Market Power in Beef Packing: Feedlot "Capture" and its Causes

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1   Introduction

Concentration in the beef packing industry has been rising for the past 25 years.   This has generated both concern among policymakers and interest from academic economists about the ability of packing plants to exploit their market position by in‡uencing the conditions under which they purchase live cattle.   Several studies of oligopsony power in beef packing have led to mixed results (see Azzam (1998) for an overview of this literature).   Some studies ...nd a small but signi...cant degree of market power, while others ...nd no evidence that packers are able to exploit their position in the purchase of fed cattle.

In most studies, exercise of market power is de...ned as the ability of packing ...rms to reduce the price they pay for their inputs below a competitive level. Unfortunately, without further assumptions, one cannot know what prices would be if the industry were "competitive." Most studies solve this problem by noting that packer costs determine what a competitive level of prices would be. They then use an estimate of costs based on input prices paid, processing costs, and marginal value product. However, as is well known, costs and marginal value product are quite di¢cult to measure accurately, let alone obtain from packing ...rms. In this paper, we avoid the problem of knowing what competitive prices would be by developing an indirect measure of packer behavior that is related to the exercise of market power but does not need cost and marginal value product data. Instead, our statistic is based on the proportion of its sales a particular feedlot makes to a given packer. This is easy to quantify if appropriate data are available.

Our statistic allows us to classify feedlots as being in the primary market area (PMA) of one or more packing plants. This gives an indirect measure of packer exercise of market power, since a packing plant presumably has more control over a feedlot when it is that feedlot's major customer. Our hypothesis is that one way for packers to exercise power over their cattle suppliers is to divide feedlots among themselves and each visit only their own feedlots. In e¤ect, the feedlots are "captive" to the packer that visits. In a competitive market, packing plants would have limited control over feedlot sales, and we would expect to see feedlots selling to all packers,

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with switches occurring as a di¤erent packer o¤ers a higher price. Thus, in a competitive market observed over several months, feedlots should sell approximately equal numbers to all packing plants in the region, and should regularly switch between customers.

The idea of feedlot capture is related to notions of captive supplies. One theory of the relationship between packing ...rms and their suppliers suggests packers capture needed supplies through contractual arrangements with feedlots (Schroeder, Mintert and Barkley (1993), Hayenga and O'Brien (1992), Ward, Koontz, Dowty, Trapp and Peel (1999), Ward, Koontz and Schroeder (1998), Ward, Schroeder, Barkley and Koontz (1996)). Our statistic goes further, and looks at the possibility that packers capture a majority of the cattle sold by the feedlot, instead of just a portion of the feedlot's output. Finding an exclusive relationship between feedlots and packers would lend support to our theory of capture.

Notice that every packer may purchase cattle from a given county, so that market areas may overlap. Thus, our ...ndings may contradict the theory of spatial market power which suggests that linear transportation costs may create exclusive areas for each plant. Since we are not using this statistic to test the e¤ects of distance on feedlot sales, overlapping market areas do not a¤ect conclusions regarding the relationship between a feedlot and its primary customer(s). Even if all packing plants purchase cattle from a given county, as long as individual feedlots within the county are visited by one or few packers, we de...ne those feedlots as "captured".

While the statistic we develop may show that a feedlot sells a large amount to a given packer, this may simply be because the packer generally o¤ers the highest net price. However, it is unlikely that a particular packing plant will o¤er the highest net price in every single period. If the market is competitive, then, we would expect to see feedlot sales regularly switching between plants over the course of a year, depending on which plant o¤ers the highest price. Our paper's second section considers how to measure the switching behavior of plants. The more feedlots are able to switch between packing plants, the more likely it is that the market is competitive, even when the statistic from the paper's ...rst section describes feedlots as captured by a particular packer.

There are many reasons why feedlots would be visited by only one packing plant, most of which do not involve packer control of the prices they pay. It may be that packers are minimizing their transactions costs by visiting only those feedlots known to the packer. In this way, the packer ensures a particular quality or size of cattle coming through the plant. The packer also minimizes the cost of negotiating to purchase a lot if it deals only with feedlots it knows. It may also be that the feedlot is so much closer to the packer that it doesn't make sense for the feedlot to sell to any other packing plant. In the paper's third section, we develop an empirical model to control for these explanations of the relationship between feedlots and packing ...rms.

