q_f}) \right] - \frac{\sum_{k \neq i, k \in \Theta} \cdot \frac{p_i \phi_{ki}^f}{\varepsilon_{ik}^f}}{\sum_{f=1}^{J} Q_f}.$$

Taking summation on both sides we get,

$$p_i \left[1 + \frac{\sum_{k \neq i, k \in \Theta} \cdot \frac{\phi_{ki}^f}{\varepsilon_{ik}^f}}{\sum_{f=1}^{J} Q_f} \right] = (P_f - mc_f)\left[\frac{\sum \eta_{ii}^f \varepsilon_{ii}^f}{Q_f} \; (H + \frac{1}{\sum_{f=1}^{J} Q_f}) \right].$$

Differentiating the above equation w.r.t. H we get,

$$(22) \quad \frac{\partial p_i}{\partial H} = P_f \frac{\sum \eta_{ii}^f \varepsilon_{ii}^f}{Q_f} \frac{\sum_{f=1}^{J} Q_f}{\sum_{k \neq i, k \in \Theta} \cdot \frac{\phi_{ki}^f}{\varepsilon_{ik}^f} + \sum_{f=1}^{J} Q_f} - 4\text{H} \frac{\sum \eta_{ii}^f \varepsilon_{ii}^f}{Q_f} \sum_{f=1}^{J} Q_f \sum_m \beta_l v_l \quad .$$

Here $P_f \frac{\sum \eta_{ii}^f \varepsilon_{ii}^f}{Q_f} = MP^{Cf}$ is the market power effect and

$4\text{H} \frac{\sum \eta_{ii}^f \varepsilon_{ii}^f}{Q_f} \sum_{f=1}^{J} Q_f \sum_m \beta_l v_l \quad = CE^{Cf}$ is the cost efficiency effect on input price.

We had assumed a fixed proportions technology, so the price elasticity of demand and price elasticity of supply in terms of output price and input price are assumed to be same

Comparison of market power and cost-efficiency effect under Price competition and Quantity competition on output price.

Here we subtract the expressions for cost efficiency effect on output price for the two models,

$$CE^{B} - CE^{C} = \left[\frac{2\eta_{ii}(\sum_{f}^{J} Q_{f} \sum_{m} \beta_{l} v_{l})}{(1+\eta_{ii})} \right] - \left[\frac{2\eta_{ii} \sum_{f=1}^{J} Q_{f} \sum_{m} \beta_{l} v_{l}}{(1+\eta_{ii})} \right].$$

Here, we can see that the expressions for cost efficiency effect on output price under price competition and quantity competition is positive and same.

Now we shall check the market power effect,

$$MP^{B} - MP^{C} = \frac{1}{s_{f}(1+\eta_{ii})} \sum_{i \in \Theta}^{6} \left[\frac{p_{i}\left(\varepsilon_{ii} + \sum_{k \neq i, k \in \Theta} \varepsilon_{ik} . \theta_{ki} \right)}{s_{f}} \right] -$$

$$\left[\frac{1}{(1+\frac{1}{\eta_{ii}})} \sum_{i=\Theta}^{6} \left(\frac{p_{i}}{\varepsilon_{ii} s_{f}} + \sum_{k \neq i, k \in \Theta} \frac{p_{i}\phi_{ki}}{\varepsilon_{ik} s_{f}} \right) \right].$$

The own price elasticity of demand will necessarily negative and the own supply elasticity is positive. However, it is somewhat difficult to assign signs to the cross price elasticity of supply. We shall consider all three cases where ε_{ik} might be positive, negative, or equal to zero.

Case a: Let us consider that $\sum \varepsilon_{ik}\theta_{ki} \quad and \quad \sum \varepsilon_{ik}\phi_{ki}$ are positive, θ_{ki}, and ϕ_{ki} are both positive under imperfect competition, η_{ii} has been assumed negative, and ε_{ii} is positive. In such a situation, MP^B is positive and MP^C is negative. Thus when the cross price elasticity of input supply is positive, market power effect on output price is greater under price competition compared to quantity competition.

Case b: Let us consider that $\sum \varepsilon_{ik}\theta_{ki} \quad and \quad \sum \varepsilon_{ik}\phi_{ki}$ are equal to zero, θ_{ki}, and ϕ_{ki} are both positive under imperfect competition, η_{ii} has been assumed negative, and ε_{ii} is positive. In such a situation, MP^B is positive, and MP^C is negative. Thus when the cross price elasticity of input supply is equal to zero, market power effect on output price is greater under price competition compared to quantity competition.

Case c: Let us consider that $\sum \varepsilon_{ik}\theta_{ki} \quad and \quad \sum \varepsilon_{ik}\phi_{ki}$ are negative, θ_{ki}, and ϕ_{ki} are both positive under imperfect competition, η_{ii} has been assumed negative, and ε_{ii} is positive. In such a situation, both MP^B and MP^C can be positive, negative or equal to zero. Thus when the cross price elasticity of input supply is positive, it is not possible to conclude whether market power effect is greater under price competition or quantity competition. Only under this case can market power effect for price competition be greater than quantity competition.

The cost efficiency effect for both the types of competition is positive in cases a, and b. Since the market power effect for price competition is also positive, we can say that the price effect of increased concentration under price competition can be positive or negative. Whereas the market power effect for quantity competition is negative, we can say that the price effect of increased concentration under quantity competition is negative. Hence, the effect of increased concentration on output price is negative for quantity competition. Thus we might conclude that increased concentration leads to a fall in output price under quantity competition whereas a rise in output price under price competition. However, it is ambiguous whose price effect is higher under conditions applying to case c.

<u>Comparison of market power and cost-efficiency effect under Price competition and Quantity competition on input price.</u>

Here we subtract the expressions for cost efficiency effect on input price for the two models,

$$CE^{Bf} - CE^{Cf} = 4\mathrm{H}\eta_{ii}^{f} \frac{\sum_{f=1}^{J} Q_f}{\sum_{k\neq i, k\in\Theta} \varepsilon_{ik}^{f}.\theta_{ki}^{f} \frac{q_i}{p_i}} \sum_{f=1}^{J} Q_f \sum_{m} \beta_l v_l \text{ - } 4\mathrm{H}\frac{\sum \eta_{ii}^{f}\varepsilon_{ii}^{f}}{Q_f} \sum_{f=1}^{J} Q_f \sum_{m} \beta_l v_l \quad .$$

Here, unlike the case of output price case we can see that the expressions for cost efficiency effect under price competition and quantity competition is not same. In the analysis for effect of increased concentration on input price two cases will arise.

<u>Case d</u>: Let us consider that $\sum \varepsilon_{ik}\theta_{ki}$ *and* $\sum \varepsilon_{ik}\phi_{ki}$ are positive, θ_{ki}, and ϕ_{ki} are both positive under imperfect competition, η_{ii} has been assumed negative, and ε_{ii} is positive. In such a situation, both CE^{B} and CE^{C} are positive. Thus when the cross price elasticity of input supply is positive, it is ambiguous to conclude whose cost efficiency is greater.

<u>Case e</u>: Let us consider that $\sum \varepsilon_{ik}\theta_{ki}$ *and* $\sum \varepsilon_{ik}\phi_{ki}$ are negative, θ_{ki}, and ϕ_{ki} are both positive under imperfect competition, η_{ii} has been assumed negative, and ε_{ii} is positive.

In such a situation, CE^B is positive and CE^C are negative. Thus when the cross price elasticity of input supply is positive, we can conclude that the cost efficiency effect under price competition is higher as compared to quantity competition.

Now we shall check the market power effect,

$$MP^{B\,f} - MP^{C\,f} \;=\; P_f\,\eta_{ii}^f \frac{\sum_{i=1}^{J} Q_i}{\sum_{k\neq i,k\in\Theta} \varepsilon_{ik}^f . \theta_{ki}^f \frac{q_i}{p_i}} - P_f \frac{\sum \eta_{ii}^f \varepsilon_{ii}^f}{Q_f}\,.$$

<u>Case f</u>: Let us consider that $\sum \varepsilon_{ik}\theta_{ki} \quad and \quad \sum \varepsilon_{ik}\phi_{ki}$ are positive, θ_{ki}, and ϕ_{ki} are both positive under imperfect competition, η_{ii} has been assumed negative, and ε_{ii} is positive. In such a situation, both MP^B and MP^C are negative. Thus when the cross price elasticity of input supply is positive, it is ambiguous to conclude whose market power is greater.

<u>Case g</u>: Let us consider that $\sum \varepsilon_{ik}\theta_{ki} \quad and \quad \sum \varepsilon_{ik}\phi_{ki}$ are negative, θ_{ki}, and ϕ_{ki} are both positive under imperfect competition, η_{ii} has been assumed negative, and ε_{ii} is positive. In such a situation, MP^B is positive and MP^C is negative. Thus when the cross price elasticity of input supply is positive, we can conclude that MP^B is greater than MP^C.

