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Estimated Impact of Non-Price Coordination of Fed Cattle Purchases on Meat Packer Processing Costs

John D. Anderson, James N. Trapp, and Ronald A. Fleming

Stochastic simulation of daily slaughter level was used in conjunction with an estimated packing plant cost curve to assess potential reductions in processing costs due to improved vertical coordination between feedlots and packing plants. Results indicate that processing cost reductions of \$1 to \$5 per head may be possible. Savings result from ensuring a more stable processing volume that is near the plant's cost-minimizing level of production.

Key Words: cattle, cost curve, meat packing, vertical coordination

An extensive body of literature discusses the nature, causes, and conceptual benefits of vertical coordination via non-price methods. However, since economists rarely have the opportunity to measure performance criteria for various forms of vertically coordinated structures, empirical estimates of the value of coordination are noticeably absent in the literature. Similarly, there are no estimates of the level of gains or losses experienced by the various participants in the supply chain. As Den Ouden et al. (1996) note:

> In spite of the extensive descriptive literature on the potential benefits and costs of improved vertical coordination, there seems to be little quantitative information on its effects both at the overall level of the chain and with respect to the individual stages (p. 287).

The cattle market provides an interesting study in the potential impacts of a change in vertical structure. In contrast to the poultry and pork industries where coordination between different levels of the supply chain is achieved primarily through direct ownership or contracting, coordination in the fed cattle market (indeed, in the beef industry in general) is primarily achieved through market prices. Because of the frequently adversarial relationship between cattle feeders and meat packers, coordination between these two levels of the beef industry solely by price

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John D. Anderson is assistant extension professor, Department of Agricultural Economics, Mississippi State University; James N. Trapp is department head, Department of Agricultural Economics, Oklahoma State University; and Ronald A. Fleming is assistant professor, Department of Agricultural Economics, University of Kentucky.

may exhibit significant inefficiencies. Production costs within the system could possibly be reduced by improving coordination through non-price means.

The objective of this research is to quantify the incentive that exists for meat packers and/or feeders to implement non-price forms of vertical coordination.[1] Specifically, this research uses numerical simulation to estimate potential reductions in processing costs which may be expected from more efficient coordination of marketing/purchasing between cattle feeders and meat packers. Results of this study will be useful for informing the ongoing debate over captive supplies (i.e., cattle on feed that are either contracted to or owned by meat packers). For example, if improved vertical coordination significantly reduces processing costs, then captive supplies could potentially have a positive impact on cattle prices—making it possible for packers to profitably pay higher prices for cattle.[2]

Packing Plant Cost Structure

The hypothesis that improved coordination between cattle feeding operations and beef packers may result in significant slaughter/processing cost reductions is based on the existence of economies of size within beef packing plants. Conceptually, economies of size exist when average total cost decreases as total physical product increases.[3] The existence of economies of size in an industry has obvious implications for the structure of the industry (Hallam, 1991). In the meat packing industry, major structural change occurring over the past 30 years has been hypothesized to be a product of economies of plant size (Ward, 1993).

Several authors have documented the existence of economies of size within beef packing plants (e.g., Duewer and Nelson, 1991; Logan and King, 1962; Sersland, 1985). More recently, Morrison Paul (2001) confirmed the existence of cost economies in large packing plants, estimating an elasticity of cost with respect to output of about 0.95, indicating that increasing output by 1% would increase total production costs by 0.95%. This relationship denotes a cost reduction of 5% on the marginal output. Similarly, MacDonald et al. (2000) estimate the elasticity of cost with respect to output for beef packing plants to be 0.93. They note that the value of this elasticity appears to have decreased over time, suggesting cost reductions

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[1] Cattle feeding operations and meat packers both have some incentive to use vertical coordination as a cost control or risk management strategy. In fact, common forms of non-price vertical coordination, such as forward contracts and marketing agreements, often involve both a buyer (packer) and a seller (feedlot). However, this study focuses on incentives for vertical coordination exclusively from the standpoint of the packing plant.

[2] Clearly, packers would not necessarily pay higher prices for cattle just because they could afford to do so. If vertical coordination sufficiently reduces competition among buyers, cattle prices could actually decline. Considerable work on the impact of captive supplies on cattle prices has produced mixed results. See, for example, Schroeder et al. (1993); Ward et al. (1996); and Texas Agricultural Market Research Center, Slaughter Procurement and Pricing Study Team (1996).

