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Factor Price Disparity and Retained Ownership of Feeder Cattle: An Application of Feedlot and Carcass Performance Data to Farm-Level Decision Making

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In this study, we used farm-level data from a university feed-out program to evaluate how the value of feeder cattle ultimately realized through finishing and grid pricing differs from their market value at public auction. Consistent with the theory of factor price disparity, results indicate that significant risk premiums exist in the feeder cattle market. Producers of cattle with known feedlot performance, carcass potential, or both might be better off retaining ownership of their calves or marketing them in a way that communicates the information that is known about their potential performance directly to the buyer.

Key Words: factor price disparity, feeder cattle, grid pricing

JEL Classifications: Q11, Q12, Q13

Value-based marketing of fed cattle (or grid pricing) is a system in which price is determined for an individual carcass on the basis of its quality grade, yield grade, and other relevant carcass merits. It represents an alternative to the traditional system of pricing cattle on an average basis (i.e., in which all cattle in a given sale lot receive the same price per unit). The development of value-based marketing systems became the focus of much industry attention in the early 1990s. In the late 1980s, a Value-Based Marketing Task Force was assembled under the auspices of the Beef Industry Council (Savell and Cross). The Task Force issued a report in 1990 outlining a number of consensus points representing key industry objectives and priority areas for research (National Cattlemen's Association). One of these consensus points was that the industry should move toward valuing cattle on an individual carcass basis as opposed to the predominant average live price basis.

One of the perceived problems in the beef industry noted by the Task Force was a lack of clear economic signals between different levels of the supply chain (Cross and Savell). Value-based marketing was seen as a way of remedying this situation. Subsequent to the release of the Task Force report, value-based marketing (and related topics) became the focus of a great deal of industry and university research. Over the last 15 years, considerable literature on grid pricing has developed. Many of these studies compare fed cattle value under grid pricing to value under average pricing on

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either a live or dressed basis (e.g., Anderson and Zeuli; Feuz; Feuz, Fausti, and Wagner, 1993; Schroeder and Graff). Much of the current literature on grid pricing addresses pricing efficiency at the fed cattle market level, exploring how price signals under grid pricing differ from those under average pricing and investigating the implications of this for fed cattle producers. Little work has been done in exploring the implication of grid pricing on producers at other levels of the supply chain.

The objective of this paper is to evaluate differences in price signals between grid pricing and average pricing upstream from the fed cattle market—specifically, at the level of the feeder calf producer. Specific objectives are twofold. First, using farm-level data from a university feed-out program, we will compare the market value of feeder cattle to their expected value as an input into a finishing/grid pricing program. This comparison will demonstrate how feed-out program data can be used by participating producers in evaluating future retained ownership decisions. Second, this research will illustrate the magnitude of farm-level differences in both the level and variability of grid pricing returns. Such differences highlight the usefulness of having farm-specific information for use in evaluating marketing alternatives.

This research represents a unique contribution to the literature in a couple of respects. First, little work has been done on how grid pricing affects market signals upstream from the fed cattle market. In doing this, this research provides not only a useful addition to pricing efficiency literature but also generates insights that could be useful to producers making retained ownership decisions. Second, the use of individual farm-level data to define grid pricing return distributions is somewhat novel. Results obtained from this approach provide an important caveat to the generalization of results of previous grid pricing studies. Finally, this research demonstrates the usefulness of university feed-out program data to marketing decision making. Over the past 15 years, many universities have developed feed-out programs to provide producers with information on the feedlot and carcass performance of their cattle. These data have been used extensively to address production management issues; however, the application of these data to farm-level marketing decisions is rather unique.

Review of Current Literature

The effect of both price and production risk on both production and marketing decisions of cow/calf producers has been fairly widely studied in the literature. Rodriguez and Taylor use stochastic dynamic programming to compare the certainty equivalents of alternative stocking densities and marketing plans for Colorado stocker cattle. Similarly, Lambert used a stochastic linear programming model to investigate optimal rates of gain for calves backgrounded on harvested feed and to determine optimal timing of sales for backgrounded calves. Although both of these studies explore the effect of price, production risk, or both on the retained ownership decision, neither considers any production phase beyond the backgrounding of feeder calves.

