Oligopsony Power, Meatpacker Conduct, and Price Dynamics: A Preliminary Investigation of Live Cattle Markets

by

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Introduction

During the past two decades, there has been a significant increase in meatpacker concentration levels, particularly in beef slaughter and boxed beef processing (Ward 1987). Concurrently, trading practices have resulted in more direct marketing of live cattle. These changes have accentuated the concern over oligopsony power in live cattle markets which can adversely influence efficiency in the pricing process and the welfare of those producers who sell to the oligopsonists.

While there is concern over market power in the beef sector, its effects are difficult to quantify. In part, this is because market power can surface in several different forms. In the short run, an oligopsony can affect the dynamics of the pricing process through price setting behavior. In the intermediate run, the firms in an oligopsony make decisions with respect to quantities of cattle to purchase and process. These are decisions with respect to plant operation speed, temporary plant openings and closings, and labor and other input contracts. In the long run, meatpackers make capital investment and corporate structure decisions which include plant construction, mergers, and other conduct usually associated with entry deterrence.

Previous research into the livestock industries has focused on intermediate and long-run behavior using the structure-conduct-performance paradigm (Cowling and Waterson). Performance indicators across industries or across subsectors of an industry, for example, prices, margins, costs, or profits, are linked to structural elements of the industries or the subsectors. Structure is used as an instrument to describe conduct because of the lack of explicit information on conduct. Examples include the work by Hayenga, Deiter, and Montoya, Quail et al., and Ward (1982) which suggest reductions in the number of buyers adversely affects competition and leads to lower producer prices. There have been few attempts, however, to examine the effects of market power on the short-run dynamics of the pricing process. Similarly, explicit models of conduct to explain market behavior in this industry have not been formulated.

The objective of this paper is to increase the understanding of the unexamined dimensions of short-run market power in the cattle industry. A model of market conduct which uses noncooperative game theory is developed to explain the interaction among meatpackers in the procurement of live cattle. Conceptually, the model provides an indication of the specific

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dynamic processes in the evolution of the margin between wholesale meat prices and live cattle price through time. Econometric analysis is conducted using direct marketing prices reported in various areas in the highplains and Corn Belt regions to assess degree to which the model accurately identifies pricing behavior. The results are assessed in terms of the existing structural characteristics of the market.

Relevant Literature

The most commonly held belief about the influence of an oligopoly/oligopsony on price dynamics is that stable price patterns result from market power (Cournot; Edgeworth). Similarly, it was considered unlikely for collusion to persist in equilibrium because the supply restrictions necessary to increase profits to the firms would lead to incentives to cheat on collusive agreements. Successful exercise of market power was believed to require information sharing among firms and an explicit enforcement mechanism to administer the collusive agreements. In this environment, market prices are relatively stable through time.

Using a temporal optimization framework, Friedman (1971) and Osborne demonstrated that oligopolist collusion could persist in equilibrium. Where firms optimize a stream of future income, if the total income to an arbitrary firm in the collusive agreement is greater than the total income from breaking the agreement then no enforcement mechanism is necessary. Firms willingly adhere to the collusive agreement because it is profitable. Interestingly in this framework an equilibrium can emerge tacitly, however, perfect information is needed between all firms to achieve this equilibrium. Again, within equilibrium market prices should be relatively stable.

Recent work (Porter (1983); Green and Porter) demonstrates that the earlier results of Friedman (1971) and Osborne are an artifact of the assumption of perfect information. In a stochastic environment or where imperfect information about competitors actions exists, noisy prices can characterize strong cooperation among the oligopoly/oligopsony members. Consider the situation where oligopsony members are currently exercising market power and individually pricing relatively low. If a rise in the aggregate (reported) market price is observed, all firms then adopt higher prices. This occurs because the initial price rise is viewed as evidence that some firms are cheating on the cooperative agreement. Purchases throughout the industry at higher prices will occur until gains to the cheating firm have been negated. Firms then revert to pricing at the lower, cooperative levels. Collusive profit levels can be achieved for individual firms tacitly and without perfect information about the actions of other industry members. Here, a strong oligopsony results in variable prices, in part, reflecting the movement between cooperative and noncooperative levels.