Hence when $\sum \varepsilon_{ik}\theta_{ki} \quad and \quad \sum \varepsilon_{ik}\phi_{ki}$ are positive, the price effect for both the models can be positive, negative or equal to zero, hence we conclude that under such a situation, the effect on the input price received by farmers in the post consolidation scenario is ambiguous. Thus it becomes difficult to even predict whose price effect will be higher. When $\sum \varepsilon_{ik}\theta_{ki} \quad and \quad \sum \varepsilon_{ik}\phi_{ki}$ are negative, the price effect under price competition can be positive, negative or equal to zero. Thus there is a possibility that there is a raise in the input price received by farmers. However, the price effect under quantity competition will be negative implying that there is surely a fall in welfare in the post-consolidation scenario for the farmers under quantity competition.

CHAPTER III

DATA AND EMPIRICAL SETUP

The empirical application uses weekly data for the U.S. beef industry ranging from 1990 to 2006 for seven markets namely, Texas, Oklahoma, Kansas, Colorado, Nebraska, Iowa, and Minnesota. The six different qualities chosen are over 80% choice steers, 65-80% choice steers, 35-65% choice steers, over 80% choice heifers, 65-80% choice heifers, 35-65% choice heifers. This data was taken from Livestock Marketing Information Centre (LMIC, 2006). Annual data for input prices and quantities for the U.S. beef manufacturing (SIC 2011) are from the National Bureau of Economic Research (NBER) database (Bartelsman, Becker, and Gray, 2000). The input prices are represented by the NBER's price indices. Wage per work-hour is computed by dividing NBER's total payroll by the total number of production work-hours in the industry. Consumer price index and producer price index for farm output are also from the Bureau of Labor Statistics (BLS).

The Herfindahl index for the U.S. beef processing industry is the steer and heifer slaughter concentration index compiled from several annual reports from the Grain Inspection, Packers and Stockyards Administration (GIPSA). Annual data are used for population, cattle inventory, Herfindahl index, personal disposable income, and price and quantity of labor, and capital.

To apply analytical results empirically, it is necessary to specify farm-input supply and retail-output demand functions. Farm-input supply and retail-output demand functions are represented by:

$$\text{(23)} \qquad \ln Q = a_0 + a_1(p^{corn} / PPI) + a_2(p^{diesel} / PPI) + \varepsilon_{ii}(p_i^f / PPI) + \varepsilon_{ik}(p_{k,k\neq i}^f / PPI),$$

and

$$\text{(24)} \qquad \ln Q = \delta_0 + \delta_1(p^{pork} / CPI) + \delta_2(I / CPI) + \delta_3(p^{turkey} / CPI) + \eta_{ii}(p_i / CPI),$$

where CPI and PPI are consumer price index and producer price index for farm products, respectively. Demand and supply schedules are specified in log-linear form to allow for nonlinearities between prices and quantities. The base year for all prices is 1987. Processors are expected to use non-farm inputs such as labor, and capital. Industry non-farm input demand schedules are obtained by applying Shephard's lemma on industry processing cost function:

$$\text{(25)} \qquad \frac{X_m}{Q} = \frac{1}{2}\sum_l \sum_m \alpha_{lm}(v_l / v_m)^{1/2} + HQ\beta_l,$$

where X_m is industry derived demand for the mth non-farm input purchased competitively.

The two pricing equations used for empirical estimation were,

$$P_f = \frac{1}{s_f(1+\eta_{ii})} H \sum_{i\in\Theta}^{6} \left[\frac{p_i\left(\varepsilon_{ii} + \sum_{k\neq i, k\in\Theta} \varepsilon_{ik}.\theta_{ki}\right)}{s_f} \right] + \frac{\eta_{ii}\sum_l \sum_m \alpha_{lm}(v_l v_m)^{1/2} - \frac{-2H\sum_f^J Q_f \sum_m \beta_l v_l}{(1+\eta_{ii})}}{(1+\eta_{ii})}, \text{ and}$$

$$P_f = \frac{\sum_l \sum_m \alpha_{lm}(v_l v_m)^{1/2} - 2H\sum_f^J Q_f \sum_m \beta_l v_l}{(1+\frac{1}{\eta_{ii}})} + \frac{H\sum_{i=\Theta}^{6}\left[\frac{p_i}{\varepsilon_{ii} s_f} + \sum_{k\neq i, k\in\Theta} \frac{p_i \phi_{ki}}{\varepsilon_{ik} s_f}\right]}{(1+\frac{1}{\eta_{ii}})}.$$

The exogenous variables are price of diesel, price of corn, price of pork, price of labor, price of capital, price of turkey, disposable income, and Herfindahl index for processors. The endogenous variables are farm prices of the inputs, total demand for processed beef, productivity of capital, and productivity of labor. The parameters estimated were η_{ii}, ε_{ii}, ε_{ik} , θ_{ki}, ϕ_{ki}, α_{lm}, and β_l .

A system of equations is estimated empirically using non-linear three stage least squares (N3SLS) estimator for each case of imperfect competition discussed in the previous section. Each system of equations includes equations for non-farm input demand for labor, and capital– equation (25), cattle supply – equation (23), retail demand – equation (24), and pricing equations. The instrumental variables required for N3SLS estimator includes all exogenous variables, population and input prices (labor, capital, corn, calves, and diesel). All systems of equations converged to a solution with a convergence criterion of 0.001.

CHAPTER IV.

EMPIRICAL RESULTS AND ANALYSIS.

In our application of the market power and cost efficiency tradeoff model to the beef packing industry, attention is limited to the steer and heifer sectors because of its predominance in the industry as a whole and because of data considerations. Parameter estimates from our two differentiated product models of imperfect competition are reported in Tables 2, and 3. Most parameter estimates have the expected signs and are significant at the one percent level.

Almost all α_{lm} have positive values, suggesting that the processors cost function is concave, and increasing in price. Own price elasticity for wholesale demand and farm supply have the expected sizes and signs, and are significant at the one percent level of statistical significance. The estimates of cross price supply elasticities were positive, and negative depending on whether the inputs are bought by the same processor or not. The inputs which are purchased by the same processor have negative cross price supply elasticities as there might be a trade off between the demands for the two due to fixed resources. However, the cross price elasticities between the inputs which the processor purchases and which he did not purchase might be positive or zero. In all cases of imperfect competition considered, conjectural variation estimates, ϕ, and θ are significant at the 1% level.

Direct estimates of market power and cost efficiency effects on output price from an increase in concentration at processors' level are obtained using equations (13) and (21), and are reported in tables 4, and 5. The total price effect of an increase in concentration at the processing level on retail price is measured as the sum of market power effects and cost savings (from equations (13), and (21)).

The estimates of cost efficiency effects on output price were positive for all inputs and almost same for both the models. This was in accordance to our analytical results. Our analytical results suggest that the market power effect for an input would be positive under price competition when the sum of the cross price elasticity of supply of that input is positive and ambiguous in sign when the cross price supply elasticity is negative. The estimates of market power effect as reported in table 5 show that this is true as for inputs 2 and 6 whose sum of cross supply elasticities is positive. However, we found that for the other inputs as well it is positive except input 1. The net price effect on output price is positive for all the inputs excepting inputs 1, 2, and 6 under price competition. In our analytical framework we deduced that the market power effect of increase in concentration on output price under quantity competition should be negative when the sum of cross price supply elasticities is positive and for other situations it is ambiguous. Our empirical estimates as reported in table 4 suggest similar results as the market power effect is negative for inputs 2 and 6 under quantity competition. For all other inputs it is positive excepting input 1. The net price effect on output price is positive for all the inputs excepting inputs 1, 2, and 6. So for these cases our results converge with results of previous studies which concluded that in the post-consolidation scenario, the cost efficiency effect supersedes market power effect and is actually welfare enhancing for both consumers and processors. Thus unlike previous studies this result suggests that the cost efficiency effect does not always supersede the market power effect of increased concentration. Moreover, a trend was noticed which clearly suggest that the increase in output price due to increase in concentration was higher under quantity competition as compared to price competition.

Estimates of market power and cost efficiency effects on input price from an increase in concentration at processors' level are obtained using equations (14) and (22), and are reported in table 6 and 7 for quantity competition and price competition respectively. All estimates of market power and cost efficiency effects are significant at the ten percent level of significance. The total effect of an increase in concentration at the processing level on retail price is measured as the sum of market power effects and cost savings (from equations (14), and (22)). In our analytical framework, we found that the cost efficiency effect and market power effect are both positive under price competition when the sum of cross price elasticity is negative. The empirical results as reported by table 7 depict similar results. The net price effect is positive for inputs 1 and 6 suggesting an increase in price received by farmers has actually increased after increased concentration. For all other inputs the price which the farmers receive has declined. Thus for these cases there is no spillover of increased profit of the processors in favor of the farmers. The market power effect and cost efficiency effect of increased concentration on input price is negative under quantity competition. For all the inputs the net price effect is negative under quantity competition suggesting that the welfare of farmers decline in the post consolidation scenario. Thus we can conclude that increase in concentration is welfare diminishing for farmers for all inputs under quantity competition and welfare enhancing for a few inputs under price competition. However, even the inputs for which the input price received by farmers decreased for both models, the extent of decrease was higher under quantity competition than price competition.

