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AN EMPIRICAL ANALYSIS OF THE EFFICIENCY OF FOUR ALTERNATIVE MARKETING METHODS FOR SLAUGHTER CATTLE

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Four alternative marketing methods for slaughter cattle were analyzed and empirically examined for pricing efficiency. Profits per head were found to be significantly different under the various marketing methods. Greater price discrimination occurred as carcass information increased. Increased price discrimination led to greater dispersion of profit from one marketing method to another. Different marketing methods appeared to send different production signals to producers. The desires of the consumer for less fat and a high quality product did not appear to be reaching the producers in the form of profit incentives under the most widely used marketing method.

KEY WORDS: Market Efficiency, Slaughter Cattle, Production Signals, Marketing Method, Price Discrimination.

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AN EMPIRICAL ANALYSIS OF THE EFFICIENCY OF FOUR ALTERNATIVE MARKETING METHODS FOR SLAUGHTER CATTLE

The beef industry faces ever increasing competition for the consumer's dollar. Per capita consumption of chicken and turkey has doubled over the last twenty years and pork consumption has remained relatively stable. Total meat consumption has increased over that time period but not nearly as much as chicken and turkey. The loser, in terms of per capita consumption, has been beef (Murra[1]).

Research at the retail level has shown that consumers generally want a leaner and more consistent cut of beef at a competitive price (Barkema and Drabenstott[2]; Menkhaus et al.[3]; Branson et al.[4]; and Yankelovich, Skelly, and White[5]). Cox, McMullen, and Garrod[6] compared beef consumers' stated preferences regarding fat to their actual purchases. They concluded that the current system of USDA grades and private brand labels is not disseminating internal fat information effectively to consumers.

Perhaps an even more fundamental flaw with the present beef marketing system is that the desires of the consumer are not being adequately relayed to the beef producer. Ward[7] identified ten agricultural marketing efficiency issues and at the top of his list was:

> *"Are the appropriate market signals being generated within the marketing system to achieve the desired (or at least conjectured to be desired) product mix expressed by consumers?"*

Consumers desire less fat, and yet as Smith[8] points out there is currently an average of 88 pounds of excess fat on each steer slaughtered in the U.S.. That adds up to over 2 billion pounds at a cost of about $2 billion annually. The National Cattleman's Association[9] has stated:

"Excess fat production is stimulated in large part by a fundamental flaw in the marketing system for cattle and boxed beef--a flaw that places the same value on trimmable fat as on edible lean."

Producers who are producing a lean, consistent carcass do not receive a price premium and those who produce less desirable carcasses may not be penalized under the most widely used marketing method. In a free market system, profit is the catalyst to change and the present marketing system generally is not sending the price signals from consumers to producers (except in the broad scope of a declining demand) to enable producers (or to force producers) to change.

The objective of this article is to analyze the pricing efficiency of four alternative marketing methods used or proposed in the beef industry. Pricing efficiency will be analyzed with regards to risk and information, quality differentiation, and responsiveness to consumer preferences. Specific objectives are to (1) compare mean profit levels under the four methods; (2) evaluate the degree of price differentiation under each of the four marketing methods; and (3) determine the production factors and/or the carcass quality variables that are rewarded under each method, i.e., understand the production signals being sent to producers.

MARKETING METHODS

The four marketing methods which will be examined are (1) selling slaughter cattle on a live weight basis, where the price is based on the live weight of the animal; (2) selling slaughter cattle on a carcass or dressed weight basis (in the beef), where the price is based on a hot carcass weight obtained in the slaughter house; (3) selling slaughter cattle on a dressed weight and grade basis (grade and yield), where the price is based on the hot

carcass weight and discounts are applied if the carcass does not grade USDA Choice or the USDA yield grade is 4 or greater; and (4) selling slaughter cattle under a value based marketing approach (the Excel Corp. Muscle Scoring System[10]). The Excel Muscle Score (EMS) is a system designed to penalize excess outside fat and reward loin eye area as a percent of body weight. Based off the par price for USDA Choice or Select grades, premiums are paid for animals with less then 0.45 inches of fat cover over the 12th rib and a loin eye area/100 pounds of carcass weight in excess of 1.8 sq. in. Likewise, discounts are applied if the fat cover is in excess of 0.60 inches or the loin eye area/100 pounds of carcass weight is less then 1.7 sq. in.