The Oligopsony Model of Live Cattle Procurement

The meatpacker procurement of live cattle is modelled as a noncooperative game. Specifically, we formulate a model which characterizes the behavior of multiple players in a single marketplace. A meatpacker produces meat (y) from live cattle (x) and a vector of other inputs (v).

The production technology is assumed to be Leontief between live animals and the other input, $y = \min[x/k,\ g(v)]$. The profit function is specified incorporating Leontief technology, stochastic events in the sector, and the actions of other players which affect the payoff of each individual player. The profit function for the *i*th firm in a given region is:

$$(1)\quad \pi_i(r_t, s_t^i, s_t^{-i}, z_t) = [r_t - s_t^i k]\ y_t^i(s_t^i, s_t^{-i}, W, \xi) - c_i(z_t, y_t^i)$$

where t denotes time, πi the profits of the *i*th firm, r_t the wholesale price of meat, s_t^i the strategy of the *i*th firm, s_t^{-i} the strategies of other firms, z_t a vector of other input prices, y_t^i the supply procured, W a set of exogenous factors, ξ the total number of animals available for procurement in a given region, and c_i the cost function of the *i*th firm.

The wholesale meat price r_t and the supply procured by the *i*th meatpacker y_t^i are influenced by stochastic events. The variable ξ is used to indicate that the total number of animals available for procurement in a given region can vary. The quantity of meat available for sale y_t^i by the *i*th firm depends on the quantity procured. The procured quantity is influenced by the strategy played by the meatpacker s_t^i, strategies played by other firms s_t^{-i}, and a set of exogenous factors *W*. The choices of strategies and the actions of firms across the industry are not directly observable by the *i*th firm. The information set to be used by the *i*th firm only contains past aggregate market prices.

In this setting, the problem for the *i*th firm is to maximize the sum of the discounted expected profits (V_i) through a strategy choice s_t^i:

$$(2)\quad V_i(s_t^i) = E\ [\sum_{t=0}^{\infty} \delta^t\ [r_t - s_t^i k]\ y_t^i(s_t^i, s_t^{-i}, W, \xi) - c_i(w_t, y_t^i)]$$

subject to the reaction function of the firm:

$$(3)\quad s_t^i = \begin{cases} p' & \text{if } \mu > m_{t-1} \\ p'' & \text{if } \mu \le m_{t-1} \end{cases}$$

where E is the expectations operator, δ is the discount factor, μ is the trigger margin level, p′ and p″ are two base live cattle price levels where $p' < p''$, and $m_{t-1} = r_{t-1} - p_{t-1}k$ is the regional margin from the previous period. The reaction function incorporates a *trigger margin strategy* in procurement which permits variability in price reflecting movement from cooperative to noncooperative periods. The margin is the net price for the meatpacker and therefore it is incorporated into the pricing strategy. If the margin from the previous period is less than the trigger level μ, then the current live cattle offer is at the cooperative price level in the current period p′; however, if the margin in the previous period was above the trigger level then the current offer is at a noncooperative level p″.

By substituting the reaction function (3) into the objective function (2) an optimal value function, $V_i(s_t^i)$, can be constructed which summarizes the multiple period problem. For a firm initially in the cooperative period:

(4) $V_i(p') = \pi_i(p') + \Pr\{\mu > m_t(W,\xi)\}\ \delta V_i(p')$

$$+ \Pr\{\mu \le m_t(W,\xi)\}\ [\ \sum_{\tau=1}^{T-1} \delta^\tau\ \pi_i(p'') + \delta^T V_i(p')].$$

That is, $V_i(p')$ equals the present period expected profits plus the expected discounted value next period. The expected value next period is the value when cooperative pricing is continued in the next period multiplied by the probability the market price stays under the trigger level, plus the returns expected during a noncooperative period multiplied by the probability of its occurrence.