CHAPTER IV.

WELFARE ANALYSIS OF CONSUMERS, PROCESSORS AND FARMERS.

Before we compare the welfare effects of price competition and quantity competition, we make certain assumptions following Azzam and Schroeter (1995). We consider $Q^d = AP^\gamma$, to be the demand function for processed beef where γ is the price elasticity of demand, and let $Q^s = BW^\varepsilon$, be the supply function for farm input where ε is the price elasticity of farm supply. We consider V=$\frac{p-c-w}{w}$ where V is the oligopsony distortion. Thus p=w (1+V) +c. Let the initial quantity be equal to Q^0= 100, w = 1, p= 1+V+c, and B= 100. For simplicity we assume an industry with homogeneous product. When the market is perfectly competitive, the price paid for the raw material is equal to the output price minus cost, thus the markup or distortion is zero. However, when the market is imperfectly competitive, then V greater than zero. Substituting for A and B in the demand and supply equations gives the inverse consumer demand function

(26). $$P = (1+V+c)100^{-1/\eta}Q^{1/\eta},$$

and the inverse input supply function

(27) $$w = 100^{-1/\varepsilon}Q^{1/\varepsilon}.$$

The demand curve for raw material input at a given quantity, net of marginal costs is

(28) $$w = (1 + V + c)100^{-1/\eta} Q^{1/\eta} - c\,.$$

Figure 1 contains graphs of equations (26), (27), and (28). Consumer demand, raw material input supply, and the raw material input derived demand curves are labeled D, S, and DD, respectively.

At this point if we imagine that the marginal processing costs fall due to plant scale economies. Further we imagine that the post-consolidation level of V is greater than initial V. This drop is marginal cost will shift the raw material input derived demand curve from DD to DD^* in the figure where DD^* is the derived demand for raw material at the lower level of marginal cost.

We find the change in Consumer Surplus, Producer's surplus, and processor's profit in the following section. We follow Figure 1 to derive the expressions for welfare loss to consumers, processors and producers due to increase in concentration[5]. The resulting post-consolidation quantity, raw material input price, and output price are denoted in figure A as Q^*, w^*, and p^*, respectively. Area *abed* represents change in consumer surplus.

Change in consumer surplus for quantity competition:

$$\Delta CS = -\left\{\left((1+V+c)100^{\frac{-1}{\gamma}} Q^{*\frac{1}{\gamma}} - (1+V+c)\right)Q^* + \int_{Q^*}^{100}\left((1+V+c)100^{\frac{-1}{\gamma}} Q^{*\frac{1}{\gamma}} - (1+V+c)\right)dQ\right\}$$

$$= -\left[(1+V+c)100^{\frac{-1}{\gamma}} Q^{*\frac{1+\gamma}{\gamma}} - (1+V+c)Q^* + \frac{\gamma}{\gamma+1}(1+V+c)100 + (1+V+c)Q^*\right]$$

$$= -\frac{1}{\gamma+1}\left[(1+V+c)\left\{100\gamma + (1+\gamma)100^{\frac{-1}{\gamma}} Q^{*\frac{1+\gamma}{\gamma}}\right\}\right]$$

$$= -\frac{1}{\gamma+1} p^0 \left\{Q^0\gamma + (1+\gamma)Q^{0\frac{-1}{\gamma}} Q^{*\frac{1+\gamma}{\gamma}}\right\}$$

$$= -\frac{1}{\gamma+1}\left\{100\gamma + (1+\gamma)100^{\frac{-1}{\gamma}} 100\left(1-\frac{H}{\gamma}\right)^{\varepsilon(1+\varepsilon)/(\varepsilon+\gamma)}\right\}.$$

Change in consumer surplus for price competition:

$$\Delta CS = -\left\{(p^0(Ap^0)^{\frac{-1}{\gamma}}(Ap^*)^{\frac{1}{\gamma}} - p^0\right\}(Ap^*)^{\frac{1}{\gamma}} + \int_{p^0}^{p^*}\left\{(p^0(Ap^0)^{\frac{-1}{\gamma}}(Ap^*)^{\frac{1}{\gamma}} - p^0\right\}dp$$

$$= -A^{\frac{1}{\gamma}}(p^0)^{\frac{\gamma-1}{\gamma}}(p^*)^{\frac{2}{\gamma}} - A^{\frac{1}{\gamma}} p^0 (p^*)^{\frac{1}{\gamma}} + A^{\frac{1}{\gamma}}\left[(p^0)^{\frac{3-\gamma}{\gamma}} - \frac{(p^*)^{\frac{1+\gamma}{\gamma}} p^0}{\frac{1+\gamma}{\gamma}}\right]$$

Putting Q= Ap^{γ}

$$\Delta CS = (Q^*)^{\frac{1}{\gamma}}\left[(p^0)^{\frac{3\gamma-1}{\gamma}} - \frac{\gamma}{\gamma+1}(p^*)^{\frac{1+\gamma}{\gamma}} p^0 - (p^0)^{\frac{\gamma-1}{\gamma}}(p^*)^{\frac{2}{\gamma}} + p^0(p^*)^{\frac{1}{\gamma}}\right]$$

$$= 100\left[1-\frac{2H-1}{\gamma}\right]^{\varepsilon/(\varepsilon+\gamma)} - \frac{\gamma}{\gamma+1}\left(\frac{\gamma(1/100)^{1/\varepsilon}100^{1/\varepsilon}}{\gamma-[2H-1]}\right)^{\frac{1+\gamma}{\gamma}}$$

$$-\left(\frac{\gamma(1/100)^{1/\varepsilon}100^{1/\varepsilon}}{\gamma-[2H-1]}\right)^{\frac{2}{\gamma}} + \left(\frac{\gamma(1/100)^{1/\varepsilon}100^{1/\varepsilon}}{\gamma-[2H-1]}\right)^{\frac{1}{\gamma}}.$$

The area *mnpo* is the change in producer surplus of raw inputs.

Change in farmer's surplus under quantity competition:

$$\Delta PS = -\left[(1-100^{-1/\varepsilon} Q^{*^{1/\varepsilon}})Q^* + \int_{Q^*}^{100} (1-100^{-1/\varepsilon} Q^{^{1/\varepsilon}})dQ \right]$$

$$= -\left[(1-100^{-1/\varepsilon} Q^{*^{1/\varepsilon}})Q^* + \left[Q - \frac{100^{-1/\varepsilon} Q^{1+\varepsilon/\varepsilon}}{1+\varepsilon/\varepsilon} \right]_{Q^*}^{100} \right]$$

$$= -\left[(1-100^{-1/\varepsilon} Q^{*^{1/\varepsilon}})Q^* + \left[100 + \frac{100^{-1/\varepsilon} Q^{*1+\varepsilon/\varepsilon}}{1+\varepsilon/\varepsilon} \right] \right]$$

$$= -\left[(1+\varepsilon)Q^* - (1+\varepsilon)100^{-1/\varepsilon} Q^{*^{1+\varepsilon/\varepsilon}} + (1+\varepsilon)100 + \varepsilon 100^{-1/\varepsilon} Q^{*^{1+\varepsilon/\varepsilon}} \right]$$

$$= -\left[(1+\varepsilon)(Q^* + 100) - 100^{-1/\varepsilon} Q^{*^{1+\varepsilon/\varepsilon}} \right]$$

$$= -\left[(1+\varepsilon)(Q^* + Q^0) - (Q^0)^{-1/\varepsilon} Q^{*^{1+\varepsilon/\varepsilon}} \right]$$

$$= -\left[(1+\varepsilon)\left(100\left[1 - \frac{H}{\eta} \right]^{\gamma\varepsilon/(\varepsilon+\gamma)} + 100 \right) - (100)^{-1/\varepsilon} 100 \left[1 - \frac{H}{\eta} \right]^{\gamma(1+\varepsilon)/(\varepsilon+\gamma)} \right]$$