The marketing method effects the amount of information available about product quality to the buyer. As one moves from marketing method (1) to (2) to (3) to (4), more information is made available and pricing accuracy improves (Purcell[11]; Riethmayer and Dietrich[12]). The amount of information available affects the degree of risk associated with the buyer's pricing decision. The buyer's risk arises from estimating such factors as dressing percentage, quality grade, and yield grade, as well as meat damage from bruising and other factors. As additional information becomes available, the risk associated with marketing the product is shifted from buyer to seller as one moves from marketing on a live weight basis to grade and yield. Ward[13] provides an excellent discussion of the first three marketing methods and provides additional detail into buyer and seller negotiations under each method. Currently Excel Corp. is not using the EMS system to purchase cattle.

Ward[13] found that in 1979, 98 percent of cattle in the southern plains and 82 percent of the cattle in the western corn belt were marketed on a live weight basis. The trend seems to be toward more cattle being marketed "in the beef" or grade and yield, but in 1986 still less then one third of the cattle

were marketed on a grade and yield basis. And in the southern plains there was still less then 10 percent of the cattle being marketed grade and yield (Caughlin, Jr.[14]).

DATA

In October of 1990, 69 groups of 5 steer calves representing 53 different producers were placed on feed as part of the South Dakota State University Retained Ownership Demonstration Project (Wagner et al.[15]). Initial data, such as age, weight, and hip height and average daily gain, days fed, and cost of gain data during the feeding period were recorded for each of the steers (Table I).

The cattle were marketed on a grade and yield basis when 3 steers out of a group of 5 steers were estimated to have sufficient fat cover to grade low choice, or when continuing to feed the group of steers would result in excess fat cover and a yield grade of 4. Opinions of South Dakota State University Beef Cattle Specialists and the commercial feedlot operator were used to determine which groups of cattle were sold on a particular date. The market price and discounts were negotiated with a commercial cattle buyer in a competitive environment.

Detailed carcass data were collected at slaughter and analyzed to determine which carcass traits had the greatest impact on profit under each of the marketing methods. A summary of the carcass data is included in Table II.

METHODOLOGY

Objective one was accomplished by calculating profits for each steer entered into the project and sold grade and yield. Hartman[16] indicated that the steers from the project were very typical of other lots of cattle being marketed at the time. The average live and dressed weight market prices for similar types of steers were obtained from DTN[17] for the appropriate marketing

dates (Table III). Expected profits were then calculated for each steer, had they been sold either on a live weight or dressed weight basis.

To obtain the price for the value based marketing approach proposed by Excel Corp.[10], their suggested premiums and discounts were applied to the choice and select price. Those premiums and discounts for the EMS system are: a $2.00/cwt. premium if fat thickness over the 12th rib is less than 0.45 inches and ribeye area/cwt of carcass weight exceeds 1.8 sq.in.; a $1.00/cwt. discount if fat thickness is between 0.60 and 0.80 inches or if the ribeye area ratio is between 1.4 and 1.7 sq. in.; and a $10.00/cwt. discount if fat thickness is greater than 0.80 inches or if the ribeye area ratio is less than 1.4 sq.in. The average profit, as well as the range and variance, are shown for each marketing method in Table IV.

Market efficiency requires uncertainty about product quality to be compensated. The four marketing methods each contain different levels of information about product quality. The following set of hypotheses addresses this issue. The null hypothesis states: Increased information about product quality has no effect on producers' mean profits. The alternative hypothesis is, increased information about product quality increases producers mean profit levels. To test this hypothesis, the Difference Between Population Means: Matched Pairs (Newbold[18]) test was set up as follows: H_0: $\mu_i - \mu_j = 0$ versus H_1: $\mu_i - \mu_j < 0$, where i and j are the four marketing methods set up in six matched pairs. H_0 is rejected if $\frac{\bar{d}-0}{S_d/\sqrt{n}} < -t_{n-1,\alpha/2}$

where the random variable t_{n-1} follows a Student's t distribution with (n-1) degrees of freedom, $\bar{d}$ is the mean of the paired differences, and S_d is the standard deviation of the paired differences.