Gebremeskel and Shumway develop a linear programming model to estimate expected value–mean absolute deviation efficient farm plans covering forage system, herd size, calving season, and feeder calf marketing plan. Their model includes the sale of finished calves as one marketing alternative. Whitson, Barry, and Lacewell also quantify the risk associated with retained ownership, comparing the level and variability of returns from a number of alternative marketing strategies, including the sale of finished cattle.

Although all of these studies address, in some fashion, the effect of risk on optimal feeder cattle marketing decisions, all predate the common use of formal grid pricing arrangements. Therefore, even studies considering the option of finishing cattle do not incorporate production risks associated with carcass performance, nor do they incorporate price risks under grid pricing. Moreover, the issue of pricing efficiency, in either fed cattle or feeder cattle markets, is well beyond the scope of any of these studies, although the inability of the traditional live-weight marketing system to effectively transmit market signals along the supply chain has been discussed elsewhere in the literature (Fausti, Feuz, and Wagner).

The effort to establish a pricing system for fed cattle that is more consistent with consumer preferences has led to the evolution of value-based pricing methods for fed cattle. Schroeder et al. performed a survey of cattle feeders to evaluate the past, current, and predicted future marketing methods for fed cattle. They found that grid sales accounted for 15.6% of total marketing in 1996, and their survey results suggested that grid sales would account for around 60% of total marketing by 2006. Actual data on grid sales indicate that such sales remain considerably lower than this estimate.[1] Still, the availability of alternative pricing methods represents a fundamental shift in valuation procedures for fed cattle, potentially affecting all levels of the beef industry.

From an individual producer's perspective, differences between marketing methods for fed cattle should be understood and evaluated not only to permit an informed decision regarding the sale of finished animals but also to evaluate the effect of evolving fed cattle pricing arrangements on the value of feeder cattle. A considerable literature has developed over the past decade investigating grid pricing systems. The differences between grid and live-weight pricing structures can be discussed in three main areas: economic return per animal, variability of income, and risk level for buyer and seller.

Economic Return on the Basis of Marketing Method

Different factors influence the final price received for (as well as the profitability of) animals priced in either live-weight or grid pricing systems. Feuz, Fausti, and Wagner (1993) determined that average daily gain is the most important factor explaining profit deviations for cattle sold on a live-weight basis, whereas quality grade has the greatest influence on profit variability for cattle marketed on a grade and yield basis.

Several authors compare the potential effect on economic returns of marketing animals on a live-weight basis versus individual grid sales. Feuz, Fausti, and Wagner (1993) examine price distributions of 340 steers marketed on a live, dressed, or grade and yield basis. In their simulation, profits from selling cattle on a live basis were statistically lower than profits from the other pricing methods.

Schroeder and Graff contrast grid prices received for a group of over 11,000 head of cattle to live- and dressed-weight prices from the region over the same period of time in 1997. Their analysis reveals an average live-equivalent value that is about $1.30/cwt higher than the live-weight price. They also simulate the ability to sort cattle to the marketing channel with the highest return on the basis of the individual animal's carcass traits, concluding that an optimal sort would have increased income by $35 per head compared with selling all cattle on a live-weight basis.

Anderson and Zeuli simulate carcass data grouped into sale lots with various levels of expected quality (45%–95% Choice) within the pens and model grid pricing compared with live-weight pricing over a period of historical market data from October 1996 to May 2001. Their results reveal that regardless of pen quality levels examined, grid pricing generated greater revenue per head compared with live pricing. They further show, however, that this

[1] It is rather difficult to get a precise handle on the extent of grid pricing with the use of public data. USDA Agricultural Marketing Service (AMS) reports negotiated grid sales, cash sales, forward contract sales, formula sales, and packer-owned cattle (USDA-AMS 2005a,b,c). For the month of July 2005, negotiated grid sales amounted to about 18% of total direct marketing. However, many (if not most) formula pricing arrangements include adjustments to a base price to reflect carcass characteristics and are thus essentially value-based marketing arrangements. If all formula sales are counted as grid sales, then for July 2005, grid sales account for 47.5% of total direct marketing. Note that these data do not include any fed cattle purchased at auction (obviously not on a grid basis). Considering all these facts, it is reasonable to assume that the level of grid sales for July 2005 was somewhere between about 18% and about 45% of total fed cattle marketing.

result depends on the time period chosen for comparison.