2 Geography and the relationship between packers and feedlots

Our ...rst task is to examine the relationship between feedlots and the packers they sell to. Our statistic is based on one developed by Brorsen, Bailey and Thomsen (1997), who look at the likelihood that a particular lot of cattle will be shipped from a particular county to a particular marketing center.[1] They use county-level data to examine the division of cattle feeding regions among major marketing areas and the degree of overlap between each trading center's primary market area (PMA). A county is de...ned as being in a trading center's primary market area if a larger percentage than expected of the lots sold from the county are shipped to the trading center.   The statistic they develop is used to determine whether geographic markets are segmented or not. Their research suggests that it is not appropriate to treat the Oklahoma City feeder cattle market separately from the Omaha market. In fact, Brorsen et al. (1997) ...nd that primary market areas for the major trading centers overlap to such an extent that the market for feeder cattle must really be treated as a national market, rather than a set of regional markets.

We modify this statistic to examine the likelihood that a given pen of cattle are sold from a particular feedlot to a particular packer. Suppose a

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[1] There is an extensive literature on the e¤ects of competition in spatial markets on prices that ...rms charge for outputs (or pay for inputs). See Zhang and Sexton (2000) for an application of this literature to beef packing. Our work does not directly consider what is known as spatial price discrimination. Instead, we study the possibility of geographic division of feedlots among packers and the e¤ects of this division on input prices.

region has K packing plants. If packers within the region are relatively close together, and assuming minimal price differentials, we would expect feedlots to sell an equal number of their lots to each packer. Feedlots which sell more than $1/K^{th}$ of their total lots to one packer are said to be in that packer's PMA. Notice that a feedlot may be in up to $K - 1$ PMAs, so that this statistic allows us to characterize the degree of overlap between packing plants. Presumably, the more PMAs a given feedlot is in, the less control any one of its customers has over its sales. Also, the larger the number of feedlots in more than one PMA, the more competitive the market is likely to be.

Problems arise when examining small feedlots, as they are more likely to be put in a PMA even when they sell the same number of lots to each packer. For example, a feedlot that sold three lots to three different packers would be put into three PMAs even though its sales were evenly divided. To obtain any information of use from these smaller feedlots, we used a smoothing technique developed by Brorsen et al. (1997) to infer how a smaller feedlot would behave were it to be an average feedlot.

In all of these formulas, p is the probability that a given lot is sold from feedlot $i \in \{1...I\}$ to packer $k \in \{1...K\}$. Thus, we define:

$$\hat{p}_{ik}^0 = \frac{\sum_{n=1}^{N_i} y_{ikn}}{N_i}$$

As the probability that lot n is sold from feedlot i to packer k. N_i is the total number of transactions feedlot i is involved in, and y_{ikn} is set to one

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if lot n was sold from feedlot i to packer k. To account for problems with smaller feedlots, we include transactions from "nearby" feedlots in describing how smaller than average feedlots behaved. Thus, our smoothed estimate of the probability of shipment from feedlot i to packer k is given by

$$\hat{p}_{ik} = \frac{\sum_{j=1}^{I} \sum_{n=1}^{N_i} \delta_{ij} y_{ikn}}{\sum_{j=1}^{I} \delta_{ij} N_j}$$

Where

$$\delta_{ij} = \begin{cases} 1 & \text{if } j = i \\ \rho_i & \text{if } i \text{ and } j \text{ are adjacent} \\ 0 & \text{otherwise} \end{cases}$$

and

$$\rho_i = \begin{cases} 1 & \text{if } N_i + N_i^{\alpha} \leq M \\ \frac{M_i N_i}{N_i^{\alpha}} & \text{if } N_i < M \text{ and } N_i + N_i^{\alpha} > M \\ 0 & \text{if } N_i \geq M \end{cases}$$

N_i^{α} is the total number of transactions the feedlots adjacent to i are involved in, and M is the number beyond which no smoothing is needed. Generally speaking, M may be taken as the average number of sales made by feedlots in the data set. That way, smaller-than-average feedlots have their sales weighted by the sales of neighboring feedlots, while larger-than-average feedlots do not.

An important step necessary for carrying out the above calculations is determining which feedlots to include in the smoothing statistic. In the work done by Brorsen et al. (1997), any county sharing a border with the

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speci...c county i was de...ned as adjacent and included when smoothing was required. Since we reinterpret this statistic to look at individual feedlots, we need some measure of the distance between feedlots.[2] Let $\bar{d}$ be the average distance between feedlots, and σ_d^2 be the variance of these distances.   We de...ne feedlots which are closer than one standard deviation below the mean as adjacent, since there is only a 16% chance that feedlots will be less than this distance apart. We argue that transportation costs are relatively minor and do not a¤ect the probability of selling to a given packer for feedlots within $\bar{d} - \sigma_d$ miles of each other.