Change in farmer's surplus under price competition:

$$\Delta PS = -\left\{\left(1-\left(\frac{Ap^{*\eta}}{B}\right)^{\frac{1}{\varepsilon}}\right)Ap^{*\eta} + \int_{p^*}^{p^0} Ap^{0^\eta} - \left(\frac{A^2 p^{2\eta}}{B}\right)^{\frac{1}{\varepsilon}} dp\right\}$$

$$= -\left[Ap^{*\gamma} - \left\{\frac{(Ap^{*\eta})^2}{B}\right\}^{\frac{1}{\varepsilon}} + \int_{p^*}^{p^0} Ap^{0^\gamma} - \left(\frac{(Ap^{0^\gamma})^2}{B}\right)^{\frac{1}{\varepsilon}} dp\right]$$

$$= -\left[Ap^{*\gamma} - \left\{\frac{(Ap^{*\gamma})^2}{B}\right\}^{\frac{1}{\varepsilon}} + \left\{\frac{Ap^{\gamma+1}}{\gamma+1} - \left(\frac{A^2}{B}\right)^{\frac{1}{\varepsilon}} \frac{p^{\frac{2\gamma+1}{\varepsilon}}}{\frac{2\gamma+\varepsilon}{\varepsilon}}\right\}_{p^*}^{p^0}\right]$$

$$= -\left[Ap^{*^\gamma} - \left\{\frac{(Ap^{*\gamma})^2}{B}\right\}^{\frac{1}{\varepsilon}} + \left\{\frac{A(p^0)^{\gamma+1}}{\gamma+1} + \varepsilon\left(\frac{A^2}{B}\right)^{\frac{1}{\varepsilon}} \frac{(p^*)^{\frac{2\gamma+\varepsilon}{\varepsilon}}}{2\gamma+\varepsilon}\right\}\right]$$

$$= -100\left(\frac{\gamma(1/100)^{1/\varepsilon}100^{1/\varepsilon}}{\gamma-[2H-1]}\right)^{\gamma} + \left(\frac{\gamma(1/100)^{1/\varepsilon}100^{1/\varepsilon}}{\gamma-[2H-1]}\right)^{\frac{2\gamma}{\varepsilon}}$$

$$-\left\{\frac{100}{\gamma+1} + \varepsilon(100)^{\frac{1}{\gamma}} \frac{\left(\frac{\gamma(1/100)^{1/\varepsilon}100^{1/\varepsilon}}{\gamma-[2H-1]}\right)^{\frac{2\gamma+\varepsilon}{\varepsilon}}}{2\gamma+\varepsilon}\right\}$$

Processor's pre-consolidation and post consolidation oligopoly rents are represented by areas jknm and fgpo, respectively. Thus the change in their profit (fgpo-jknm) is given by

$$\begin{aligned}
\Delta\pi &= \{w^*(1+V^*)-w^*\}Q^* - 100(1+V) - 100 \\
&= \{w^*(1+V^*)-w^*\}Q^* - 100V \\
&= \{p^* - (1-s)c - w^*\}Q^* - 100V \\
&= (1+V+c)100^{-\frac{1}{\gamma}}Q^{*\frac{1}{\gamma}} - (1-s)c - 100^{-\frac{1}{\gamma}}Q^{*\frac{1}{\gamma}} - 100V \\
&= (1+V+c)(Q^0)^{-\frac{1}{\gamma}}Q^{*\frac{1}{\gamma}} - (1-s)c - (Q^0)^{-\frac{1}{\gamma}}Q^{*\frac{1}{\gamma}} - Q^0V \\
&= (1+V+c)(100)^{-\frac{1}{\gamma}}100\left[1-\frac{H}{\gamma}\right]^{\varepsilon/(\varepsilon+\gamma)} - (1-s)c - (100)^{-\frac{1}{\gamma}}100\left[1-\frac{H}{\gamma}\right]^{\varepsilon/(\varepsilon+\gamma)} - 100V \\
&= (1+p-c+c)(100)^{-\frac{1}{\gamma}}100\left[1-\frac{H}{\gamma}\right]^{\varepsilon/(\varepsilon+\gamma)} - (1-s)c - (100)^{-\frac{1}{\gamma}}100\left[1-\frac{H}{\gamma}\right]^{\varepsilon/(\varepsilon+\gamma)} - 100(p-c) \\
&= (1+\frac{\gamma(1/100)^{1/\varepsilon}100^{1/\varepsilon}}{\gamma-H})(100)^{-\frac{1}{\gamma}}\left[1-\frac{H}{\gamma}\right]^{\varepsilon/(\varepsilon+\gamma)} \\
&\quad - (1-s)c - (100)^{-\frac{1}{\gamma}}100\left[1-\frac{H}{\gamma}\right]^{\varepsilon/(\varepsilon+\gamma)} - 100\left(\frac{\gamma(1/100)^{1/\varepsilon}100^{1/\varepsilon}}{\gamma-H} - c\right).
\end{aligned}$$

Following Azzam and Schroeter (1995) we use the expression for distortion

$V = \dfrac{p-c-w}{w} = \dfrac{\lambda - H(\lambda-1)}{\varepsilon}$ where λ is the conjectural variation elasticity. First, estimates of pre-consolidation values of V and H were obtained using information from outside sources. Then the estimate of supply elasticity was combined with the test case values of λ and H to determine the estimates of actual distortion. At the pre consolidation level the value of λ is set to zero. For simplicity, we use the baseline and test case levels of distortion from Azzam and Schroeter's paper. The baseline and test case values of distortion have been taken as 0.0300, 0.0450, and 0.1136 and a simulation was done to see the actual change in consumer, producer surplus and processor's rent.

We found that there was a welfare loss for both consumers and producers with increased concentration. The extent of loss was slightly lower under price competition as compared to quantity competition. However, processors profit was higher under quantity competition compared to its counterpart. Thus, we can conclude that Price competition leads to smaller levels of welfare loss to consumers and producers whereas Quantity competition is more welfare enhancing for processors.

Chapter V.

CONCLUSIONS.

In our study we have modeled oligopsony power- cost efficiency tradeoffs in the food processing industry for a differentiated products model. We applied this model to the beef packing industry as this industry fits the oligopsony profile and it has experienced unprecedented changes which are thought to have endangered cost efficiency gains arising from plant economies, due to increased market power. This study estimated the tradeoff between market power and cost efficiency from increase in industry concentration in the beef packing industry on output as well as input price for both price competition and quantity competition while allowing for imperfect competition at the processing level. Previous studies on this kind of analysis of tradeoff have left out the case of price competition and used assumptions about market structure supporting quantity competition. Moreover, the earlier studies have not attempted to perform market power-cost efficiency trade-off analysis for farmers. Earlier studies on the comparison of welfare effects of price competition and quantity competition were primarily analytical and were not supported by empirical evidence. Our study further analyses the welfare effect on the various participants like consumers, farmers and processors.

In our analytical framework we were able to show when the effect on price (input and output) and welfare effects under alternative assumptions of imperfect competition.

The empirical results reported in this study suggest that, increase in concentration led to effect on final good price when the sum of cross price elasticity of supply is positive for both the models. For the inputs whose sum of cross price elasticity of supply is negative, the net price effect is negative leading to the conclusion that for these inputs, the welfare of consumers as well as processors is raised. However, the effect on input price is somewhat different and increased concentration might lead to actually a fall in the price of inputs which the farmers receive in most of the cases. Only under Bertrand competition, there might be a possibility that the price received by farmers actually rise in the post consolidation scenario. Infact, even when the price effect was positive, the extent of increase in both output price and input price was lower under price competition than under quantity competition. Our simulation results suggest that the loss in surplus for consumers and producers were slightly less under price competition as compared to quantity competition. However, the oligopsony rent was surely higher under quantity competition than under price competition.

For our empirical analysis we estimated the two models separately thus we have slightly different parameter estimates under the two models considered. This procedure has certain limitations as the results might be influenced by the different parameter estimates. For further research, a sensitivity analysis can be done by performing the same analysis under different assumptions, e.g. we can use the parameter estimates of quantity competition for both the models excepting the conjectural variation elasticity of price elasticity; and again use the parameter estimates of price competition for both the models excepting the conjectural variation elasticity of Cournot. With this kind of analysis we can see whether our results in this study are biased due to the empirical procedure adopted.

The results presented here have important policy implications. They suggest that consolidations in the beef industry are not always efficiency driven. Infact in most cases it has led to welfare loss of both consumers and farmers. Atleast for the input price, generally there has been no spillover effect of profit earned by processors on farmers due to increased concentration. However, the inclusion of oligopoly power of retailers separately in the same model might lead to different results.

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Endnotes

1. $$Q_0 = \frac{100}{(P_0)^{\eta}} = \frac{100}{\left[\dfrac{\eta(1/100)^{1/\varepsilon} Q_0{}^{1/\varepsilon}}{\eta - [H + \delta(1-H)]}\right]^{\eta}}$$

$$or, (Q_0)^{\frac{\varepsilon+\eta}{\varepsilon}} \left[\eta(1/100)^{1/\varepsilon}\right]^{\eta} = 100\left[\eta - \left(H + \delta(1-H)\right)\right]^{\eta}$$

$$or, (Q_0)^{\frac{\varepsilon+\eta}{\varepsilon}} = 100^{\frac{\varepsilon+\eta}{\varepsilon}} \left[\frac{\left(\eta - \left(H + \delta(1-H)\right)\right)}{\eta}\right]^{\eta}$$

2. The concept of conjectural variation for price competition has been borrowed from Jeffrey J. Reimer's article "Market Conduct in the U.S. Ready-to-Eat Cereal Industry" published in Journal of Agricultural & Food Industrial Organization (2004, vol:2, article:9)

3. Following Appelbaum (1982) we also consider that the industry cost function is given by a generalized Leontief cost function (of the Gorman Polar form)

$$c = \sum_i \sum_j b_{ij}(w_i w_j)^{\frac{1}{2}}\, y + \sum_i b_i w_i, \qquad i, j = K, L, M,$$

4. For the above assumptions and approach we closely follow Azzam and Schroeter's article "The tradeoff between oligopsony power and cost efficiency in horizontal consolidation: an example from beef packing" published in American Journal of Agricultural Economics" (Nov. 1995, Vol: 77, No.:4)

5. The rental price of capital, and the productivity of capital, labor and processing materials are 2-digit SIC data for Food & Kindred Products provided electronically by the Bureau of Labor Statistics.