[3] In general, economies of size refers to per unit cost reductions that are realized as output increases along the expansion path—implying all inputs, including plant size, are variable. Ward (1988) makes a useful distinction between intra-plant economies (cost savings achieved by increasing output within a given plant) and firm economies (cost savings achieved by a firm which may operate multiple plants). Applying Ward's terminology, this study deals exclusively with intra-plant cost economies.

associated with increasing output have become larger over the past 30 years as a result of changes in processing technology.

Such consistent evidence regarding the existence of size economies within beef packing plants is important to any discussion of vertical coordination because size economies provide an incentive for plant managers to maintain production at or near some cost-minimizing level of operation. Ward et al. (1996) report that costs increase dramatically when plant capacity is underutilized in the short run. Ward (1990) offers a thorough discussion on the importance to packing plants of operating at full capacity. He notes that capacity utilization (i.e., actual slaughter relative to capacity) as well as plant size affects production costs and, by extension, pricing decisions by meat packers. In summarizing work by Sersland, Ward (1988) estimates that increasing capacity utilization by 10% would reduce slaughter costs by almost $3 per head—an economically significant amount given the small margins characterizing both the meat packing and cattle feeding sectors.

The present study extends the existing literature by quantifying how production costs in meat packing plants are affected by changes in the level of plant capacity utilization as well as by changes in the variability of that level of utilization. While it builds on the earlier work of Ward (1988), this research differs in two major respects. First, this study considers the variability and the level of capacity utilization, and second, the data and methods employed here are substantially different from those of Ward.

Data Description and Model Development

During a previous study on packer concentration, the USDA's Grain Inspection, Packers and Stockyards Administration (GIPSA) collected daily slaughter volumes for the 43 largest packing plants in the country from April 5, 1992, to April 3, 1993. Due to confidentiality restrictions, the actual data and the identities of the plants included in the data set could not be released. However, GIPSA was able to provide summary statistics related to the slaughter capacity utilization of all plants, along with a histogram of that aggregate slaughter capacity data.

In order to summarize slaughter capacity utilization by plants in the data set, GIPSA (at the authors' request) first computed the average slaughter level for the 15 highest slaughter volume days for each plant over the period of time covered by the data. For each plant, this value was assumed to represent plant capacity, and was used to calculate a daily slaughter capacity utilization index (*SCUI*) of the following form:

$$(1) \qquad SCUI_{tj} = (SLGVOL_{tj}/AVGSL15_j)100,$$

where $SCUI_{tj}$ is the slaughter capacity utilization index for plant j on day t; $SLGVOL_{tj}$ is the reported slaughter volume for plant j on day t; and $AVGSL15_j$ is the average slaughter level for the 15 days with the highest slaughter volume for plant j. Table 1 reports the summary statistics on *SCUI* provided by GIPSA.

Table 1. Statistical Summary of GIPSA Plant Utilization Index Data (April 5, 1992 to April 3, 1993)

Description	Value
Slaughter Capacity Utilization Index (*SCUI*) Statistics:	
< Mean	84.92
< Median	88.63
< Variance	173.28
< Third Moment	!3,436.81
< Fourth Moment	183,420.34
Number of Plants	43
Number of Observations	9,145
Number of Saturday Observations	450

To determine an appropriate distribution for this calculated measure of slaughter capacity utilization, 10,000 random *SCUI* observations were generated using an inverse transformation of an empirical cumulative distribution of *SCUI* based on the histogram provided by GIPSA. Figure 1 presents the original GIPSA histogram along with a histogram of the simulated data. Note the shape of the simulated distribution conforms very closely to the shape of the histogram provided by GIPSA.[4]

Using the program *ExpertFit*,[5] simulated data were found to be from an Extreme Value Type A (EVTA) distribution (Law and Vincent, 1999). A random variable, x, has an EVTA distribution with parameters γ and β if the density function of X is

$$f(x) = \frac{1}{\beta} e^{[(x-\gamma)/\beta]} e^{-e^{[(x-\gamma)/\beta]}} \tag{2}$$

for all real numbers x. Mean and variance for the EVTA distribution can be calculated using γ and β as follows:

$$\bar{X} = \gamma - 0.57722\beta \tag{3}$$

and

$$\sigma_x^2 = 1.64493\beta^2. \tag{4}$$

Using these equations, in combination with mean and variance information provided by GIPSA and reported in table 1, the γ and β values defining an appropriate distribution for *SCUI* were calculated as 90.8444 and 10.2636, respectively.

