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Risk and Market Participant Behavior
in the U.S. Slaughter Cattle Market

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Economics staff Paper 94-4

April, 1994

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Incomplete and varying degrees of information on product quality creates risk

in a market transaction. Numerous researchers have documented that market

participants will react differently in the presence of risk depending upon their attitudes

toward risk. Many of these studies have classified agricultural market participants

according to the Arrow-Pratt risk aversion coefficient into three general categories of

risk averse, risk neutral, or risk preferring (Raskin and Cochran, Wilson and Eidman,

King and Robinson) and have found individuals in all three categories.

The U.S. slaughter cattle market is currently operating in an environment

where the amount of information available on product quality varies depending upon

the marketing method used. There are presently three main cash marketing methods

available to producers in the US: (1) live weight; (2) dressed weight (in-the-beef);

and (3) dressed weight and grade (grade and yield). The information differential

generates uncertainty (risk). It follows that the degree of risk associated with each of

these marketing methods varies with the amount of information available on product

quality.

In a recent paper by Feuz, Fausti, and Wagner it was reported that producers'

profits differed between the live, in-the-beef, and grade and yield marketing methods

for slaughter cattle. They indicated that profits on average were highest with grade

and yield marketing and lowest with live weight marketing. They also found that the

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variance in producer profits (risk) were greatest for grade and yield and smallest for live weight marketing.

The objectives of this research are to determine: 1) what effect the risk associated with incomplete information across marketing methods is having on the market price for slaughter cattle; and 2) what effect product quality uncertainty is having on buyer and seller behavior. The accomplishment of these objectives should provide additional insight into the U.S. slaughter cattle market and be particularly valuable to those looking to modify the existing marketing methods or create new value based marketing methods.

Theory

If the U.S. slaughter cattle market is efficient and there is full information across all marketing methods, then one would expect the distribution of revenue received by sellers should be equal across all marketing methods. However, the structure of the market is such that there is not full information nor equal degrees of incomplete information across the marketing methods. We contend that the information structure of the slaughter cattle market accounts for some of the profit differentials reported by Feuz, Fausti, and Wagner.

From the buyer's (meatpacker's) perspective, the grade and yield marketing method is the full information method. The price paid to the seller is based on the actual carcass weight and the USDA Quality and Yield Grades of that carcass. If cattle are marketed in-the-beef, the carcass weight is known with certainty, but buyers must estimate the expected quality and yield grades. There is a risk of incorrectly

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estimating the quality and yield grades and offering a price that is not in line with the actual quality of the cattle. When cattle are marketed on a live weight basis, the buyer must estimate the dressing percent (dressing percent = carcass weight/live weight) and the quality and yield grades. There is not only the risk of incorrectly estimating the quality of the cattle, but also of paying for more or less carcass weight than actually exists. Ward provides a more detailed description of the three marketing methods and the information available with each method.

Ward argued that a buyer's risk increased going from grade and yield to in-the-beef to live weight pricing and that buyers offset that risk by offering a lower price in the live and in-the-beef markets. Ward's argument is consistent with the results derived in the factor market literature when quality uncertainty is the issue. For a discussion of the literature see J.D. Hey. An empirical example of this phenomenon is documented in the labor market literature, where a wage differential exists among workers in a specific job classification. The differential is called statistical discrimination and is attributed to different degrees of risk associated with different population sub-groups (Baldwin; Aigner and Cain). We agree with Ward's argument and shall provide evidence that buyers are essentially charging sellers a risk premium in the live and dressed weight markets. Furthermore, it is hypothesized that the live market has the greater risk premium.

While the risk to the buyer increases going from grade and yield to in-the-beef to live weight marketing, Caughlin correctly points out that the risk to the seller decreases. With live weight marketing, the seller knows with certainty at the time of

sale the total revenue from any pen of cattle. However, with dressed weight or grade and yield marketing, the price is known at the time of sale but the dressing percent or carcass weight is not known for dressed weight marketing, and carcass weight, quality and yield grades are not known for grade and yield marketing.