Thus, our smoothed statistic is essentially a weighted average between $\hat{p}_{ik}^0$ and $\hat{p}_{ik}^{\alpha}$, where $\hat{p}_{ik}^{\alpha}$ represents the (possibly smoothed) probability of sales to packer k from feedlots adjacent to i. This weighted average is given by:

$$\hat{p}_{ik} = \frac{N_i \hat{p}_{ik}^0 + \,^{\circ}{}_i N_i^{\alpha} \hat{p}_{ik}^{\alpha}}{N_i + \,^{\circ}{}_i N_i^{\alpha}}$$

When p_{ik} is de...ned as the true probability of transactions between feedlot i and packer k, and $p_{ik}^{\alpha} = \mu p_{ik}$, then

$$E(\hat{p}_{ik}) = \frac{N_i p_{ik} + \,^{\circ}{}_i N_i^{\alpha} p_{ik} \mu}{N_i + \,^{\circ}{}_i N_i^{\alpha}}$$

According to this formula, there is no bias when feedlot i and the adjacent feedlots have the same transaction probabilities ($\mu = 1$) or when there is no smoothing ($^{\circ}{}_i = 0$).

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[2] Notice that it is the distance between feedlots that is used, not the distance from the feedlots to packing plants in the area.

If lot sales are independent events, then both $N_i \hat{p}_{ik}^0$ and $\sum_i N_i^\alpha \hat{p}_{ik}^\alpha$ have a binomial distribution. Assuming that $\mu = 1$ (that is, the underlying probability that feedlot i ships to a given packer is the same as the probability that i's neighbors ship to the same packer) the numerator of $\hat{p}_{ik}$ also has a binomial distribution. Steel and Torrie (1960) show that the number of observations required to invoke the central limit theorem depends on $1=K$. For example, if $1=K = 0:25$, then 140 observations are required to invoke the central limit theorem and use a normal distribution to approximate the binomial distribution. If $1=K = 0:125$, then 500 observations are required to invoke the central limit theorem, and if $1=K = 0:5$, then only 30 observations are needed before the central limit theorem can be invoked. Assuming that the number of sales is large enough, we can create the following statistic Z_{ik} which has an asymptotic standard normal distribution:

$$Z_{ik} = \frac{\hat{p}_{ik} \; i \;\; p_0}{\sqrt[3]{4}_{\hat{p}_{ik}}}$$

where $p_0 = p_{ik}$, $\sqrt[3]{4}_{\hat{p}_{ik}}^2 = p_{ik}(1 \; i \;\; p_{ik})=c$, and $c = N_i + \sum_i N_i^\alpha$: When the number of sales is not large enough to invoke the central limit theorem, we are required to assume that $\mu = 1$ (i.e. that feedlot i and its neighbors are equally likely to ship to a given packer), and use the binomial distribution to determine the likelihood that $\hat{p}_{ik}$ is signi...cantly di¤erent from $1=K$.

Thus far, we have de...ned a feedlot as in a packer's PMA area if $\hat{p}_{ik} > 1=K$. Notice, however, that this test statistic allows one to use various values for p_{ik} in classifying feedlots as in a packer's primary market area.

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For example, the researcher might wish to classify a feedlot in a packing plant's primary market area only if it ships over three-quarters of its output to that plant. In this case, $p_{ik} = 0.75$ would be used, and only those feedlots with $\hat{p}_{ik} > 0.75$ would be classified as in a PMA.

3 "Captive" feedlots and switching behavior

While a feedlot may be in a packer's primary market area, this masks much potential instability in the relationship between the feedlot and the packer. As noted by Gort (1963), a given industry may be quite concentrated but still competitive, if the stability of relationships within the industry is low. For example, the feedlot may regularly sell a small portion of its output to other packers, or it may sell to whichever packing plant visits first. Also, the feedlot have switched between primary customers at some point during the period under observation.

According to Gort (1963), when stability in relationships is low, large firms are engaged in competition for market share so that even though concentration is high, instability in market shares ensures competitive behavior. This idea was expanded upon by Davies and Geroski (1997), and Baldwin and Gorecki (1994), who performed cross-sectional regression analysis on manufacturing industries in the U.K. and Canada respectively, and find that concentration and stability are not always positively correlated. That is, an industry may be quite concentrated, but relationships between buyers and sellers so unstable that prices remain competitive. Our statistic

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developed above gives a measure of spatial market power, but it may mask a large degree of instability which limits packers' ability to exercise market power.