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[4] The only apparent difference between the histograms of the simulated and actual data is the fact that more observations were simulated than were represented in the GIPSA histogram (10,000 simulated observations versus 9,145 observations in the data summarized by GIPSA). The number of simulated observations is not important for the present purpose as long as the distribution of those observations is consistent with the original data.

[5] The *ExpertFit* program is designed to determine which of 31 continuous or 7 discrete probability distributions best represents a given data set.

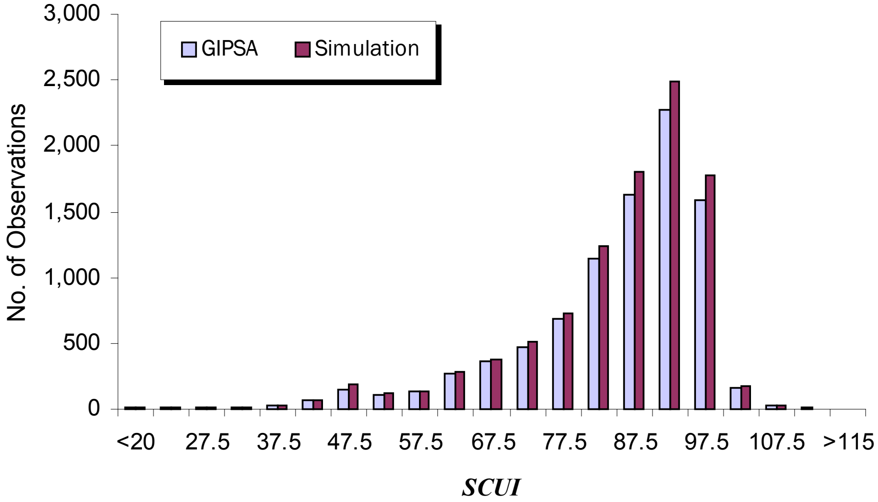

Figure 1. Comparison of distribution of GIPSA *SCUI* data with simulated *SCUI* data

Using this distribution for capacity utilization, the cost to the packing industry implied by volatility in slaughter rates was estimated by stochastic simulation. For the simulation, 1,500 random plant capacity utilization rates were generated from the EVTA(γ, β) cumulative distribution function defined above.[6,7] The slaughter cost associated with each random capacity utilization rate was evaluated using the processing cost data reported in table 2, derived from the 1991 work of Duewer and Nelson.[8] Linear interpolation was used to evaluate costs for random capacity figures between those reported in the table.

The mean of the 1,500 processing cost figures was $92.42. Comparing this cost level to the cost associated with operation of a plant at 100% capacity ($87.50/head)

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[6] Ten thousand observations were originally drawn to define the parameters of the *SCUI* distribution because this number was roughly equal to the number of observations in the original GIPSA data set (which, again, was not available but was summarized with descriptive statistics and a histogram). When drawing directly from the EVTA distribution for the purpose of generating cost estimates, it was not necessary to use 10,000 observations since cost estimates did not change appreciably with sample sizes of greater than 1,500.

[7] In the simulation, no observations were drawn from the portion of the distribution below an *SCUI* value of 66. It is hypothesized that days when a plant operated at less than two-thirds of its capacity were days when production was reduced due to mechanical problems, health inspections, storms, or some other factor which caused the suspension of one or more shifts during the day (this would include Saturdays and holidays). The selection of a critical *SCUI* value of 66 is somewhat arbitrary, but there is no way to empirically determine any more appropriate value. The main point is for the value to be low enough to capture the effect of coordination problems which interfere with slaughter volume, but not so low that the effect of major technical problems (which could not be affected by improved coordination) on slaughter volume is included.