Thus, sellers' revenue per head under each marketing method is defined as :

$$\text{(1)} \qquad Live\ Revenue\ =\ Live\ Price * Live\ Weight,$$

$$\text{(2)} \quad E(Dressed\ Revenue)\ =\ Dressed\ Price * Live\ Weight * E(Dressing\ Percent),$$

$$E(GY\ Revenue)\ =\ E(GY\ Price = f(Quality, Yield)) * Live\ Weight * E(Dressing\ Percent),$$
$$\text{(3)}$$

where E is the expectations operator, and GY is the grade and yield marketing method. The risk to sellers is that the actual revenue from in-the-beef or grade and yield marketing is not equal to the expected revenue because the carcass weight and/or the quality and yield grades of the cattle were different then expected.

In analyzing the structure of the U.S. slaughter cattle market, Ward found that in 1979, 98 percent of the cattle in the Southern Plains and 82 percent of the cattle in the western corn belt were marketed on a live weight basis. Dressed weight pricing accounted for an additional one percent and 18 percent of the sales in the two regions, respectively. Caughlin reported that in 1986 grade and yield sales accounted for about half of the sales in the western corn belt while grade and yield sales were still less than ten percent of the sales in the Southern Plains.

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Since sellers choose the marketing method, and since there are cattle being marketed under all three marketing methods, if risk premiums vary between market marketing methods, then there must be a difference in the risk preferences of sellers. This is consistent with Pratt's definition of absolute risk aversion, with respect to the relationship between the size and sign of a risk premium and the agent's preference toward risk:

$$(4) \qquad E(\Pi_{uu}) \underset{<}{\overset{>}{-}} \Pi_c \qquad \text{for} \quad U'' \underset{>}{\overset{<}{-}} 0.$$

If sellers had asymmetric information concerning cattle quality, there also could be advantages to marketing the cattle under a particular method. This could have the impact of creating a "lemons" market in the live weight market, the market with the least amount of information. Akerlof provides a detailed description of the effect uncertainty and asymmetric information have on markets. For this research, it will be assumed that information is symmetric and that differences in marketing method chosen can be attributable to differences in risk preference.

Data and Methodology

Data

Detailed data were collected on 69 pens of steer calves in 1991 and 84 pens of steer calves in 1992 as part of a retained ownership demonstration project (Wagner et al. 1991 and 1992). These steers were marketed on a grade and yield basis in the spring of the year when three out of the five steers were estimated to be at 0.4 inches of fat over the 12th rib. The Choice market price and discounts for Select carcasses,

Yield grade 4 carcasses ($10-12/cwt), carcasses over 950 pounds ($10/cwt), or carcasses under 550 pounds ($12/cwt) were negotiated with a commercial cattle buyer in a competitive market. The average live and dressed weight market prices for similar types of steers were obtained from market quotes[1] and revenue per head was calculated as if the steers had been sold under all three marketing methods. Market prices for the various marketing dates and marketing methods and average revenue under each marketing method are shown in Table 1.

The data are most representative of the upper midwest/western corn belt region of the U.S. The data also are limited to the March through June marketing time frame. The results generated are thought to be representative of this marketing area and time frame. However, additional research is needed to determine if similar results would occur in other marketing areas and time frames.

Risk and Behavior

To test the assumption that buyers of cattle offset the risk associated with lack of information on dressing percent and cattle quality by offering lowering prices in the live and dressed weight markets, the following two testable hypotheses are set forth: (1) there will be a significant risk premium charged to the seller in both the live weight and dressed weight marketing methods; and (2) the risk premium will be greater with live weight than dressed weight marketing. The expected value of the risk premiums for live and dressed weight marketing methods are defined as follows:

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$$(5) \qquad LRP = \frac{\sum_{i=1}^{n} GYREV_i - LREV_i}{n}$$

$$(6) \qquad DRP = \frac{\sum_{i=1}^{n} GYREV_i - DREV_i}{n}$$

where LRP and DRP are the live weight and dressed weight risk premiums, respectively; $LREV_i$, $DREV_i$, and $GYREV_i$ is the average revenue per head associated with a pen of cattle marketed under the live weight, dressed weight, and grade and yield marketing methods; and n is the number of pens of cattle marketed.