Table 1. Means, standard deviations, and maximum and minimum values for variables used in the empirical estimation (N = 859, weekly data 1990-2006).

Variable	Symbol	MEAN	Standard deviation	Minimum	Maximum
Production of 80% choice steer	*FQST80*	16.10	16.41	0.07	82.89
Production of 65-80% choice steer	*FQST65*	86.38	44.72	9.07	582.88
Production of 35-65% choice steer	*FQST35*	545.20	217.13	6.69	1711.51
Production of 80% choice heifers	*FQH80*	11.57	12.65	0.03	96.53
Production of 65-80% choice heifers	*FQH65*	73.51	36.82	3.62	317.13
Production of 35-65% choice heifers	*FQH35*	415.29	139.64	13.07	1180.29
Farm price of 80% choice steers	*FPST80*	7.37	0.98	0.04	11.27
Farm price of 65-80% choice steer	*FPST65*	7.21	0.99	9.83	11.52
Farm price of 35-65% choice steer	*FPST35*	7.22	0.98	0.40	10.81
Farm price of 80% choice heifers	*FPH80*	7.20	0.97	5.65	11.30
Farm price of 65-80% choice heifers	*FPH65*	7.21	0.99	5.63	10.80
Farm price of 35-65% choice heifers	*FPH35*	7.22	0.99	5.56	18.02
Commercial beef production	Q	24.00	1.52	21.09	26.39
Retail price of processed beef	P	2.24	0.56	0.87	0.30
Retail price of pork ($/lb)	P^{pork}	2.48	0.25	20.60	28.20
Price of turkey ($/cwt)	P^{turkey}	10.00	0.20	9.70	10.50
Per capita income (thousand $)	I	25.16	3.51	17.13	30.51
Consumer price index (84-86 = 100)	CPI	171.03	16.38	132.35	201.60
Producer price index (82 = 100)	PPI	127.33	18.28	98.40	155.70
Price of No2 diesel ($/gallon)	p^{diesel}	5.27	0.76	4.74	1.09
Price of corn ($/bus)	p^{corn}	2.34	0.45	1.85	3.60
Price of labor ($/hour)	v_L	7.75	1.71	4.04	9.94

Table 1. Means, standard deviations, and maximum and minimum values for variables used in the empirical estimation (N = 859, weekly data 1990-2006).

Variable	Symbol	MEAN	Standard deviation	Minimum	Maximum
Rental price of capital (2000 = 1)	v_K	0.70	0.35	0.15	1.31
Productivity of capital (1996=100)	Q/X_K	101.48	3.15	97.00	110.10
Productivity of workers (1996=100)	Q/X_L	83.17	15.06	56.60	106.30
Herfindahl index for steer and heifer slaughter	H	1952.81	55.46	1661.00	2096.00
Population (millions)	POP	281.74	10.52	250.13	299.39

Table 2. Parameter estimates and standard errors for Quantity Competition.

Parameter	Estimate	Std. Error	Parameter	Estimate	Std. Error
ϕ_{ki}	0.00031	0.00031	ε_{55}	1.308	0.14
η_1	-0.422	0.021	ε_{56}	0.0856	0.0078
ε_{11}	1.25	0.024	ε_{66}	0.970	0.0073
ε_{12}	-0.654	0.0029	β_L	-7E-07	3.8E-07
ε_{13}	-0.104	0.0203	β_K	5.5E-08	7.7E-08
ε_{14}	-1.187	0.024	α_{LL}	0.072	0.0064
ε_{15}	0.235	0.027	α_{KK}	0.0099	0.0046
ε_{16}	-0.120	0.018	α_{LK}	0.00073	0.002
ε_{22}	1.209	0.001	δ_0	3.98	0.13
ε_{23}	-0.142	0.0024	δ_1	0.0015	0.00052
ε_{24}	0.122	0.021	δ_2	0.044	0.019
ε_{25}	0.104	0.0023	δ_3	-0.035	0.007
ε_{26}	-0.091	0.0019	α_0	3.25	0.072
ε_{33}	0.456	0.019	α_1	-0.036	0.014
ε_{34}	-0.047	0.013	α_2	-0.067	0.014
ε_{35}	0.761	0.00065			
ε_{36}	-0.429	0.0007			
ε_{44}	0.734	0.0056			
ε_{45}	0.081	0.000039			
ε_{46}	-0.067	0.00027			

Table 3. Parameter estimates and standard errors for Price Competition.

Parameter	Estimate	Std. Error	Parameter	Estimate	Std. Error
θ_{ki}	0.00017	0.00023	ε_{55}	1.198	0.0214
η_1	-0.623	0.02	ε_{56}	0.087	0.0178
ε_{11}	1.253	0.024	ε_{66}	1.041	0.0073
ε_{12}	-0.595	0.0029	β_L	-4E-07	3.8E-07
ε_{13}	-0.114	0.0203	β_K	5.4E-08	7.7E-08
ε_{14}	-1.185	0.025	α_{LL}	0.071	0.0054
ε_{15}	0.225	0.022	α_{KK}	0.0089	0.0046
ε_{16}	-0.120	0.018	α_{LK}	0.00063	0.002
ε_{22}	1.209	0.001	δ_0	2.78	0.13
ε_{23}	-0.140	0.0024	δ_1	0.0025	0.00052
ε_{24}	-0.126	0.021	δ_2	0.034	0.019
ε_{25}	0.212	0.0023	δ_3	-0.025	0.07
ε_{26}	-0.1	0.0019	α_0	3.15	0.062
ε_{33}	0.446	0.012	α_1	-0.035	0.0024
ε_{34}	-0.05	0.013	α_2	-0.057	0.014
ε_{35}	0.761	0.00065			
ε_{36}	-0.422	0.0007			
ε_{44}	0.758	0.0056			
ε_{45}	0.071	0.000039			
ε_{46}	-0.065	0.00027			

Table 4. Market power and cost efficiency effects on output price for two models of imperfect competition in the U.S. beef Industry, 1990 – 2006 (Quantity Competition).

	Estimate	*Std. Error*
Input 1: 80% choice steers		
Market power Effect	0.00056	0.000014
Cost Efficiency Effect	0.00027	0.000026
Total Effect	0.00029	0.00004
Input 2: 65-80% choice steers		
Market power Effect	0.00036	2.45E-05
Cost Efficiency Effect	0.00029	0.00002
Total Effect	0.00007	0.00007
Input 3: 35-65% choice steers		
Market power Effect	0.00069	0.000026
Cost Efficiency Effect	0.00043	0.00004
Total Effect	0.00026	0.000018
Input 4: 80% choice heifers		
Market power Effect	0.000436	0.000063
Cost Efficiency Effect	0.00024	0.00002
Total Effect	0.000196	0.000059
Input 5: 65- 80% choice heifers		
Market power Effect	0.000453	0.000043
Cost Efficiency Effect	0.00027	0.00005
Total Effect	0.000183	0.00059
Input 6: 35- 65% choice heifers		
Market power Effect	0.00087	0.000033
Cost Efficiency Effect	0.00043	0.00002
Total Effect	0.00044	0.00059

Table 5. Market power and cost efficiency effects on output price for two models of imperfect competition in the U.S. beef Industry, 1990 – 2006 (Price Competition).

	Estimate	Std. Error
Input 1: 80% choice steers		
Market power Effect	0.00041	0.00005
Cost Efficiency Effect	0.0003	0.00014
Total Effect	0.00011	0.000059
Input 2: 65-80% choice steers		
Market power Effect	0.00051	0.000043
Cost Efficiency Effect	0.0003	0.00005
Total Effect	0.00021	0.000059
Input 3: 35-65% choice steers		
Market power Effect	0.00074	0.00007
Cost Efficiency Effect	0.0004	0.00014
Total Effect	0.00034	0.000053
Input 4: 80% choice heifers		
Market power Effect	0.00037	0.000026
Cost Efficiency Effect	0.00024	0.00004
Total Effect	0.00013	0.000018
Input 5: 65- 80% choice heifers		
Market power Effect	0.000461	1.86E-05
Cost Efficiency Effect	0.00028	0.00006
Total Effect	0.000181	0.000016
Input 6: 35- 65% choice heifers		
Market power Effect	0.00074	4.45E-05
Cost Efficiency Effect	0.00043	0.000043
Total Effect	0.00031	0.00002

Table 6. Market power and cost efficiency effects on input price for two models of imperfect competition in the U.S. beef Industry, 1990 – 2006 (Quantity Competition).