Rewriting the value function (4) and examining the first order conditions reveals the equilibrium tradeoff in determining optimal firm output. Assuming an interior solution, the first order conditions are:

(5) $\partial V_i/\partial s_i = [\partial \pi_i(p')/\partial s_i]\ [1-\delta+(\delta-\delta^T)\ \Pr\{\mu \le m(W,\xi)\}]$

$$+ [\pi_i(p')-\pi_i(p'')]\ [(\delta-\delta^T)[\mu y'(W)/y(W)^2]\ \Pr\{\mu \le m(W,\xi)\}] = 0.$$

This indicates that the marginal return to the firm from increasing its offer price and thus its production in cooperative periods $[\partial \pi_i(p')/\partial s_i]$ must exactly offset the marginal increases in the chance of a loss in returns $[\pi_i(p')-\pi_i(p'')]$ by triggering a noncooperative episode.

The structure of prices resulting from this framework reflects the attempts by the meatpackers to maintain a profitable market environment. At p', where π (p') > π (p"), there is an incentive to cheat. To reduce the likelihood of cheating the oligopsony market never prices as low as a monopsony situation during cooperative periods. Also, to punish cheating, when it appears that a firm is deviating from p' all firms will price at p" for T-1 periods (where p" > p'). Finally, as an incentive to maintain an attractive price structure, the difference between p' and p" must be sufficiently far apart to ensure that the value of the stream of returns for cooperating is greater than the stream from cheating.

The theoretical model suggests that a discontinuous pattern of prices will emerge over time. During cooperative periods, when the market is not influenced dramatically by stochastic elements, prices should not deviate from a low price collusive strategy. In a stochastic environment with imperfect information about the behavior of other firms, market prices may cross the trigger levels. When this occurs, the firms revert to a higher noncooperative price level. The econometric analysis below examines market data for the presence of this discontinuous pattern.[1]

Econometric Models

The first order conditions for maximizing profits of a meatpacking firm and the results from the economic model are used to derive an econometric model of margin dynamics. The profit function for the *i*th firm is:

(6) $\pi_i = (r - p_i k)\, y_i(p_i, p_{-i}) - c_i(y_i)$

where p_i is the price of the *i*th firm, p_{-i} is an n-1 vector of prices offered by other firms. The first order conditions for maximizing the profit function through the choice of price are:

(7) $\partial\pi_i/\partial p_i = (r - p_i k)\,[\partial y_i/\partial p_i + \sum_{j\neq i} (\partial y_i/\partial p_j)\,(\partial p_j/\partial p_i)]$

$- k y_i - \partial c_i/\partial y_i = 0$

where p_j denotes the price offered by the *j*th firm, $j\neq i$.

This formulation requires several assumptions to permit estimation. First, the marginal cost component for other factors is assumed to be constant or $\partial c_i/\partial y_i = \alpha_i$. This implies that labor and energy costs for the individual plants do not vary extensively over the time periods of the analysis. Second, the short-run price response in procurement and meat sales to live cattle price offers are equal across all firms:

(8) $\partial y_i/\partial p_j = \partial y_i/\partial p_k = \ldots = \partial y_i/\partial p_l = -\partial y_i/\partial p_i$.

Basically, this requires continuity of cattle feeding in the regions considered and the homogeneity of the commodity. Third, the symmetry from the economic model results in all other firms responding equally to a change in the offer price by the *i*th firm:

(9) $\partial p_j/\partial p_i = \partial p_k/\partial p_i = \ldots = \partial p_l/\partial p_i$.

Finally, it is assumed that the change in procurement by any firm in response to a ceteris paribus price change is a constant, $\partial y/\partial p_i = \gamma$.

Using these assumptions and the price response symmetry, the first order condition can be rewritten as:

(10) $(r - p_i k)(\gamma)[1 - (\partial p_j/\partial p_i)(n-1)] - k\, y_i - \alpha_i = 0$.