The live weight risk premium can be separated into the risk premium associated with dressing percent uncertainty and the risk premium associated with quality and yield grade uncertainty by subtracting Equation 5 from Equation 6, or by calculating the dressed to live weight risk premium as follows:

$$(7) \qquad LDRP = \frac{\sum_{i=1}^{n} DREV_i - LREV_i}{n}.$$

The specific testable hypotheses are then:

H_0: LRP = 0 $\qquad$ H_1: LRP > 0

H_0: DRP = 0 $\qquad$ H_1: DRP > 0

H_0: LRP = DRP $\qquad$ H_1: LRP > DRP.

They will be tested using the Difference between Population Means: Matched Pair test (Newbold).

From the theoretical discussion, it was hypothesized that risk to the buyer decreased and the risk to the seller increased going from live to dressed to grade and yield marketing. The risk is due to uncertainty of the dressing percent and of the quality and yield grades. An approximation of this risk can be measured by calculating the variance of the paired revenue differences used to calculate the risk premiums in Equations 5-7 as follows:

$$
(8) \quad Var(LRP) = \frac{\sum_{i=1}^{n} (GYREV_i - LREV_i)^2 - \frac{\left(\sum_{i=1}^{n} GYREV_i - LREV_i\right)^2}{n}}{n-1},
$$

$$
(9) \quad Var(DRP) = \frac{\sum_{i=1}^{n} (GYREV_i - DREV_i)^2 - \frac{\left(\sum_{i=1}^{n} GYREV_i - DREV_i\right)^2}{n}}{n-1}.
$$

$$
(10) \quad Var(LDRP) = \frac{\sum_{i=1}^{n} (DREV_i - LREV_i)^2 - \frac{\left(\sum_{i=1}^{n} DREV_i - LREV_i\right)^2}{n}}{n-1},
$$

The variance from Equation 8 is due to the variability in dressing percent, quality grade and yield grade, compare Equations 1 and 3. The variance in Equation 9 is associated with the variability of quality and yield grades, compare Equations 2

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and 3, and Equation 10 is associated with the variability in dressing percent, compare Equations 1 and 2.

Pratt has shown that the insurance (risk) premium is equal to one-half the variance of the risk times the absolute risk aversion coefficient:

(11) $$RP = (Var(Risk)*r)/2.$$

where r is the absolute risk aversion coefficient.

Rearranging Equation 11, as follows:

(12) $$r = 2RP/Var(risk),$$

provides for the estimation of the absolute risk aversion coefficient. Using the risk premiums calculated from Equations 5-7 and the variance of the risk from Equations 8-10, the absolute risk aversion coefficient can be derived for buyers. Those equations are as follows:

(13) $$r_{lg} = 2LRP/Var(LRP),$$

(14) $$r_{dg} = 2DRP/Var(DRP).$$

(15) $$r_{ld} = 2LDRP/Var(LDRP),$$

Results

Risk Premium Results

The average risk premiums were calculated using Equations 5-7 and the above mentioned data. The average risk premiums were then used to conduct hypothesis

tests to determine if the average risk premiums were statistically different from zero. Evidence from the tests provide strong support for non-zero risk premiums in all three cases. The results are displayed in Table 2.