The second set of hypotheses addresses the market efficiency issue regarding the effect product quality uncertainty has on buyer price discrimination as reflected in the producers' profit variance. The null hypothesis states: Increased information about product quality has no effect on producers' profit variance. The alternative hypothesis: Increased information about product quality will increase producers' profit variance. The appropriate test is the Test for Equality of Variances of Two Normal Populations (Newbold[18]).

The test hypotheses for increasing variances are:

$H_0: \sigma^2_L = \sigma^2_D$ $\quad$ $H_1: \sigma^2_L < \sigma^2_D$

$H_0: \sigma^2_L = \sigma^2_G$ $\quad$ $H_1: \sigma^2_L < \sigma^2_G$

$H_0: \sigma^2_L = \sigma^2_E$ $\quad$ $H_1: \sigma^2_L < \sigma^2_E$

$H_0: \sigma^2_D = \sigma^2_G$ $\quad$ $H_1: \sigma^2_D < \sigma^2_G$

$H_0: \sigma^2_D = \sigma^2_E$ $\quad$ $H_1: \sigma^2_D < \sigma^2_E$

$H_0: \sigma^2_G = \sigma^2_E$ $\quad$ $H_1: \sigma^2_G < \sigma^2_E$

where L, D, G, and E are live weight, dressed weight, grade and yield, and EMS marketing methods respectively. H_0 is rejected if $S^2_D/S^2_L > F_{nd-1,nl-1,\alpha}$.

The relationship between profit and selected production measures and carcass characteristics under each of the four marketing methods also is of interest in identifying the marketing signals being sent to producers. In analyzing the data different production variables and carcass characteristics appeared to be more significant in explaining profit variation under each different marketing method. Ordinary least squares (OLS) regression was used to identify which variables would best explain the variation in profit under each marketing method. The variable were entered into the regression equation using the forward selection procedure in SAS[19]. By using the forward selection procedure, the coefficient of determination, R^2, is partitioned into

a partial R^2 value which measures the additional amount of variation each variable is explaining in the model.

RESULTS

Differences in Mean Level of Profit

The mean level of profit for the 340 steers marketed under the four marketing methods was previously displayed in Table IV. The SAS Proc Means procedure (SAS[19]) was used to test for statistical difference of these mean rates of profit. Those findings are summarized in Table V.

Profits were estimated to be statistically lower when cattle were marketed on a live weight basis than under any other marketing method. Under this alternative, a buyer must estimate dressing percentage, quality grade, yield grade, and any other defects to the carcass. It appears that the price offered is low enough to protect the buyer from inaccurately estimating one or some of the carcass traits. In essence the seller is paying the risk premium associated with the lack of carcass information. Strong empirical evidence has been provided to support the hypothesis that market efficiency is requiring compensation for increased uncertainty about product quality when cattle are marketed under the live system.

Marketing cattle on a dressed weight basis was the most profitable marketing method. However, the $34.76 per head profit wasn't statistically higher than profits under either the grade and yield or EMS methods.

The fact that profits did not increase significantly when going from marketing under the dressed weight method to grade and yield method does not help dispel the bias that many cattle producers have against marketing on a grade and yield basis. Under the grade and yield method, a price is established for a Choice, Yield Grade 3 carcass within a particular weight range. Discounts are then applied for Select grade, Yield Grades 4 and 5, and

light and heavy carcasses. No premiums are paid for Prime Grade or Yield Grades 1 or 2. There is a risk to producers that a few of their cattle may be discounted (beyond the expected proportion grading Select) and none of their superior cattle will be rewarded.

The mean level of profit under the EMS method was slightly higher than the grade and yield method and significant at the $\alpha=.10$ level. This method rewards superior cattle with premiums, as well as applying discounts to inferior cattle. From a market efficiency point of view this is desirable in that the price is more reflective of the true or perceived value of the carcass.

Range and Variance of Profit

It was hypothesized that as more information became available, there would be greater price discrimination, and hence, greater dispersion in producers' profit. The range in profit under each marketing method did increase from marketing on a live weight basis to the Excel Muscle Score method, Table IV. The variance also increased from the live weight to the dressed weight to the grade and yield method, but didn't change significantly from grade and yield to the EMS method. This would tend to support the hypothesis of greater price discrimination with more product quality information available.