The interactive nature of the pricing process from the economic model can be directly incorporated into this framework. In noncooperative periods, the term $\partial p_j/\partial p_i$ is zero, and in cooperative periods the term is positive as all firms in the region reduce their offer prices. That is,

(11) $\partial p_j/\partial p_i = \beta = \begin{cases} \beta_0 > 0 & \text{if } m_t \text{ is in the cooperative regime} \\ 0 & \text{if } m_t \text{ is in the noncooperative regime,} \end{cases}$

where β is a function and β_0 is a constant.

To complete the empirical structure of the model, it is necessary to express the margin as a function of the supply of live cattle. Due to data limitations, several steps are taken to permit an empirical formulation of the model. First, because only aggregate price data are available, the first order conditions are summed over the n-players in the given regional market. Denoting *y* is the regional aggregate supply (i.e., $y_t = \Sigma y_t^{1}$), dividing both sides by n and entering the time subscripts yields:

$$(12)\ m_t = (r_t - p_t k) = \frac{\alpha + (k/n)}{\gamma[1 - \beta(n-1)]} y_t = \phi\, y_t$$

where $p_t = \Sigma p_{it}/n$ is the live cattle price aggregated over all meatpackers in the region and $\alpha = \Sigma \alpha_i/n$ is the mean marginal cost of other inputs.

Second, due to the lack of daily quantity data, it is necessary to substitute a function which expresses live animal supply in terms of exogenous factors for y_t. The daily aggregate live cattle supply is not own price responsive but influenced by seasonal factors, factors affecting the future profitability of feeding, and randomness. Here, the aggregate supply function is represented as a linear function of exogenous factors and a random error:

$$(13)\ y_t = W_t'\, \eta + \xi_t$$

where W_t is a set of the exogenous factors and the term ξ_t is an error.

Substituting the supply function (13) into the margin equation (12) yields a switching regression problem:

$$(14)\quad \begin{aligned} m_t &= W_t'\, \phi_1 \eta + \phi_1 \xi_t \quad \text{if } m_t \text{ is in the cooperative regime} \\ m_t &= W_t'\, \phi_2 \eta + \phi_2 \xi_t \quad \text{if } m_t \text{ is in the noncooperative regime} \end{aligned}$$

where

$$\phi_1 = \frac{\alpha + (k/n)}{\gamma[1 - \beta_0(n-1)]} \quad \text{and} \quad \phi_2 = \frac{\alpha + (k/n)}{\gamma}.$$

Rewriting the model with the parameters in reduced form:

$$(15)\quad \begin{aligned} m_t &= W_t'\, \psi_1 + \epsilon_{1t} \quad \text{if } m_t \text{ is cooperative} \\ m_t &= W_t'\, \psi_2 + \epsilon_{2t} \quad \text{if } m_t \text{ is noncooperative} \end{aligned}$$

where $\xi_t \sim N(0,\sigma^2)$, $\epsilon_{1t} \sim N(0,\sigma_1^2)$, $\epsilon_{2t} \sim N(0,\sigma_2^2)$ and

$$\sigma_2^2 = (\psi_2'\psi_2)/(\psi_1'\psi_1)\ \sigma_1^2.$$

Few of the structural parameters are identified, however, β_0 is, albeit with some subjectivity:

$$\beta_0 = [1 - \exp\{\psi_2 - \psi_1\}] \ /\ (n-1).$$

The number of major firms which can influence the supply procured by an arbitrary (major) firm must be know a priori. Imputing the number of meatpackers in the regions the analysis can be done with confidence.

This switching framework is formulated and estimated using a simple Bernoulli switching regression. The two regimes, cooperative and noncooperative, are assumed to appear with probability λ_1 and $\lambda_2 = (1 - \lambda_1)$ which are independent of time. This assumption is an approximation to the regime switching process suggested by the economic model. The temporal independence removes the linkage between levels of past margins and the state of cooperation.