The tests found: 1) a statistically significant risk premium of $6.22 per head being charged, on average, by buyers when purchasing cattle in the live weight market instead of the grade and yield alternative; 2) the risk premium buyers charged for purchasing in the dressed weight market instead of the grade and yield alternative was $2.55 per head; and 3) the risk premium buyers charged for purchasing in the live market instead of the dressed weight alternative was $3.67 per head. Based on these risk premiums, it appears that buyers perceive a greater risk in estimating dressing percent than in estimating quality and yield grades. For example, the average dressed price during the study was $122.13 per cwt and estimating a 64% dressing percent when actual dressing percent is 62% would mean an overpayment of $29.31 per head for a 1200 pound steer. And estimating a pen of steers to grade 50% choice when only 40% actually graded choice would have been an overpayment of only $3.84 per head, based on a 750 pound carcass weight and the actual choice and select prices observed during the study.

To summarize, the following statements are supported by the evidence provided by the hypothesis tests: 1) buyers of cattle charge a risk premium in the live and dressed weight markets; and 2) the risk premium increases as the risk increases.

Calculated Risk Aversion Coefficients

The results of estimating the Pratt-Arrow risk aversion coefficients using Equations 13-15 are presented in Table 2. All of the calculated risk aversion coefficients are positive and equal, indicating that buyer risk averse behavior does not change across marketing methods. This is the result one would expect to find. Risk aversion coefficients should not change as the level of risk changes. Increased risk should only the effect the risk premium charged.

Risk to Sellers

Revenue to sellers is know with certainty in the live market at the time the cash market transaction takes place for an individual pen of cattle, Equation 1. However, our results show that on average sellers can expect a higher revenue in both the dressed weight and grade and yield market. And yet, as both Ward and Caughlin have noted, many sellers still use the live weight market. This behavior, on the part of sellers, is a departure from the theory of individual profit maximization. However, risk aversion and utility maximization rather than profit maximization can rationally explain seller behavior.

If sellers are not risk neutral, then both the expected value of the return and the degree of risk associated with that level of return are important considerations to the marketing decision. The mean, standard deviation, and coefficient of variation of revenue for each marketing method are displayed in Table 1. The returns do increase going from live to dressed to grade and yield marketing, but the risk also increases.[2] Not only do the standard deviations increase, but the level of risk proportional to the

mean also increases, as measured by the coefficients of variation of 0.072, 0.082, and 0.084 for the live, dressed, and grade and yield marketing methods, respectively.

A number of empirical studies can be found in the agricultural literature on estimated risk aversion coefficients. For example: 1) Raskin and Cochran; 2)Elam; and 3) Holt and Brandt, have all estimated the risk aversion coefficients for producers in the agricultural sector. Elam estimated risk aversion coefficients for leveraged cattle feeders choosing to forward contract versus hedge their slaughter steers and reported risk aversion coefficients of 0.02 to 0.04. Holt and Brandt estimated the risk aversion coefficient for various hog hedging strategies and reported decision makers as "risk averse" with risk aversion coefficients of 0.02 - 0.04 and those with risk aversion coefficients of 0.08 - 0.10 were classified as "highly risk averse.

Raskin and Cochran raised the issue of classifying decision makers based on the value of the Pratt-Arrow risk aversion coefficient and how the magnitude of the underlying distribution can effect this classification. However, the magnitude of the underlying distributions from this study is similar to the two studies by Elam and by Holt and Brandt, allowing for some comparisons of the estimated risk aversion coefficients. It would appear that cattle feeders are "risk averse" on average.

The implications of the above studies for our results are that risk aversion levels vary among cattle producers and the risk preference of the seller is driving the seller's marketing decision. Those sellers who have the least aversion to risk market their cattle grade and yield. Those producers who have the greatest level of risk aversion market their cattle on a live weight basis. Given the estimated risk aversion

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coefficients from the studies above and our estimate of the packer's risk aversion coefficient; varying degrees of risk aversion provide a reasonable explanation for the percentage break down of cattle marketed in each method reported by Caughlin and Ward.