	Estimate	Std. Error
Input 1: 80% choice steers		
Market power Effect	-0.00005	0.000014
Cost Efficiency Effect	0.00027	-0.0003
Total Effect	-0.00032	0.00004
Input 2: 65-80% choice steers		
Market power Effect	0.00012	2.45E-05
Cost Efficiency Effect	0.00029	-0.0003
Total Effect	-0.00017	0.00007
Input 3: 35-65% choice steers		
Market power Effect	0.00042	0.000026
Cost Efficiency Effect	0.00043	-0.00006
Total Effect	-0.00001	0.000018
Input 4: 80% choice heifers		
Market power Effect	0.00007	0.000063
Cost Efficiency Effect	0.00024	-0.0003
Total Effect	-0.00017	0.000059
Input 5: 65- 80% choice heifers		
Market power Effect	-0.000453	0.000043
Cost Efficiency Effect	0.00027	-0.00027
Total Effect	-0.000480	0.00059
Input 6: 35- 65% choice heifers		
Market power Effect	-0.00038	0.000033
Cost Efficiency Effect	0.00043	-0.0003
Total Effect	-0.00081	0.00059

Table 7. Market power and cost efficiency effects on input price for two models of imperfect competition in the U.S. beef Industry, 1990 – 2006 (Price Competition).

	Estimate	Std. Error
Input 1: 80% choice steers		
Market power Effect	-0.00001	0.00005
Cost Efficiency Effect	0.00031	-0.0005
Total Effect	-0.00032	5.90E-05
Input 2: 65-80% choice steers		
Market power Effect	-0.000015	4.30E-05
Cost Efficiency Effect	0.00012	-0.0005
Total Effect	-0.000135	0.000059
Input 3: 35-65% choice steers		
Market power Effect	-0.00004	0.00007
Cost Efficiency Effect	0.00052	-0.0005
Total Effect	-0.00056	5.30E-05
Input 4: 80% choice heifers		
Market power Effect	-0.000023	2.60E-05
Cost Efficiency Effect	0.00014	-0.0005
Total Effect	-0.000163	1.80E-05
Input 5: 65- 80% choice heifers		
Market power Effect	-0.00005	1.86E-05
Cost Efficiency Effect	0.00028	-0.0005
Total Effect	-0.00033	1.60E-05
Input 6: 35- 65% choice heifers		
Market power Effect	-0.00004	4.45E-05
Cost Efficiency Effect	0.00052	-0.0005
Total Effect	-0.00056	0.00002

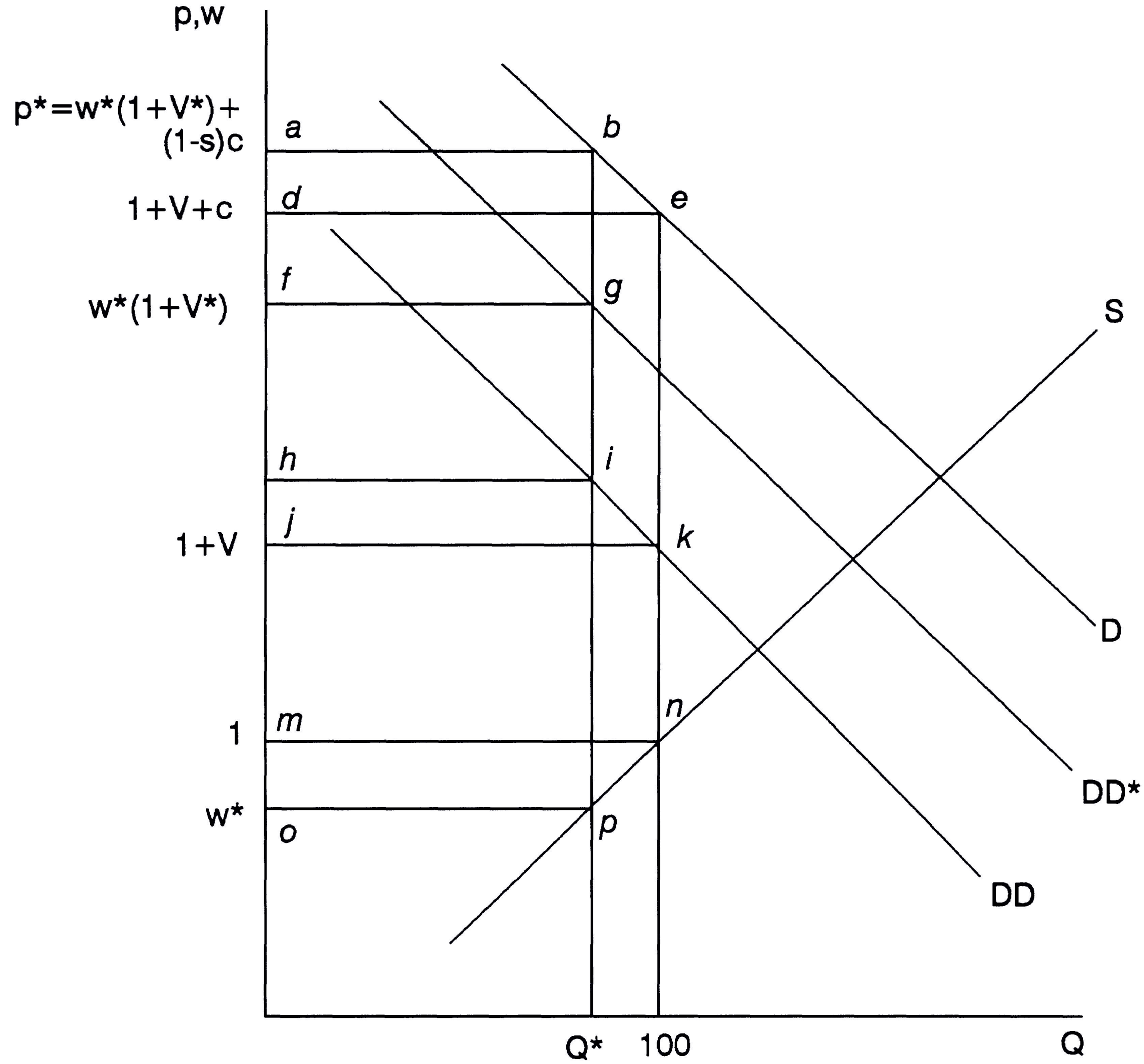
Table 8. Simulation Results

	Simulation 1		Simulation 2	
Baseline Case Distortion	0		0	
Test Case Projections				
Distortion	0.045		0.1136	
Changes in welfare				
	Cournot	Bertrand	Cournot	Bertrand
Consumers surplus(CS)	-1.152	-1.087	-5.976	-5.898
Producer's surplus(PS)	-0.29	-0.276	-1.761	-1.241
Processor's surplus	1.441	1.363	7.726	7.136

Table 9. Comparison of market power and cost efficiency effects on output and input prices.

$\sum \varepsilon_{ik}\theta_{ki}$ **>0,** $\sum \varepsilon_{ik}\phi_{ki}$ **>0**			
Effect on Output Price			
	Market Power Effect	Cost Efficiency Effect	Total Price Effect
Cournot	<0	>0	ambiguous
Bertrand	>0	>0	>0
Effect on Input Price			
Cournot	<0	<0	<0
Bertrand	<0	<0	<0
$\sum \varepsilon_{ik}\theta_{ki}$ **<0,** $\sum \varepsilon_{ik}\phi_{ki}$ **<0**			
Effect on Output Price			
Cournot	ambiguous	>0	ambiguous
Bertrand	ambiguous	>0	ambiguous
Effect on Input Price			
Cournot	>0	<0	ambiguous
Bertrand	<0	>0	ambiguous

Figure 1. The trade off between market power and cost efficiency effects of concentration



Source: Azzam, A.M., and J.R. Schroeter. "The Tradeoff between Oligopsony Power and Cost Efficiency in Horizontal Consolidation: An example from Beef Packing." American Journal Agricultural Economics, 77 (1995): 825-836.