[8] Other authors have developed more complex models of beef processing costs (e.g., MacDonald et al., 2000; Morrison Paul, 2001). However, a more parsimonious representation of the relationship between volume and costs is needed for this study. Cost curves developed by Ward (1988, 1993) based on work by Sersland are also available; however, a comparison of Sersland's (1985) study on packing plant costs to the Deuwer and Nelson (1991) work reveals their results are quite similar (Ward, 1993).

Table 2. Combined Killing and Fabrication Costs/Head for Alternative Slaughter Rates

Slaughter Rate as a Percentage of Physical Plant Capacity (%)	Killing and Fabrication Costs ($/head)
40	169.69
50	138.13
60	117.81
70	105.79
80	96.61
90	89.59
100	87.50
110	87.61
120	87.74

yields a difference of $4.92. This difference is interpreted to be the typical cost inefficiency experienced by slaughter plants during the period covered by the GIPSA data set. This inefficiency can be decomposed into two parts: (*a*) the cost of operating at an average capacity below the optimal capacity, and (*b*) the cost of volatility around that average level.

An explanation of the first of these two cost components is straightforward. The simulated mean slaughter capacity utilization rate was 87.6%. The processing cost associated with this rate (derived by linear interpolation) is $91.26. The difference between $91.26 and $87.50 (the cost associated with 100% capacity utilization) is $3.76. Thus, the majority of the total $4.92 cost inefficiency is due to the average plant utilization rate being about 12.5% below the assumed least-cost utilization rate of 100. The remaining $1.16 of cost inefficiency ($4.92 – $3.76) can therefore be attributed to variability around the mean capacity utilization rate.

Conceptually, variability around the mean capacity utilization rate could increase processing costs as a result of two factors: (*a*) the shape of the cost curve, and (*b*) the distribution of capacity utilization rates. The cost curve rises more rapidly below the capacity of 87.6% than it falls above that capacity; therefore, random deviations below the mean capacity utilization rate are penalized by added costs more than random deviations above the mean are rewarded with reduced costs. The skewness of the distribution of capacity utilization observations has a mixed effect on processing costs. More observations will be randomly drawn from above the mean than from below, causing more decreases in cost (relative to the cost at the mean) than increases. However, the direction of the skew also implies that observations drawn below the mean will typically be further from the mean than observations drawn above the mean. Deviations below the mean will thus incur bigger cost penalties than the cost reductions received by the typically smaller deviations above the mean.

Table 3. Simulated Cost Inefficiencies from Non-Optimal Average Daily Slaughter Rates and Variable Daily Slaughter Rates Assuming Different Optimal Capacity Levels

[1] Ratio of Actual vs. Optimal Capacity Utilization Rate	[2] Optimal Capacity Utilization Rate	[3] Total Cost Inefficiency ($)	[4] Inefficiency from Instability ($)	[5] Inefficiency from Non-Optimal Utilization Rates ($)
0.834	105	7.17	0.47	6.69
0.876	100	4.92	1.16	3.76
0.922	95	3.14	1.52	1.62
0.974	90	1.84	1.29	0.55
1.031	85	1.00	0.96	0.03
1.095	80	0.51	0.40	0.10
1.168	75	0.28	0.09	0.20

Optimal Slaughter Capacity Utilization

The assumption that a plant's optimal (i.e., least-cost) slaughter capacity is equal to the average slaughter level for its 15 highest slaughter volume days, while logical, is arbitrary. Sensitivity analysis can be conducted to determine the effect of this assumption on cost inefficiency estimates. In this analysis, the capacity utilization rate assumed to correspond to the minimum point on the cost curve was adjusted in increments of five points between 75 and 105.[9] This results in ratios between the assumed optimal capacity utilization and the mean of the simulated *SCUI* ranging from about 0.83 to 1.17. These ratios indicate how close the simulated *SCUI* is to the assumed optimal level. A ratio of 1.00 would indicate the simulated *SCUI* was exactly equal to the optimal (or cost-minimizing) level of capacity utilization. Complete sensitivity test results are reported in table 3. Inefficiency cost estimates from the original simulation (i.e., optimal *SCUI* assumed to be 100) are found in the second row of the table. The other rows report results of alternative assumptions about the optimal *SCUI*.