The results of the equality of variance test are displayed in Table VI. The null hypothesis of equal variance is rejected under all comparisons except for the grade and yield compared to the EMS method. This test assumes a normal distribution. The live profit distribution is negatively skewed and fails a test for normality. This may create some bias in the test parameter. The hypotheses test, however, suggest that there is evidence to support the hypothesis that increased information about product quality increases buyers'

price discrimination and increases producers' profit variance. This conclusion suggests the market is operating efficiently; it is adjusting to new product quality information as it becomes available under the different marketing methods

Regression Analysis

The results of the regression procedure appear to confirm the observation made in the previous section, that indeed different variables are more important in explaining profit under the various marketing methods. Or stated differently, alternative marketing methods send different marketing signals to producers. Table VII contains the results of the OLS regression procedure.

The three variables that explain the greatest amount of the variation in profit under the live marketing approach all are production related. The average daily gain of the steers adds the most to the R^2 value, followed by the number of days on feed and total cost of gain which are inversely related to profit. Given these marketing signals and the fact that a majority of cattle are marketed under this method, it is not surprising that beef producers have concentrated on raising heavier, faster growing, and more efficient feed utilizing animals. Nor are the findings of the of the NCA's beef quality assurance task force surprising(Cenex/Land O Lake Ag Service[20]). They found that in 1974 the typical steer had .58 inches of fat thickness on a 679 pound carcass and today the typical steer has .59 inches of fat on a 759 pound carcass. They also found that quality grade had declined somewhat over that time period. The desires of the consumers for leaner beef are not being transmitted to producers through the live marketing method.

Average daily gain followed by dressing percent are the two independent variables that explain most of the variation in profit under the dressed

weight marketing method. The number of days on feed and the total cost of gain also are significant in explaining dressed weight profit variation. Neither the quality of the meat nor the size of the ribeye are significant in explaining profit variation under either the live or dressed weight marketing method.

As one might expect, the USDA quality grade is most important to explaining profit variation under the grade and yield marketing method. Average daily gain, dressing percent and days fed still are important in explaining profit variation. The USDA quality grade and the dressing percent explain 62 percent of the variation in profit under the grade and yield marketing method. Unlike the live or dressed weight marketing methods, the grade and yield marketing method sends more carcass merit marketing signals than feedlot production signals to producers.

With the value based marketing approach proposed by Excel Corp., the USDA quality grade and dressing percent are the two most important variables in explaining profit. Daily gain in the feedlot and days on feed remain significant, but the size of the ribeye per 100 pounds of hot carcass weight now also is significant. The EMS method appears to send the strongest marketing signals to producers regarding carcass merit of any of the marketing methods considered.

In analyzing the results of the regression procedure, it is apparent that different marketing signals are being sent to producers from alternative marketing methods. Further, it would appear that when marketing under the live weight or dressed weight methods, the most common marketing methods, feedlot production factors affect profit more than carcass characteristics. It also is obvious that feedlot production factors are important regardless of the marketing method used, particularly as they affect days on feed in a

declining cattle market. Their importance may be diminished in a stable or increasing market situation.

As part of the regression procedures output, the correlation coefficients between the dependant variables and the independent variables are computed. There are some implications for market efficiency that can be made from these correlation coefficients. Fat, a negative attribute in the consumers' eyes, is positively correlated with profit under all the marketing methods, except for the EMS method. The USDA quality grade is not significantly correlated with profit under either the live weight or dressed weight method. Lastly, dressing percent and ribeye area (an indication of the amount of lean meat on an animal) are negatively correlated with profit under the live weight marketing method.

SUMMARY AND IMPLICATIONS

Over the last two decades consumption of chicken and turkey has increased, while per capita consumption of beef has declined. Consumer concern over fat often is cited as contributing to a declining beef demand. The pricing efficiency of four alternative slaughter cattle marketing methods were examined to (1) test if profits were equal under each method; (2) ascertain the degree of price discrimination by analyzing the range and dispersion of profit under each method; and (3) determine what, if any, production signals are being sent to cattle producers via the marketing channel.