The economic model suggests that the current margin is in cooperative regime if the margin in the previous period was above the trigger level, or if the margin was at noncooperative levels for the previous T-1 periods. Likewise, the current margin is in the noncooperative regime if the margin in the previous period was less than the trigger level, or if a reversion to noncooperative behavior was triggered less than T-1 periods prior. Implicit in the economic model is the fact that the trigger level is chosen by optimizing firms so that exogenous factors are likely to change μ through time. The Bernoulli approximation bows to the complexity of the model by not trying to specify the switching process beyond assuming it is some constant probability.

The error terms associated with both regimes are assumed to be distributed normal therefore, the density of an arbitrary observation m_t is:

$$h(m_t) = \lambda_1/\sqrt{2\pi}\sigma_1 \exp\{-1/2\sigma_1^2 (m_t - W_t'\psi_1)^2\}$$
$$+ \lambda_2/\sqrt{2\pi}\sigma_2 \exp\{-1/2\sigma_2^2 (m_t - W_t'\psi_2)^2\}.$$

The likelihood function for the model and sample is:

$$(16)\quad L = \prod_{t=1}^{S} h(m_t)$$

and the maximum likelihood estimates for the parameters ψ_1, ψ_2, σ_1, σ_2, λ_1, and λ_2 are found by maximizing the nonlinear log-likelihood function with an iterative method.

The estimation procedure follows a Newton-Raphson iterative routine (Judge et al.). Incorporating the constraints between σ_1 and σ_2, and between λ_1 and λ_2 allows the relevant parameter vector to be defined as $\theta = (\lambda_1\ \psi_1\ \psi_2\ \sigma_1)$. The Newton-Raphson iterative scheme which is defined as:

$$\theta^{i+1} = \theta^i - (J(\theta^i))^{-1} d(\theta^i),$$

where $J(\theta^i)$ and $d(\theta^i)$ are the Jacobian matrix and the gradient vector of the likelihood function evaluated at the parameter values θ^i. The inverse of the Jacobian matrix is used as the estimate of the covariance matrix of parameter estimates. The maximum likelihood estimates are denoted $\theta^* = (\lambda_1^*\ \psi_1^*\ \psi_2^*\ \sigma_1^*)$.

Following Kiefer (1980), a series of regime classification probabilities can be calculated. Using the maximum likelihood estimates and Bayes rule,

$$w_t^* = \frac{\lambda_1^* \, h(m_t|W_t,\theta_L^*,I_t{=}1)}{\lambda_1^* \, h(m_t|W_t,\theta_L^*,I_t{=}1) + \lambda_2^* \, h(m_t|W_t,\theta_L^*,I_t{=}0)}$$

where θ_L is the portion of θ which contains the parameters from the linear models. The series $\{w_t^*\}$ provides estimates of I_t. From Lee and Porter, the probability of a regime classification error is minimized by,

$$(17)\quad I_t^* = \begin{cases} 1 & \text{if } w_t^* > 0.5 \\ 0 & \text{if } w_t^* \leq 0.5. \end{cases}$$

The series I_t^* can be examined for information on the minimum, maximum and average lengths of the noncooperative periods and lengths between reversionary periods.

Hypothesis testing for the presence of collusive behavior in pricing can be performed through testing for the existence of the switching regression model. Likelihood ratio methods are used to test for the presence of the switching model. The general form of the likelihood ratio test is:

$$2[\ln L(\theta^*) - \ln L(\theta^R)] \ a\sim \ \chi^2(r)$$

where $L(\theta^*)$ is the value of the likelihood of the switching model, $L(\theta^R)$ is the value of the likelihood of the single regime model, and r is the number of restrictions on parameters for the general model to be constrained to the restricted model. The restricted model implies a single regime so that the number of restrictions equals the number of parameters in the vector η, plus one to account for the Bernoulli parameter.