Two patterns emerging from the sensitivity analysis help to summarize the nature of the cost inefficiency caused by low and volatile slaughter capacity utilization rates. First, as expected, the closer actual average slaughter capacity utilization is to the assumed optimal level, the lower the cost inefficiency from non-optimal capacity utilization becomes (column 5 in table 3). More interesting is the fact that the cost

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[9] The difference between the capacity utilization rate assumed to be optimal and the observed capacity utilization rate (as calculated from the GIPSA data) could be due to a couple of factors. First, low supplies of cattle during the data period could have made it difficult for packing plants to procure enough cattle to operate at the optimal level. Second, the method used to calculate optimal slaughter capacity utilization (i.e., calculating average slaughter level for the 15 days in the data period with the highest slaughter volume) may have resulted in an overestimate of the plant's optimal slaughter rate. Finally, the difference could be the result of some combination of both of these factors.

inefficiency associated with non-optimal utilization of capacity rises faster with increasing levels of underutilization than with increasing levels of overutilization. This is because the Duewer-Nelson cost curve remains relatively flat beyond its low cost volume.

The second general observation is that cost inefficiencies generated from unstable slaughter levels appear to peak when plants are operating somewhere between about 90% and 95% of the assumed optimal slaughter capacity utilization. Intuitively, it may seem the largest cost of instability would occur at an average slaughter level equal to the capacity utilization rate at the low point on the cost curve, since deviations in either direction would result in higher costs. However, the cost curve used here is very flat around its low point. Hence the majority of the deviations occurring in this area do not affect cost by a very great magnitude. The largest cost of instability occurs where the slope of the cost curve is changing most rapidly. As noted earlier, this results in deviations below the mean incurring a cost increase that is considerably larger than the cost decrease received on deviations above the mean.

SCUI Distribution and Packing Plant Cost Structure

It is important to remember that the distribution of capacity utilization was defined using data aggregated from many different plants. Different plants would likely have different capacity utilization distributions. Indeed, Ward (1990) reports larger plants are generally able to operate closer to capacity and with less variance in their level of operation than smaller plants. Likewise, plants of different sizes using different technologies will definitely have different cost structures. Given the available data, it would be impossible to define different capacity utilization distributions based on plant size; however, additional simulations can be used to investigate how processing cost inefficiency estimates are affected by assumptions related to the *SCUI* distribution. Similar sensitivity analysis can be performed to investigate how the shape of the cost curve impacts cost inefficiency.[10]

In the first of these analyses, the β and γ parameters defining the EVTA distribution were varied to result in EVTA distributions with the same mean as the original but with different higher moments. Again, an inverse transformation of these EVTA distributions was used to simulate additional *SCUI* data sets (with no observations drawn below $SCUI = 66$). Estimates of cost inefficiency were calculated for each of 14 data sets differing in their variance and skewness. These results are presented in table 4 along with information on the second and third moments of the simulated observations (i.e., variance and skewness calculated from the data sets with no observations below $SCUI = 66$).

Results in table 4 indicate the cost of instability increases with increasing variance. The relationship between skewness and instability costs is less clear. In a simple OLS regression of the cost of instability on variance and skewness, the estimated

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[10] Plants of different sizes would have cost curves differing not only in their shape but in their level; however, the cost inefficiencies being investigated in this study depend only on the curves' shape.

Table 4. Simulated Cost Inefficiencies Estimated with Different *SCUI* Distribution Parameters

SCUI Variance	*SCUI* Skewness	Total Cost Inefficiency ($)	Inefficiency from Instability ($)	Inefficiency from Non-Optimal Utilization Rates ($)
91.959	−0.222	4.92	1.16	3.76
72.000	−0.326	5.10	0.77	4.32
74.377	−0.240	5.10	0.82	4.28
79.720	−0.197	5.05	0.95	4.09
79.747	−0.249	4.99	0.95	4.04
84.343	−0.198	5.09	0.99	4.11
88.942	−0.275	4.99	1.06	3.93
92.905	−0.210	5.20	1.05	4.15
93.257	−0.130	4.89	1.23	3.67
97.980	−0.114	4.74	1.36	3.38
96.692	−0.132	4.85	1.29	3.55
103.465	−0.164	4.56	1.53	3.04
109.199	−0.130	4.70	1.57	3.13
109.974	−0.137	4.59	1.63	2.96
113.358	−0.108	4.56	1.74	2.82