The four different marketing methods were: (1) live weight basis, (2) carcass or dressed weight basis, (3) dressed weight and grade more commonly known as grade and yield, and (4) a value based marketing approach proposed by Excel Corporation, the Excel Muscle Score (EMS) system, designed to penalize excess fat cover and reward ribeye area per 100 pounds of carcass weight.

In 1990-91 340 steers were marketed on a grade and yield basis as part of the South Dakota Retained Ownership Demonstration. Profits were calculated for each of the four marketing methods and variables having the greatest impact on profit were determined. The live weight marketing method was the least profitable marketing method. There was no statistical difference between the profit rate under the other methods, except the Excel Muscle Score method had a slightly higher mean level of profit than the grade and yield method.

The range in profit increased in going from marketing under the live weight to dressed weight to grade and yield to EMS method. It would appear that as more carcass information is available, more price discrimination occurs. The variance of profit was statistically greater under the grade and yield method and the EMS method than under either the live weight or dressed weight marketing methods.

OLS regression procedures were used to identify the feedlot production variables and carcass characteristics that were significantly related to profit under each marketing method. In general, the feedlot production variables were more significant than the carcass characteristics under the live weight and the dressed weight marketing methods. While feedlot production variables still were important under the grade and yield and EMS methods, several carcass characteristics, such as, USDA quality grade, and dressing percent also were highly significant. The amount of outside fat cover was positively related to profit under all of the marketing methods except the EMS method.

Implications

Several implications can be drawn from this research concerning the efficiency of various slaughter cattle marketing methods. There is a

considerable amount of risk involved in estimating various carcass characteristics and either the buyer or seller generally will pay a risk premium associated with this imperfect, asymmetric information. Further, due to the lack of carcass information under either the live or dressed weight marketing method, little price discrimination occurs. The price is based on estimated averages and inferior grading animals receive the same price has superior grading animals.

Only when steers are sold on a grade and yield basis or a value based marketing approach do the carcass characteristics appear to become as important to profit as the feedlot production variables. The amount of trimmable outside fat, unwanted by the consumer, is positively related to profit under all of the marketing methods except for the value based approach proposed by Excel Corp.

Since the majority of slaughter cattle are marketed under either a live or dressed weight method, the market is not effectively communicating the desires of the consumer to the producer. Even under the current USDA quality and yield grade standards, fat still is not penalized sufficiently to cause producers to alter their production practices. It appears some changes are needed in the premiums and discounts associated with various USDA quality and yield grades or a value based marketing approach is required in order for the desires of the consumer to be translated to the producer in the form of profit incentives to produce superior grading, leaner cattle.

Additional research is needed to analyze the risk premium associated with the lack of carcass information under some of the marketing methods. While the markets may be efficient from an expected value - variance analysis, there appears to be some structural inefficiencies in the manner price signals are sent from consumers to producers.

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Table I. Initial Data and Feedlot Performance Data For the 345 Steers in the South Dakota Retained Ownership Demonstration.

Variable	Units	Average	Std. Dev.	Maximum	Minimum
Initial Height	Inches	44.55	1.81	50.00	40.00
Initial Backfat[a/]	Inches	0.10	0.04	0.20	0.02
Initial Weight	Pounds	555	73.96	790	375
Initial Age	Days	204	19.52	267	158
Days on Feed	Days	200	19.55	242	170
Average Daily Gain	Pounds	2.89	0.35	4.16	1.90
Feed Cost of Gain	$/cwt	40.68	3.08	55.06	33.43
Total Cost of Gain	$/cwt	52.42	3.77	70.80	41.77

[a/] Determined with an ultra-sound instrument.

Table II. Slaughter Data for the 340 Steers Marketed in the South Dakota Retained Ownership Demonstration.

Variable	Units	Average	Std. Dev	Maximum	Minimum
Live Slaughter Weight	Pounds	1133	101.56	1406	864
Hot Carcass Weight	Pounds	726	70.15	936	531
Dressing Percent	Percent	64.07	1.83	70.43	57.39
USDA Choice Grade[a/]	Percent	48	27	100	0
USDA Yield Grade	Grade	2.27	0.68	4.00	1.00
Outside Fat (12th rib)	Inches	0.43	0.15	0.90	0.10
Ribeye Area	Sq. In.	12.78	1.53	17.90	8.90
Marbling[b/]	Units	4.83	0.64	8.00	3.50
Ribeye Area/100 Lbs. Carcass Weight	Ratio	1.76	0.17	2.38	1.36

[a/] Percentage choice for each group of 5 steers.