With trigger price strategies, the strength of the collusion is measured by the significance and size of the conjecture, β_0, and the length of time in the cooperative period. Correlations of the regime probabilities across the spatial markets will permit an evaluation of the market power in multiple market places.

Data and Modelling Results

Price quotes from direct feedlot-to-meatpacker sales of 900 to 1100 pound steers for four U.S. regions are used in the analysis. The four regions are: Iowa and Southern Minnesota, Eastern Nebraska, Western Kansas, and Texas. Prices for these regions are reported daily on wire services and were gathered from the USDA's weekly LS-214 publication. Direct sales quotes are used because these prices reflect the actual offers made by the order buyers of meatpackers. The wholesale price used to calculate the margins is the USDA daily boxed beef cutout value series.

The supply is formulated as a linear function influenced by factors affecting the future profitability of feeding and seasonal factors. The daily 6-month interest rate and the daily closing corn futures price of the nearby contract are used to reflect the future profitability of feeding. The seasonal components are sets of dummy variables on days of the week, the fourth week in the month, and the season of the year. In many market regions, transactions are heaviest early in the week. Further, the supply from feedlots may be different during the fourth week of the month as operators prepare to meet cash demand of billings commonly faced on the first of each month. The seasonal dummies are used to capture the live cattle supply fluctuations that occur in the spring and fall due to the fluctuations of the calf crop.

Use of the noncooperative game theoretic in this context requires that the industry be relatively stable over time. Specifically, the parameters of the cost and demand functions should be stable. This temporal stability is necessary for the Nash framework to be a credible equilibrium. The meatpacking industry does not globally possess this feature. Examination of the prices and the structure of the industry from the period 1980 to 1986 indicates that two subperiods of relative stability exist. These are from June, 1980, through June, 1982, and from June, 1984, through June, 1986. These data periods are used in the empirical analysis.

The estimated model and the accompanying statistics provide an indication of the presence of oligopsony power in the meatpacking industry. Table 1 lists the major meatpackers in the selected market regions. Tables 2 and 3 present the test statistics for the presence of the trigger pricing strategies in the margin relationships and the values of the conjectures (i.e., the difference between the cooperative and noncooperative prices), respectively.[2] Table 4 reports the percent of time the markets are in noncooperative regimes. Finally, table 5 presents the simple correlations coefficients of the temporal probabilities that a market is in a noncooperative regime.

Several patterns emerge from an examination of the results. First, the trigger price model as represented by the switching margin regressions does not reflect the behavior of prices in the Western Kansas market (table 2). Interesting, this market has the largest number of major meatpackers in competition for the available cattle supply. Second, the most significant evidence of the trigger price strategy and accompanying periods of cooperative pricing behavior exists in the Iowa and the Eastern Nebraska markets. The evidence of its presence is stronger during the second period as the magnitude of the test statistics and the conjectures increase. Also, during the second period, the behavior of prices in the Texas market is consistent with the trigger price strategy.

The results of the percentage of time the markets are in the noncooperative regime indicate that for the Iowa, Eastern Nebraska, and Texas markets, a smaller proportion of the time was spent in the noncooperative regimes during the second period. The correlations of the temporal probabilities across the various markets indicate that switching between the two regimes is becoming more correlated over time. This suggests that the exercise of market power is becoming oriented in a multiple market fashion. In an atmosphere of increased cooperative pricing behavior, this suggests the potential for increased oligopsony returns and lower relative prices for producer cattle.

Summary, Conclusions and Implications

Concern over market power has sparked studies to measure its various dimensions in the beef sector. Here, a model is used to investigate the dimensions of short-run market power. Noncooperative game theory is used to specify the structure of the interaction among meatpackers in the procurement of live cattle. In a stochastic environment, the structure of the model indicates that a strong oligopsony can result in variable prices reflecting the movement between cooperative and noncooperative pricing periods.