Appendix 1. SAS Code for Empirical Estimation

```
DATA SET1;
INFILE SET1;
INPUT YEAR FPST80 FPST65 FPST35 FPH80 FPH65 FPH35
FQST80 FQST65 FQST35 FQH80 FQH65 FQH35 DPST80
DPST65 DPST35 DPH80 DPH65 DPH35 DQST80 DQST65 DQST35 DQH80
DQH65 DQH35 DISINC CPI PPI CORNP PAY PRICAP POP HHIP;
LABEL FQST80 = 'DOMESTIC SUPPLY OF 80% CHOICE STEERS BEEF MIL.LBS'
FQST65= 'DOMESTIC SUPPLY OF 65-80% CHOICE STEERS BEEF MIL.LBS'
FQST35= 'DOMESTIC SUPPLY OF 35-65% CHOICE STEERS BEEF MIL.LBS'
FQH80 = 'DOMESTIC SUPPLY OF 80% CHOICE HEIFERS BEEF MIL.LBS'
FQH65= 'DOMESTIC SUPPLY OF 65-80% CHOICE HEIFERS BEEF MIL.LBS'
FQH35= 'DOMESTIC SUPPLY OF 35-65% CHOICE HEIFERS BEEF MIL.LBS'
FPST80  = 'FARM PRICE OF 80% CHOICE STEERS in CURRENT  CENTS/LB'
FPST 65='FARM PRICE OF 65-80% CHOICE STEERS in CURRENT CENTS/LB'
FPST 35 = 'FARM PRICE OF 35-65% STEER CALVES in CURRENT CENTS/LB'
FPH80 =' FARM PRICE OF 80% CHOICE heifers in CURRENT CENTS/LB'
FPH65='FARM PRICE OF 65-80% CHOICE heifers in CURRENT CENTS/LB'
FPH35 ='FARM PRICE OF 35-65% CHOICE heifers in CURRENT CENTS/LB'
DPST80=' SUPPLY OF DRESSED 80% CHOICE STEERS BEEF MIL.LBS'
DPST65=' SUPPLY OF DRESSED 65-80% CHOICE STEERS BEEF MIL.LBS'
DPST35=' SUPPLY OF DRESSED 35-65% CHOICE STEERS BEEF MIL.LBS'
DPH80=' SUPPLY OF DRESSED 80% CHOICE HEIFERS BEEF MIL.LBS'
DPH65='DOMESTIC SUPPLY OF 80% CHOICE HEIFERS BEEF MIL.LBS'
DPH35='DOMESTIC SUPPLY OF 80% CHOICE HEIFERS BEEF MIL.LBS'
DQST80= ' PRICE OF PROCESSED 80% STEER in CURRENT CENTS/LB'
DQST80=' PRICE PROCESSED OF 65-80% STEER  in CURRENT CENTS/LB'
DQST80=' PRICE OF PROCESSED 35-65% STEER  in CURRENT CENTS/LB'
DQST80=' PRICE OF PROCESSED 80% HEIFERS in CURRENT CENTS/LB'
DQST80=' PRICE PROCESSED OF 65-80% HEIFERS in CURRENT CENTS/LB'
DQST80='PRICE PROCESSED OF 65-35% HEIFERS in CURRENT CENTS/LB'
DISINC= 'DISPOSABLE INCOME PER PERSON IN CURRENT USD'
CPI = 'CPI FOR ALL FOOD 84-86=100'
PPI = 'PPI FOR FARM PRODUCTS,1982=100 (BLS)'
PAY = 'TOTAL INDUSTRY PAYROLL, (NBER_DATA)'
CAPCOST = 'TOTAL COST OF CAPITAL (BILLIONS), NBER_DATA'
PRICAP = 'RENTAL PRICE OF CAPITAL (BLS_DATA), INDEX, 2000=100'
THOURS = 'TOTAL HOURS OF WORK BY ALL PRODUCTION WORKERS,(NBER_DATA)'
POP = 'US POPULATION IN MILLIONS'
CAPPRO = 'Y/K FOR FOOD & KINDRED PRDUCTS 1996=100'
WORKPRO = 'PRODUCTIV. OF WORK-HOURS, FOOD&KIND 1996=100'
TOTDEM= 'TOTAL OUTPUT OF ALL THE BRANDS'
OMEGA='CONJECTURAL VARIATION ELASTICITY FOR QUANTITY COMPETITION'
ALPHA='CONJECTURAL VARIATION ELASTICITY FOR PRICE COMPETITION'

;
RUN;
DATA SET2; SET SET1;
/* THESE INDEXES ARE FROM BLS, FOOD & KINDRED PRODUCTS */;
OUTCAP1=CAPPRO;
OUTWOR1=WORKPRO;
/*CHANGE OF BASE AND DEFLATING THE DATA. THE NEW BASIS YEAR =1987*/;
CPIBASE87=113.5;
CPI87=CPI/CPIBASE87;
PPIBASE87=95.5;
```

```
PPI87=PPI/PPIBASE87;
ICPI=1/CPI87;
IPPI=1/PPI87;
INCOME=DISINC/1000;/*SCALE INCOME TO THOUSAND DOLLARS*/
TOTDEM= DQST80+DQST65+DQST35+DQH80+DQH65+DQH35;

PST80=FPST80/112; /*DIVIDE FARM PRICE BY 112 BECAUSE IT WAS IS IN
$/CWT*/;
PST65=FPST65/112;
PST35=FPST35/112;
PH80=FPH80/112;
PH65=FPH65/112;
PH35=FPH35/112;
PPST80=DPST80/112; /*DIVIDE DRESSED PRICE BY 112 BECAUSE ITWAS IS IN
$/CWT*/;
PPST65=DPST80/112;
PPST35=DPST80/112;
PPH80=DPH80/112;
PPH65=DPH65/112;
PPH80=DPH35/112;
LDQST80=LOG(DQST80);
FQST80=FQST80;
PLAB1=PAY/THOURS; /*PRICE OF WORK/HOUR */
PPORK=PPOR/100;/*DIVIDE POPOR BY 100 BECAUSE ITWAS IS IN CENTS/LB*/;
PTURKEY=PTURK/112;/* $/CWT = $/112 LB */
PDIESEL=PRIDIE/100;/* CONVERT CENTS/GALLON TO $/GALLON*/
/*PUT THE PRICE MATERIALS INDEX IN THE SAME FORMAT (0-1) TO MATCH
PIMAT*/
PCAP=PRICAP/100;
PLAB=PLAB1;
W_Y=1/OUTWOR1; /*THIS VARIABLES WITH A "1" IN FRONT ARE FROM BLS*/
K_Y=1/OUTCAP1;
PROC MEANS;
RUN;
/*PROFIT MAXIMIZATION */

PROC MODEL DATA=SET2;
EXOGENOUS PDIESEL PCORN PPORK PLAB PCAP PTURKEY INCOME HHIP ;
ENDOGENOUS PPST80 DQST80 LDQST80 PST80 PST65 PST35 PH80 PH65 PH35 W_Y
K_Y ;
BOUNDS EFS>0;
/*PRICING EQUATION FOR 80% CHOICE STEERS-PRICE COMPETITION*/
PPST80= (TOTDEM/DQST80*(1+ED))*HHIP*(PST80*(ES80
+(CES8065+ CES8035+ CES80H80+ CES80H65+CES80H35)*ALPHA))
+ED*(( B1*(PLAB*PLAB)**0.5+B2*(PCAP*PCAP)**0.5+ B3*(PLAB*PCAP)**0.5
+ B4*2*HHIP*TOTDEM*PLAB+B5*2*HHIP*TOTDEM*PCAP)/(1+ED));

/*THE SET OF SUPPLY EQUATIONS */
LDQST80=A0+A1*(PCORN*IPPI)+A2*(PDIESEL*IPPI)+E11*(PST80/IPPI)+
E12*(PST65/IPPI)+E13*(PST35/IPPI)+E14*(PH80/IPPI)+
E15*(PH65/IPPI)+ E16*(PH35/IPPI);
LDQST865=A0+A1*(PCORN*IPPI)+A2*(PDIESEL*IPPI)+E22*(PST65/IPPI)+
E21*(PST80/IPPI)+E23*(PST35/IPPI)+E24*(PH80/IPPI)+
E25*(PH65/IPPI)+ E26*(PH35/IPPI);
LDQST35=A0+A1*(PCORN*IPPI)+A2*(PDIESEL*IPPI)+E33*(PST35/IPPI)+
E31*(PST80/IPPI)+E32*(PST65/IPPI)+E34*(PH80/IPPI)+
E35*(PH65/IPPI)+ E36*(PH35/IPPI);
```

```
LDQH80=A0+A1*(PCORN*IPPI)+A2*(PDIESEL*IPPI)+E44*(PH80/IPPI)+
E41*(PST80/IPPI)+E42*(PST65/IPPI)+E43*(PH35/IPPI)+
E45*(PH65/IPPI)+ E46*(PH35/IPPI);
LDQH65=A0+A1*(PCORN*IPPI)+A2*(PDIESEL*IPPI)+E55*(PH65/IPPI)+
E51*(PST80/IPPI)+E52*(PST65/IPPI)+E53*(PST35/IPPI)+
E54*(PH80/IPPI)+ E56*(PH35/IPPI);
LDQH35=A0+A1*(PCORN*IPPI)+A2*(PDIESEL*IPPI)+E66*(PH35/IPPI)+
E61*(PST80/IPPI)+E62*(PST65/IPPI)+E63*(PST35/IPPI)+
E64*(PH80/IPPI)+ E65*(PH65/IPPI);
/*THE SET OF DEMAND EQUATIONS*/
DQST80=EXP(D0+D1*(PPORK/ICPI)+D2*(INCOME/ICPI)+D3*(PTURKEY/ICPI)+ED*(PP
ST80/ICPI));
DQST65=EXP(D0+D1*(PPORK/ICPI)+D2*(INCOME/ICPI)+D3*(PTURKEY/ICPI)+ED*(PP
ST80/ICPI));
DQST35=EXP(D0+D1*(PPORK/ICPI)+D2*(INCOME/ICPI)+D3*(PTURKEY/ICPI)+ED*(PP
ST80/ICPI));
DQH80=EXP(D0+D1*(PPORK/ICPI)+D2*(INCOME/ICPI)+D3*(PTURKEY/ICPI)+ED*(PPS
T80/ICPI));
DQH65=EXP(D0+D1*(PPORK/ICPI)+D2*(INCOME/ICPI)+D3*(PTURKEY/ICPI)+ED*(PPS
T80/ICPI));
DQH35=EXP(D0+D1*(PPORK/ICPI)+D2*(INCOME/ICPI)+D3*(PTURKEY/ICPI)+ED*(PPS
T80/ICPI));

W_Y=B1+B4*HHIP*TOTDEM+0.5*B3*(PCAP/PLAB)**0.5;
K_Y=B2+B5*HHIP*TOTDEM+0.5*B3*(PLAB/PCAP)**0.5;

RUN;
FIT DQST80 LDQST80 PPST80 W_Y K_Y M_Y START=(ED=-0.3 D1=0.1 D2=0.2
D3=0.25 ES80=0.15 A1=-0.12
A2=-3 ) /STARTITER PRL=LR N3SLS MAXITER=1000 CONVERGE=0.001 FSRSQ;
INSTRUMENTS  _EXOG_ FQST80 PDIESEL PCORN  PLAB PCAP;
RUN;

ESTIMATE 'MARKET POWER'(TOTDEM/DQST80*(1+ED))*HHIP*(PST80*(ES80
+(CES8065+ CES8035+ CES80H80+ CES80H65+CES80H35)*ALPHA))
ESTIMATE 'COST EFF' ED*( B1*(PLAB*PLAB)**0.5+B2*(PCAP*PCAP)**0.5+
B3*(PLAB*PCAP)**0.5
+ B4*2*HHIP*TOTDEM*PLAB+B5*2*HHIP*TOTDEM*PCAP)/(1+ED);
RUN;

PROC MODEL DATA=SET2;
EXOGENOUS PDIESEL PCORN PPORK PLAB PCAP PTURKEY INCOME HHIP ;
ENDOGENOUS PPST80 TOTDEM PST80 PST65 PST35 PH80 PH65 PH35 W_Y K_Y ;
BOUNDS EFS>0;

/*PRICING EQUATION FOR 80% CHOICE STEERS-QUANTITY COMPETITION*/

PPST80= ED*(( B1*(PLAB*PLAB)**0.5+B2*(PCAP*PCAP)**0.5
+ B3*(PLAB*PCAP)**0.5+
B4*2*HHIP*TOTDEM*PLAB+B5*2*HHIP*TOTDEM*PCAP)/(1+ED))+
H*PST80/ES80 + PST80*OMEGA/CES8065+ PST80*OMEGA/CES8035+
PST80*OMEGA/CES80H80+
PST80*OMEGA/CES80H65+ PST80*OMEGA/CES80H35;

/*THE SET Of SUPPLY EQUATIONS */
DQST80=A0+A1*(PCORN*IPPI)+A2*(PDIESEL*IPPI)
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+E11*(PST80/IPPI)+E12*(PST65/IPPI)+E13*(PST35/IPPI)+E14*(PH80/IPPI)+
E15*(PH65/IPPI)+ E16*(PH35/IPPI);
DQST65=A0+A1*(PCORN*IPPI)+A2*(PDIESEL*IPPI)
+E21*(PST80/IPPI)+E22*(PST65/IPPI)+E23*(PST35/IPPI)+E24*(PH80/IPPI)+
E25*(PH65/IPPI)+ E26*(PH35/IPPI);
DQST35=A0+A1*(PCORN*IPPI)+A2*(PDIESEL*IPPI)
+E31*(PST80/IPPI)+E32*(PST65/IPPI)+E33*(PST35/IPPI)+E34*(PH80/IPPI)+
E35*(PH65/IPPI)+ E36*(PH35/IPPI);
DQH80=A0+A1*(PCORN*IPPI)+A2*(PDIESEL*IPPI)
+E41*(PST80/IPPI)+E42*(PST65/IPPI)+E43*(PST35/IPPI)+E44*(PH80/IPPI)+
E45*(PH65/IPPI)+ E46*(PH35/IPPI);
DQH65=A0+A1*(PCORN*IPPI)+A2*(PDIESEL*IPPI)
+E51*(PST80/IPPI)+E52*(PST65/IPPI)+E53*(PST35/IPPI)+E54*(PH80/IPPI)+
E55*(PH65/IPPI)+ E56*(PH35/IPPI);
DQH35=A0+A1*(PCORN*IPPI)+A2*(PDIESEL*IPPI)
+E61*(PST80/IPPI)+E62*(PST65/IPPI)+E63*(PST35/IPPI)+E64*(PH80/IPPI)+
E65*(PH65/IPPI)+ E66*(PH35/IPPI);


/*THE DEMAND EQUATION*/
DQST80=D0+D1*(PPORK/ICPI)+D2*(INCOME/ICPI)+D3*(PTURKEY/ICPI)+ED*(PPST80
/ICPI);
DQST65=D0+D1*(PPORK/ICPI)+D2*(INCOME/ICPI)+D3*(PTURKEY/ICPI)+ED*(PPST80
/ICPI);
DQST35=D0+D1*(PPORK/ICPI)+D2*(INCOME/ICPI)+D3*(PTURKEY/ICPI)+ED*(PPST80
/ICPI);
DQH80=D0+D1*(PPORK/ICPI)+D2*(INCOME/ICPI)+D3*(PTURKEY/ICPI)+ED*(PPST80/
ICPI);
DQH65=D0+D1*(PPORK/ICPI)+D2*(INCOME/ICPI)+D3*(PTURKEY/ICPI)+ED*(PPST80/
ICPI);
DQH35=D0+D1*(PPORK/ICPI)+D2*(INCOME/ICPI)+D3*(PTURKEY/ICPI)+ED*(PPST80/
ICPI);

W_Y=B1+B4*HHIP*TOTDEM+0.5*B3*(PCAP/PLAB)**0.5;
K_Y=B2+B5*HHIP*TOTDEM+0.5*B3*(PLAB/PCAP)**0.5;

RUN;

FIT DQST80 LDQST80 PPST80 W_Y K_Y M_Y START=(ED=-0.3 D1=0.1 D2=0.2
D3=0.25 ES80=0.15 A1=-0.12
A2=-3 ) /STARTITER PRL=LR N3SLS MAXITER=1000 CONVERGE=0.001 FSRSQ;
INSTRUMENTS  _EXOG_ FQST80 PDIESEL PCORN  PLAB PCAP;
RUN;

ESTIMATE 'MARKET POWER'(TOTDEM/DQST80*(1+ED))*HHIP*(PST80*(ES80
+(CES8065+ CES8035+ CES80H80+ CES80H65+CES80H35)*ALPHA))
ESTIMATE 'COST EFF' ED*( B1*(PLAB*PLAB)**0.5+B2*(PCAP*PCAP)**0.5+
B3*(PLAB*PCAP)**0.5
+ B4*2*HHIP*TOTDEM*PLAB+B5*2*HHIP*TOTDEM*PCAP)/(1+ED);
RUN;
```