The literature clearly shows that the same set of cattle could receive a different price (in both dollars per hundred weight and total pen gross revenue) when marketed via live or grid pricing. The magnitude of the difference will be influenced by the specific traits of the cattle and the exact specifications of the grid used to price the animals. Evaluation of predicted differences in gross revenue for the sale group is critical when selecting a marketing method.

Income Variability

With respect to income variability, Schroeder and Graff (p. 100) find that 50% of the cattle in their data received a price within a $2/cwt range when sold on a live-weight basis. In contrast, when sold on a grid, just over 50% of the cattle received a price within a $6/cwt range. They conclude that

> "Choice-to-Select boxed beef wholesale cut out price spread had the greatest effect on variability of price per hundredweight for carcasses sold on a grid followed by the variability in quality grade of carcasses in the pen."

As noted, grid prices reflect the carcass traits of individual animals. Individual animals, even within the same pen, can vary significantly in traits affecting grid price (e.g., quality grade or yield grade). Assigning value to individual carcasses increases pricing accuracy, thereby resulting in greater price variability per pen (Ward et al.). An advantage of the increased price variability observed in the grid pricing system is that more accurate price signals are transferred to producers. A disadvantage, however, is the greater price risk faced by the fed cattle producer.

Risk Effect of Pricing in Different Methods

Two major types of risk are associated with buying and selling fed cattle: a general price risk inherent in a competitive market and informational risk (Fausti and Feuz). Price risk is inherent in either live or grid pricing systems, and this risk is shared to some degree by both buyer and seller. Mintert notes that cattle feeders face high levels of variability in economic returns that are greatly influenced by variability in fed cattle sales prices.

The pricing system for cattle at harvest dictates which party (buyer or seller) incurs the informational risk (i.e., the risk that the cattle will not grade or yield as expected) inherent in the transaction. When cattle are sold on a live-weight basis, the seller incurs very little informational risk. The final weight of the cattle (the main determination of gross revenue for the pen) can be fairly accurately determined before sale, and carcass characteristics such as quality grade and yield grade are not explicitly considered. In this type of pricing system, the buyer incurs all losses associated with poor carcass performance but could also realize higher than expected returns because of above-average–quality cattle. On the other hand, when cattle are sold on a grid, carcass characteristics are known when the sale price is determined. Because, the buyer will not overpay for lower quality cattle, the risk of lower than expected quality is shifted to the seller.

Several authors (Fausti and Feuz; Fausti, Feuz, and Wagner; Ward et al.) have suggested that informational differences between marketing alternatives generate uncertainty that affects behavior of market participants. Specifically, buyers could offer lower prices when purchasing pens of cattle on a live-weight basis as a form of risk aversion. In effect, the buyer charges the seller a risk premium because of the uncertainty of cattle performance. Fausti and Feuz (p. 539) describe this phenomenon using the theory of factor price disparity, which asserts that

> ". . . a risk neutral firm will pay less for an input with uncertainty over its total product than it will pay for an input when its contribution to production is known with certainty."

The price disparity caused by this uncertainty amplifies as available information to the buyer at the time of establishing a price decreases. Feuz, Fausti, and Wagner (1995) find empirical evidence to this effect. In comparing live, dressed, and grid purchases of fed cattle, they find that risk premiums are higher on cattle purchased on a live basis compared with those purchased on a dressed-weight basis. This concept also applies, however, to prices further up the supply chain.