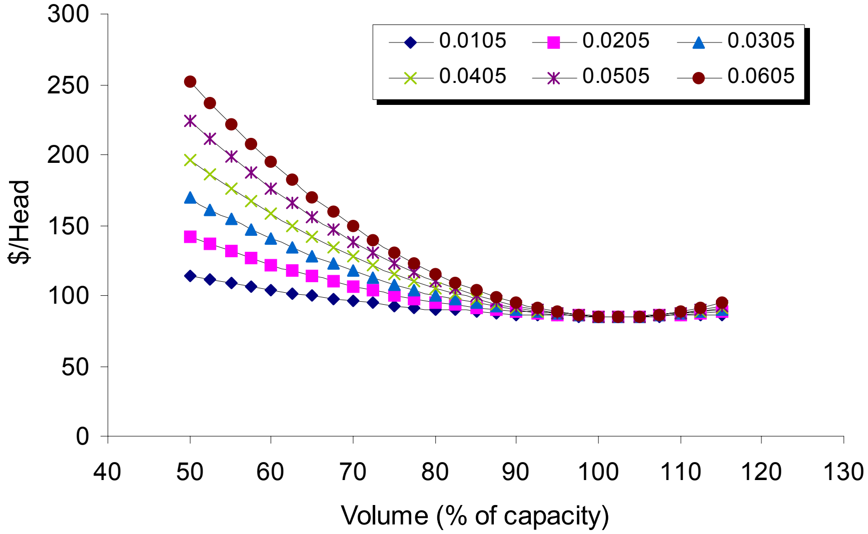
Note: Figures in the first row are from simulation using *SCUI* distribution estimated from GIPSA data.

coefficient on skewness is not significantly different from zero, while the coefficient on variance is highly significant and positive (coefficient of 0.021 with a standard error of 0.002). Variance rather than skewness has the major impact on the cost inefficiency due to capacity utilization variability. This coefficient implies an elasticity between cost inefficiency and *SCUI* variance of about 1.66 (using the cost of instability and variance data in row 1 of table 4). This means a 1% change in variance of slaughter capacity utilization would be expected to result in a nearly 1.7% change (in the same direction) in processing cost inefficiency.

To investigate the impact of the shape of the cost curve on processing cost inefficiency, a quadratic function was fit to the cost curve data from table 1 using OLS regression. The following parameters were estimated:

$$C = 300.50 - 4.203V + 0.0205V^2, \tag{5}$$

where C is processing cost per head and V is processing volume as a percentage of capacity. To develop alternative shapes for this simple processing cost relationship (in order to represent different technologies in processing plants), the coefficient on the quadratic term was varied between 0.0105 and 0.0605 in increments of 0.01. Using the solver feature in Excel, intercept and first-order coefficients were found that would result in minimum processing volumes and costs equal to those associated



Note: Values in legend indicate the 2nd derivative of the cost curve.

Figure 2. Average processing cost curves used in estimating impact of curvature of cost function on estimates of cost inefficiency

with equation (5). Resulting cost relationships are presented in figure 2. These relationships were used in combination with the first simulated *SCUI* data set [$N = 1{,}500$, ~EVTA($\gamma = 90.8444$, $\beta = 10.2636$)] to estimate processing cost inefficiency. Results of those simulations are presented in table 5.

The most interesting result of the cost relationship analysis is that costs due to *SCUI* variability increase as the curvature of the function increases. Viewing the cost relationships in figure 2, it is clear that with a mean capacity utilization of about 88%, deviations below the mean will result in a cost increase and deviations above the mean will result in a cost decrease. However, because the curve is steeper below the mean than above it, cost increases associated with below-average utilization will be greater than cost decreases associated with above-average utilization. The greater the degree of curvature in the cost function, the greater this disparity between cost increases (for below-average utilization) and cost decreases (for above-average utilization) becomes. These results support the argument that the cost of a given level of variability in processing volume depends on where the plant is operating on its cost curve. Results also provide additional details about the previously discussed relationship between variability in processing volume and the shape of the cost curve.