Using direct market prices, the econometric analysis indicates that the model accurately reflects pricing behavior in several regions. The findings also indicate that the distortion in prices is more significant in more recent times and is related to the existing structural characteristics of the markets.

The findings suggest that the noncooperative game theory model developed here is a useful tool to examine the existence of short-run market power in the procurement of live cattle. The results also provide an agenda for future identification of the strength of the collusive activities in these markets. More complete monetary measures of the difference in margin levels between cooperative and noncooperative periods need to be constructed. The proportion of time that a given market is in the cooperative period multiplied by the difference in the margins can provide an estimate of the dollar per hundredweight loss to cattle feeders resulting from the oligopsony. Also, the existence and degree of interregional trigger margins need to be examined to capture the complete complexity of these markets. Results from these analyses will provide a more thorough understanding of the presence and extent of oligopsonistic practices in these markets. They should also provide a clearer vision of the policy implications for this important sector.

NOTES

1. The number of equilibria possible from this optimization problem are large and the exact equilibrium depends on the conduct of players through the strategies chosen. The payoff maximizing strategy, or the choice of the trigger margin component levels, depends on parameters in the profit function, the trigger margin level and the length of the noncooperative periods, $s^{i*}(\mu,T)$. The trigger margin level and the noncooperative period length are not determined by structural parameters in the model. *The actual levels which emerge are determined by the conduct of the players in the industry.*

2. These results should be viewed as a preliminary assessment of the degree of oligopsony power in cattle procurement. The analysis needs to be extended to other markets. Also, here, the value of β, the difference between the cooperative and noncooperative prices, can vary with the level of the independent variables. Consistency with the theoretical model requires the value to be constant.

Table 1. A Listing of the Direct Markets and the Major Meatpackers in those Markets.

Direct Markets	Major Meatpackers
Iowa and S. Minnesota	Spencer Beef, IBP, Dubuque, Swift/Con Agra
Eastern Nebraska	IBP, Spencer/Excel, Dubuque
Western Kansas	IBP, Excel, Val-Agri/Con Agra, National, Hyplains
Texas and New Mexico	Val-Agri/Swift Independent/Con Agra, Excel, IBP, National

Table 2. Test Statistics for the Null Hypothesis that No Switching Regression is Present for the Margin Models

	5/80-7/82		7/84-7/86	
Market	Test Statistic	P-Value	Test Statistic	P-Value
Iowa	35.2828	0.0001	91.3784	0.0001
E. Nebraska ..	20.0673	0.0658	177.2970	0.0001
W. Kansas	2.9525	0.9959	10.2482	0.5942
Texas	9.8086	0.6328	36.2003	0.0003

Table 3. Estimates of Conjectures Across the Direct Markets[a]

		5/80-7/82		7/84-7/86	
Market	Number of Meatpackers	Parameter	Conjecture	Parameter	Conjecture
Iowa	4	1.0987	0.3662	1.1959	0.3986
E. Nebraska ...	3	0.8486	0.4243	0.9677	0.4839
W. Kansas	5	0.6578	0.1644	0.4680	0.1170
Texas	4	0.8175	0.2725	0.5827	0.1942

[a] The conjectures are based on the seasonal, temporal dummy variables and the intercept.

Table 4. The Percentage of Time the Respective Markets are in the Noncooperative Regime

Market	5/80-7/82	7/84-7/86
Iowa	0.8890	0.6526
E. Nebraska	0.7164	0.6799
W. Kansas	0.6464	0.7243
Texas	0.7652	0.7283

Table 5. Correlations Between the Temporal Probabilities that the Given Market is in the Noncooperative Regime

5/80-7/82	E. Nebraska	W. Kansas	Texas
Iowa	-0.0772	0.0035	0.1177
E. Nebraska		0.1084	-0.1262
W. Kansas			-0.1918

7/84-7/86	E. Nebraska	W. Kansas	Texas
Iowa	0.1891	0.2656	0.2260
E. Nebraska		0.4266	0.2407
W. Kansas			0.4179

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