One way to bring out this potential instability would be to divide the sample into shorter time periods (one week or one month for example), and perform our PMA calculations for each period. We then have a new set of data, Z_{ikt} where t indexes period. The larger the number of periods a feedlot is in a given packer's PMA, the higher the stability in the relationship. The more feedlots with stable relationships with one or a few packers, the less likely is the market to be competitive. Thus, sorting feedlots into groups based on the percentage of one-week periods in which they were classi...ed into their primary customer's (as given by Z_{ik} for the entire data set) PMA might indicate the stability of relationships in the market. Alternatively, one could ...nd the average and standard deviation among feedlots for the number of periods in which both Z_{ikt} and Z_{ik} put feedlot i into packer k's PMA. This average would be de...ned as

$$W_k = \frac{\sum_i \sum_t w_{ikt}}{I}$$

$$\text{where } w_{ikt} = \begin{cases} 1 & \text{if } Z_{ikt} \text{ and } Z_{ik} \text{ are both signi...cantly positive} \\ 0 & \text{otherwise} \end{cases}$$

A larger average suggests more stable relationships, as does a smaller standard deviation.

Alternatively, it might be possible to determine the number of shorter

(one-week) periods during which the feedlot sells only to its primary customer. The larger this number, the more stable is the relationship between the packer and its primary customer, and the higher the likelihood that the feedlot is indeed "captured" by its primary customer. Once again, one can group feedlots based on the number of periods sold to primary customers. If a large number of feedlots usually sell exclusively to their primary customer then relationships in this market are fairly stable. Also as before, one could calculate the average and standard deviation for the number of periods that feedlots sell to their primary customer. In this case, the variable of interest would be $E_k = (\sum_i \sum_t e_{ikt}) = I$, where $e_{ikt} = 1$ if feedlot i sells exclusively to packer k (its primary customer) in period t. As before, larger averages with smaller standard deviations suggest a higher degree of stability in the market.

4 Explaining the division of feedlots

So far, we have suggested two indirect measures of the competitiveness of a market. We have also tried to draw inferences regarding the exercise of market power based on these indirect measures. Once again, we run up against the problem that many factors can explain the stability of packer-feedlot relationships, most of which are not related to the exercise of packer market power. In this section, we suggest a regression equation to control for alternative explanations of stability in the packer-feedlot relationship. The coefficients on the regressors will give some idea of the importance of

each factor to the stability of the packer-feedlot relationship. In addition, the regression residuals can be analyzed to see if they have any sort of underlying relationship. Such a relationship, if found, might be indicative of the exercise of market power.

As noted, stability in the relationship between feedlots and packers can be explained by many things. For example, it might be that the feedlot is located right next door to the packing plant, so that the cost to transport a pen from seller to buyer is near zero. Perhaps the packer consistently o¤ers the feedlot a higher price net of transportation costs than its competitors. The feedlot may have a contract with the packer which accounts for a large part of its sales. Relationships are costly to establish, and buyers may not think it worth their while to visit smaller feedlots known to sell the majority of their output to another packer.

To distinguish each of these causes, the following empirical model could be used.

$$PROP_{ijt} = f(PROP_{ijt_{i}\ 1}; PDIF_{t}; PCTCONTR; FLSIZE_{it}; PERSIST_{it})$$

and

$$PDIF_{t} = P_{ijt\ i}\ P_{ikt} = g(DIST; COMPDIST; QUALITY; CAP)$$

Where $PROP_{ijt}$ gives the percentage of spot market transactions between feedlot i and its primary customer j in period t; $PDIF_{t}$ gives the ...tted

difference in price offered by the prmary customer and all other packers, $PCTCONTR$ gives the percentage of its output that the feedlot sells to its primary customer on contract, and $FLSIZE_{it}$ is the number of lots sold by the ith feedlot during each period and acts as a proxy for feedlot size. Economies of size in developing and maintaining relationships between feedlots and packers may reduce transaction costs between a large feedlot and a packer compared to smaller feedlots. If this is true then $FLSIZE$ will have a positive, significant coefficient. $PERSIST$ is a dummy variable set to one if the difference in prices offered by packers is large and lasts more than one period. We include the variable $PERSIST$ to test the possibility that while current period price differences may not have a large effect on feedlot sales to a given packer, a persistent price difference will eventually cause a larger shift in sales.

The difference in price offered by the primary customer and all other packers k is presumed to depend on $DIST$, the distance from the feedlot to packer j, $COMPDIST$, the distance from feedlot i to packer k, $QUALITY$, the quality of the lot being sold, and CAP, the capacity utilization of the purchasing packing plant and its nearby competitors.