Estimated Inefficiency Costs and the Cattle Cycle

Of all the values presented in tables 3–5, which is the most accurate estimate of actual industry costs to packing plants due to non-optimal and unstable slaughter volumes?

Table 5. Simulated Cost Inefficiencies Estimated with Different Processing Cost Curves

First Derivative	Second Derivative	Total Cost Inefficiency ($)	Inefficiency from Instability ($)	Inefficiency from Non-Optimal Utilization Rates ($)
!0.313	0.021	2.40	0.70	1.69
!0.611	0.041	4.68	1.37	3.30
!0.909	0.061	6.96	2.04	4.92
!1.207	0.081	9.24	2.71	6.53
!1.505	0.101	11.52	3.38	8.14
!1.804	0.121	13.80	4.05	9.75

While determining a definitive answer is difficult, table 3 provides a starting point for some useful inferences.

GIPSA data used in this study were collected over a period in which the slaughter level was about 1% above the previous cyclical low in slaughter numbers and about 12% below the previous cyclical high in slaughter numbers. This implies that over an entire cattle cycle, the average number of slaughter cattle available should be roughly 5% higher than the number of cattle available over the period for which these data were collected. Thus, assuming the industry's aggregate slaughter capacity does not change over a cattle cycle, it can be inferred that over an entire cycle, slaughter plants would typically be able to operate about 5% closer to their physical capacity limit than they did during the period covered by the data. Since the average capacity utilization rate in the truncated GIPSA data was between 87% and 88%, this implies an average capacity utilization rate over an entire cycle of between 92% and 93%.

Given the assumption that packing plants operate at an average capacity utilization rate of about 92% over the course of a cattle cycle and the assumption that the least-cost level of operation is at a plant's physical maximum rate, the third row of table 3 becomes uniquely relevant. It is for a plant operating at just over 92% of its optimal capacity. The indicated total inefficiency cost is $3.14/head with $1.52 of that cost due to slaughter volatility and $1.62 due to a less-than-optimal volume.

The inefficiency cost value derived above represents the long-run (i.e., over the course of an entire cattle cycle) cost of non-optimal and variable capacity utilization for a packing plant with a cost structure similar to that depicted in table 2.[11] It is important to recognize, however, that total inefficiency cost likely changes dramatically over the cattle cycle. During low points in the cattle numbers cycle, the plant

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[11] Obviously, it would be impossible to derive a single value which accurately represents cost inefficiencies for plants of varying sizes and employing different technology. The point of this exercise is simply to provide some sense of how cost inefficiency may be expected to vary in a representative packing plant as cattle numbers change over the course of a cattle cycle.

utilization rate could drop to around 86%. This could cause an inefficiency cost of around \$5/head. During the peak of the cattle numbers cycle, the plant utilization rate could rise to about 99%, thus causing the total cost inefficiency to drop to around \$1/head.

Processing cost savings of \$1 to \$5 per head may seem small compared to the total value of the animal being processed; nevertheless, this amount is certainly economically significant when compared to feedlot and/or packer profit margins. Data on packer profits are highly confidential and not readily available. However, Trapp (1989) analyzed feedlot profit records from custom feeding operations and found average feeding profits per head over a complete cattle cycle (i.e., a 10-year period) of approximately \$10/head.

The potential processing cost reductions identified in this study represent a very important incentive for packers to use non-price means of coordination. Forward contracting, marketing agreements, and direct ownership of cattle in feedlots are all examples of such non-price coordination. Packers can use supplies of cattle controlled by ownership or contractual arrangements (i.e., captive supplies) as a sort of buffer stock to help reduce cost inefficiencies associated with suboptimal and/or variable capacity utilization. When cattle are relatively scarce (abundant), more (fewer) of the captive supply cattle can be brought into the slaughter mix, thus helping the packer to maintain slaughter at closer to the optimal level and with less variability in the slaughter level.

Of course, as noted, producers are concerned that having captive supplies available to packers when cattle are relatively scarce will allow them to bid less aggressively for their remaining cattle needs. This is certainly a legitimate concern; however, it is also important to recognize the potential for positive impacts resulting from the cost reductions offered by captive supplies. These reductions in cost would not necessarily translate directly into higher packer profits. Some or all of this cost savings may be passed on to retailers in the form of lower prices for beef (thus improving the competitive position of beef relative to competing meats) or to feeders in the form of higher prices for cattle.