Conclusions

This paper presents an analysis of the risk associated with lack of full information over alternative slaughter cattle cash marketing methods. Of particular interest, was buyer and seller behavior in the presence of that risk. Data from the upper midwest/western cornbelt region of the U.S. were used to test the hypothesis that buyers would charge a risk premium in the live and dressed weight marketing methods. The risk to buyers purchasing under live, dressed, or grade and yield pricing was approximated and the level of risk aversion of buyers was estimated.

Statistically significant risk premiums were found to be charged by packers when buying slaughter steers on either a live or dressed weight basis compared to buying on a grade and yield basis. The risk premium for live marketing averaged $6.22 per head and the risk premium for dressed marketing was $2.55 per head. There is more risk in correctly estimating the carcass characteristics on a live basis, and this is reflected in the premium. The results substantiated our hypothesis that cattle buyers would charge a risk premium in the live and dressed weight markets.

Specific Pratt-Arrow risk aversion coefficients were calculated for buyers based on the risk premiums charged and variance of the risk for each marketing method. These risk aversion coefficient were all equal at 0.02. The level of risk did

not change the level of risk aversion, it only affected the magnitude of the risk premium being charged. This result is consistent with the literature on uncertainty.

The risk to sellers increases going from the live to dressed to grade and yield marketing. Grade and yield marketing results in the highest expected revenue and live weight marketing results in the lowest average revenue of the marketing methods. If sellers were identical in their attitudes towards risk, then cattle would only be sold via one of the marketing methods. However, since there are cattle sold under all three marketing methods, we conclude that varying attitudes (risk aversion coefficients) among producers explains the use of all three slaughter cattle marketing methods.

This paper provides strong empirical evidence that product quality uncertainty affects the pricing and marketing decisions of participants in the slaughter cattle market. We conclude that buyers do charge a risk premium in the live and dressed markets; that buyers are risk averse; and, that varying levels of risk aversion among sellers accounts for the use of all three slaughter cattle marketing methods.

Footnotes

1.Hartman indicated the cattle from the project were representative of the cattle being purchased in the general market area. The Nebraska Direct Dressed and Live weight market prices were obtained from Data Transmission Network and the USDA, Livestock and Wool Statistics, and were then adjusted down for the local basis by $1/cwt and $0.64/cwt for dressed and live weight, respectively.

2.The variation in revenue is based on variations in weight, dressing percent, quality grade and yield grade of the cattle in our data set. Actual variations in market returns would also include variations in prices offered. This is a limitation of our data set. While not empirically tested in this paper, we hypothesize that the variations in market returns would increase from live to dressed to grade and yield marketing.

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Table 1.   Market Prices ($/cwt) for Various Marketing Dates and

Alternative Marketing Methods and Expected Revenue Under each

Marketing Method.

| Marketing Date | Live | Dressed | Grade & Yield | |
			Choice	Select
Year 1, 1991				
April 10	80.96	127.00	130.00	125.00
May 2	79.57	125.50	129.00	122.00
May 8 & 9	78.81	124.00	128.00	120.00
June 20	73.59	115.00	119.00	111.00
Year 2, 1992				
March 31	77.97	124.00	125.00	123.00
April 14	78.40	123.00	126.00	124.00
April 23	76.44	120.00	122.00	119.00
May 19	75.97	118.50	125.00	119.00
Revenue				
Mean	873.24	876.91	879.46	
Standard Deviation	62.94	71.59	74.08	
Coefficient of Variation	0.072	0.082	0.084	

Table 2.   Risk Premiums, Variances of Revenue Differences, and Arrow-Pratt

Absolute Risk Aversion Coefficients Associated with Alternative

Marketing Methods.

Marketing Method Comparison	Risk Premium	Variance	Risk Aversion Coefficient
Live vs Grade & Yield	$6.22**	586.35	0.02
Dressed vs Grade & Yield	2.55*	206.75	0.02
Live vs Dressed	3.67*	340.37	0.02

One asterisk and two asterisks denote premiums are significantly different than zero at

the .05 and .01 level, respectively.