VITA

Debasmita Basu

Candidate for the Degree of
Masters of Science

Thesis: EFFECTS OF HORIZONTAL CONCENTRATION IN THE CATTLE PROCUREMENT MARKET OF THE U.S.BEEF PACKING INDUSTRY: PRICE VS. QUANTITY COMPETITION

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Title of Study: EFFECTS OF HORIZONTAL CONCENTRATION IN THE CATTLE PROCUREMENT MARKET OF THE U.S.BEEF PACKING INDUSTRY: PRICE VS. QUANTITY COMPETITION.

Pages in Study: 60   Candidate for the Degree of Master of Science

Major Field : Agricultural Economics

The motivation of this study was to conduct a market power - cost efficiency effect analysis for price competition, and compare the effects with quantity competition and check whether the results from previous studies on quantity competition that market power effect is superseded by cost efficiency effect is reversed under alternative assumptions of market structure. We compare effects of horizontal mergers in the U.S. beef packing industry on input as well as output price under quantity and price competitions. This model was applied to weekly data for U.S. beef packing industry and we empirically investigated the welfare loss to individual participants such as farmers, consumers and processors for both types of model.

The results suggest that consolidations in the beef industry are not always efficiency driven. Infact, in most cases it has led to welfare loss of both consumers and farmers. Atleast, for the input price, generally there has been no spillover effect of profit earned by processors on farmers due to increased concentration. However, price competition led to lower loss in welfare as compared to quantity competition.

Advisor's Approval Dr. Chanjin Chung