Summary and Conclusions

A stochastic simulation designed to measure the impact of fed cattle supply variability on packer costs was performed using a distribution of plant capacity utilization derived from a summary of data obtained from GIPSA. Results indicate that in the long run (i.e., over an entire cattle cycle) packers probably lose just over \$2/head to cattle supply variability and capacity underutilization. This figure likely varies a great deal over the course of a cattle cycle—from approximately \$5/head when cattle numbers are near their cyclical low, to around \$1/head when cattle numbers are near their cyclical high. Figures of this magnitude are quite economically significant in relation to packer and feeder profit margins.

The potential cost savings from ensuring more stable processing flows at or near an optimal level represent an incentive for packers to pursue various forms of non-price vertical coordination strategies. The benefits of vertical coordination may accrue to segments of the industry beyond the packing sector. This will occur if the cost savings from non-price vertical coordination (or some portion of those savings) are distributed to others in the supply chain (e.g., as higher prices to feedlots for cattle or as lower prices for beef to retailers).

References

Den Ouden, M., A. A. Dijkhuizen, R. B. M. Huirne, and P. J. P. Zuurbier. (1996). "Vertical cooperation in agricultural production-marketing chains, with special reference to product differentiation in pork." *Agribusiness: An International Journal* 12, 277–290.

Duewer, L. A., and K. E. Nelson. (1991). "Beefpacking and processing plants: Computer-assisted cost analysis." Staff Report No. AGES 9115, USDA/Economic Research Service, Commodity Economics Division, Washington, DC.

Hallam, A. (1991). "Economies of size and scale in agriculture: An interpretive review of empirical measurement." *Review of Agricultural Economics* 13, 155–172.

Law, A. M., and S. Vincent. (1999). *ExpertFit User's Guide.* Tucson, AZ: Averill M. Law & Associates.

Logan, S. H., and G. A. King. (1962). "Economies of scale in beef slaughter plants." Research Report No. 260, Giannini Foundation, University of California-Davis.

MacDonald, J. M., M. E. Ollinger, K. E. Nelson, and C. R. Handy. (2000). "Consolidation in U.S. meatpacking." Pub. No. AER-785, USDA/Economic Research Service, Washington, DC.

Morrison Paul, C. J. (2001). "Market and cost structure in the U.S. beef packing industry: A plant-level analysis." *American Journal of Agricultural Economics* 83, 64–76.

Schroeder, T. C., R. Jones, J. Mintert, and A. P. Barkley. (1993). "The impact of forward contracting on fed cattle transaction prices." *Review of Agricultural Economics* 15, 25–37.

Sersland, C. J. (1985). "Cost analysis of the steer and heifer processing industry and implications on long-run industry structure." Unpublished Ph.D. dissertation, Department of Agricultural Economics, Oklahoma State University, Stillwater.

Texas Agricultural Market Research Center, Slaughter Cattle Procurement and Pricing Study Team. (1996). "Price determination in slaughter cattle procurement." Pub. No. GIPSA-RR 96-2, USDA/Grain Inspection, Packers and Stockyards Administration, Washington, DC.

Trapp, J. N. (1989). "Seasonal aspects of cattle feeding profits." *Oklahoma Current Farm Economics* 62, 19–30.

U.S. Department of Agriculture, Grain Inspection, Packers and Stockyards Administration. (1993). Unpublished summarized data from GIPSA's "1992–93 Packer concentration study." USDA/GIPSA, Washington, DC.

Ward, C. E. (1988). *Meatpacking Competition and Pricing*. Blacksburg, VA: Research Institute on Livestock Pricing.

———. (1990). "Meatpacking plant capacity and utilization: Implications for competition and pricing." *Agribusiness: An International Journal* 6, 65–73.

———. (1993). "Comparative analysis of cattle slaughtering and fabricating costs." *Agribusiness: An International Journal* 9, 441–451.

Ward, C. E., T. C. Schroeder, A. P. Barkley, and S. R. Koontz. (1996). "Role of captive supplies in beef packing." Pub. No. GIPSA-RR 96-3, USDA/Grain Inspection, Packers and Stockyards Administration, Washington, DC.