This specification leads to two tests of market power. First, if the market is competitive, feedlots should sell to the packer offering the highest price net of transportation costs. Thus, we expect the coefficient on $PDIF$ to be positive and significant. If it is negative or not significant, then feedlots do not necessarily sell to the packer offering the highest price. Given

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that we have controlled for other explanations of the stability of feedlot-packer relationships, this gives evidence that packers have some degree of control over feedlots. Second, each of these variables is included to control for alternative explanations of the stability of feedlot-packer relationships. Any unexplained variation in the dependent variable may tentatively be attributed to packer control over feedlots.

Our specification also allows us to examine the possibility that the spot and contract markets are related. By including PCTCONTR in our main regression, we are able to test the hypothesis that the more a feedlot sells to a packer in the contract market, the more it will sell to that same packer in the spot market. This hypothesis is supported if the coefficient on PCTCONTR is positive and significant. If contracts are made to avoid transaction costs, then a relationship between the contract and spot market suggests that transaction costs may explain some of the stability in spot market sales found above.

5 Conclusion

Consolidations in the beef packing industry have led to many attempts to determine the degree to which packers are able to control their environment. Several studies have defined environmental control as the ability of packers to reduce the prices they pay for fed beef. Unfortunately, this definition depends crucially on the ability to determine what input prices would have been in a competitive market. Generally speaking, studies use estimates of

packer costs to make inferences about what competitive prices would have been. While this is theoretically satisfying, estimating packer costs is a di¢cult exercise, and conclusions regarding market power depend critically on accurate estimates.

We propose an alternative view of market power. If packers exercise what we call spatial market power, then they are able to behave as monopsonists toward their "captive" input suppliers. Thus, examining the strength of the relationship between packing ...rms and feedlots should give an indication of whether packers are able to in‡uence the terms under which they purchse fed cattle. Our indicators have the advantage of depending on easily observed and measured variables.

Of course packers may have exclusive relationships with feedlots for many reasons not related to the exercise of market power. In the paper's third section, we discuss some of these reasons, and suggest a regression model designed to control for many of them. Taken together, our indicators and regression results may give indirect evidence of packer behavior. Inasmuch as our evidence does not rely on hard-to-measure variables, it may allow for more de...nitive conclusions regarding whether concern about the market structure beef packing is justi...ed.

References

Azzam, A.: 1998, Competition in the us meatpacking industry: is it history?, Agricultural Economics **18**, 107–126.

Baldwin, J. R. and Gorecki, P. K.: 1994, Concentration and mobility statistics in canada's manufacturing sector, *Journal of Industrial Economics* **42**, 93–102.

Brorsen, B. W., Bailey, D. and Thomsen, M. R.: 1997, Mapping market areas using nonparametric smoothing, *Geographical Analysis* **29**, 214–231.

Davies, S. W. and Geroski, P. A.: 1997, Changes in concentration, turbulence, and the dynamics of market shares, *Review of Economics and Statistics* **79**, 383–391.

Gort, M.: 1963, Analysis of stability and change in market shares, *Journal of Political Economy* **71**, 51–63.

Hayenga, M. and O'Brien, D.: 1992, Packer competition, forward contracting price impacts, and the relevant market for fed cattle, *in* W. D. Purcell and K. O'Connor (eds), *Pricing and Coordination in Consolidated Livestock Markets*, Research Institute on Livestock Pricing, Virginia Tech.

Schroeder, T. C., Mintert, J. and Barkley, A.: 1993, The impact of forward contract on fed cattle transaction prices, *Review of Agricultural Economics* **15**, 325–337.

Steel, R. G. and Torrie, J. H.: 1960, *Principles and Procedures of Statistics*, McGraw Hill, New York.

Ward, C. E., Koontz, S. R., Dowty, T. L., Trapp, J. N. and Peel, D. S.: 1999, Marketing agreement impacts in an experimental market for fed cattle, *American Journal of Agricultural Economics* **81**, forthcoming.

Ward, C. E., Koontz, S. R. and Schroeder, T. C.: 1998, Impacts from captive supplies on fed cattle transaction prices, *Journal of Agricultural and Resource Economics* **23**, 494–514.

Ward, C. E., Schroeder, T. C., Barkley, A. P. and Koontz, S. R.: 1996, Role of captive supplies in beef packing, Technical report, Grain Inspection, Packers and Stockyards Administration, Packers and Stockyards Programs, U.S. Department of Agriculture GIPSA-RR-96-3.

Zhang, M. and Sexton, R. J.: 2000, Captive supplies and the case market price: A spatial markets approach, *Journal of Agricultural and Resource Economics* **25**, 88–108.