[b/] 3.0 = Traces; 4.0 = Slight; 5.0 = Small; 6.0 = Modest; 7.0 = Moderate; and 8.0 = Slightly Abundant.

Table III. The Market Prices (Dollars per cwt.) For The Various Marketing Methods

Marketing Date	Live Weight	Dressed Weight	Grade and Yield	
			Choice	Select
April 10	80.00	127.50	130.00	125.00
May 2	78.75	125.5	129.00	122.00
May 8	78.00	124.00	128.00	120.00
May 9	78.00	124.00	128.00	120.00
June 20	72.00	115.00	119.00	111.00

Table IV. The Mean Profit ($/head) and the Dispersion About the Mean Under Each of the Four Marketing Methods.

Marketing Method	N	Mean	Variance	Maximum	Minimum
Live Weight	340	$16.88	1369.36	$140.10	-$83.24
Dressed Weight	340	34.76	1714.27	130.97	-111.00
Grade and Yield	340	32.91	2994.66	163.73	-139.92
Excel Muscle Score	340	34.17	2868.88	163.10	-147.15

Table V. The Statistical Difference of Mean Level of Profit ($/head) Under the Four Marketing Methods.

Marketing Methods	Mean Difference	Standard Error	T	Level of Significance[a/]
Live - Dressed	-17.88	1.439	-12.419	0.01
Live - Grade	-16.03	2.199	-7.288	0.01
Live - EMS	-17.29	2.206	-7.837	0.01
Dressed - Grade	1.85	1.546	1.195	N.S.
Dressed - EMS	0.59	1.549	0.381	N.S.
Grade - EMS	-1.26	0.795	-1.580	0.10

[a/] One Tailed Level of Significance.

Table VI. Summary of Null Hypothesis Test of Equal Variance Versus the Alternative of Increasing Variance Among Marketing Methods.

Marketing Method	Variances	$F_{339,339}$	Significance
Live < Dressed	1714.27/1369.36	1.25	0.05
Live < Grade & Yield	2994.66/1369.36	2.19	0.01
Live < EMS	2868.88/1369.36	2.09	0.01
Dressed < Grade & Yield	2994.66/1714.27	1.75	0.01
Dressed < EMS	2868.88/1714.27	1.67	0.01
Grade & Yield < EMS	2868.88/2994.66	0.96	Not Significant

Table VII. Results of OLS Regression Analysis Indicating the Variables That Are Most Significant in Explaining the Variation on Profit.

Profit Live Weight Method
R^2=0.92 F=1360.87

Variable	Parameter	Std. Error	Partial R^2
Intercept	112.16	14.612	
Average Daily Gain	63.77	1.931	0.704
Days Fed	-0.86	0.030	0.187
Total Cost of Gain	-2.06	0.171	0.033

Profit Dressed Weight Method
R^2=0.93 F=1194.95

Variable	Parameter	Std. Error	Partial R^2
Intercept	-839.14	23.705	
Average Daily Gain	69.45	2.008	0.448
Dressing Percent	14.52	0.339	0.333
Days Fed	-0.82	0.031	0.136
Total Cost of Gain	-1.76	0.188	0.017

Profit Grade and Yield Method
R^2=0.92 F=1026.97

Variable	Parameter	Standard Error	Partial R^2
Intercept	-952.45	32.943	
USDA Quality Grade	56.01	1.700	0.417
Average Daily Gain	76.78	2.608	0.225
Dressing Percent	14.03	0.456	0.207
Days Fed	-0.81	0.044	0.075

Profit Excel Muscle Score Method
R^2=0.92 F=763.82

Variable	Parameter	Standard Error	Partial R^2
Intercept	-1018.19	33.937	
USDA Quality Grade	57.30	1.754	0.394
Dressing Percent	13.25	0.466	0.215
Average Daily Gain	80.78	2.730	0.207
Days Fed	-0.84	0.045	0.071
Ribeye / 100 lbs HCW	62.91	5.362	0.033

Note: All of the parameter estimates are significant at the α=.01 level.