Conceptual Model

Under the assumptions of perfect competition and a single variable factor of production (X), a firm's profit function is represented as

(1) $\Pi = pf(X) - rX - b,$

where p is the value of the firm's output, $f(X)$ is the production function, r is the price of the single-variable input, and b is the firm's fixed cost per unit. The first-order condition for profit maximization holds that

(2) $\frac{d\Pi}{dx} = pf'(X) - r = 0.$

This implies the familiar condition that the profit-maximizing level of X is found where the value of the marginal product (VMP) equals the input price. In discussing fed cattle pricing methods, Fausti and Feuz note that where total product is uncertain, utility rather than profit maximization is the appropriate objective. Assuming a Von Neumann-Morgenstern utility function, the firm's expected utility is expressed as

(3) $E[U(\Pi)] = E\{U[pf(vX) - rX - b]\},$

where v is a random variable with $E[v] = 1$, which denotes that output is uncertain, and other variables are as previously defined. The first-order condition for utility maximization is then

(4) $dE[U(\Pi)]/dx = E\{U'(\Pi)[pvf'(vX) - r]\} = 0.$

This is analogous to Equation 2 for profit maximization without uncertainty in total product. Equation 4 can be rearranged as

(5) $E\{U'(\Pi)[pvf'(vX)]\} = E[U'(\Pi)]r$

to explicitly express the notion that maximizing utility from profits entails purchasing input X at a price that is equal to its expected VMP. Following the approach of Horowitz, Fausti, and Feuz, we express Equation (5) as

(6) $pE[vf'(vX)] = r - \{p \cdot \text{cov}[U'(\Pi), vf'(vX)]/E[U'(\Pi)]\}.$

They further demonstrate that the sign of the covariance term in this equation is the same as the sign of the second derivative of the utility function, so that

(7) $E[pvf'(vX)] - r \gtreqless 0,$

depending on the sign of the second derivative of the utility function $U''(\Pi)$. The essential point is that where there is uncertainty regarding the total product of an input, the utility-maximizing relationship between that input's purchase price and its VMP depends on the decision maker's risk preferences, which are defined by $U''(\Pi)$. More specifically, a risk-averse decision maker (characterized by $U''(\Pi) < 0$) will purchase the input at a price (r) that is less than its expected VMP.[2] Feuz, Fausti, and Wagner (1995) find strong support for the assumption of risk aversion among buyers in the fed cattle market.

In the feeder cattle market, cattle feeders formulate bids by estimating expected net feeding returns. The expected break-even price per unit of a feeder calf is based on expected future output (i.e., fed cattle) prices as well as expected feed prices and cattle performance (both affecting expected total feeding costs).

[2] Note that in Equation (7), output price p remains within the expectations operator (contrary to the Fausti and Feuz model). The reason for this is that in the context of modeling factor price disparity in the feeder cattle market, expected VMP will be affected not only by uncertainty related to the total product associated with X, but also by uncertainty related to p (specifically, the fed cattle price at the end of the feeding period). This does little to change the nature of the problem conceptually. Empirically, however, it is not possible to determine how much of the observed difference between VMP and input price is the result of uncertainty related to total product and how much is because of uncertainty related to output price.

Future fed cattle prices and final carcass characteristics are clearly uncertain. Thus, assessing the potential final value of feeder cattle that are not even in the feedlot yet is clearly difficult. Additional uncertainty exists regarding the feedlot performance potential of feeder cattle, an important factor affecting feeding costs and, by extension, feeder cattle value.

The foregoing conceptual model implies that a risk-averse buyer of feeder cattle will build a significant risk premium into their bids in response to both price and production uncertainties. It is hypothesized that the "true" value of feeder cattle (i.e., the ultimate fed cattle grid value minus total feeding costs) will be quite different from the feeder cattle's market value (as determined in public auction markets). The primary reason for this is the uncertainty related to the feeder cattle's true value. This uncertainty results in part from price risk associated with future fed cattle market conditions (including prices and grid premiums and discounts) but also from uncertainty related to the physical performance of the cattle. The fact that production and price risks are intertwined in the determination of expected feeder cattle value makes the application of the factor price disparity concept less precise than in previous applications to the fed cattle market (in which uncertain carcass characteristics were the sole source of informational risk); however, the theory still provides a useful framework for examining the effect of grid pricing on pricing accuracy in the feeder cattle market.

From a feeder cattle producer's perspective, the fact that a feeder calf's potential value as an input into a finishing/grid pricing system might differ markedly from its market value is a very important issue. If, from past experience with the same or similar genetics and management, a producer has a greater degree of certainty regarding cattle performance in the feedlot or in terms of carcass merits, then the market price might significantly undervalue those cattle. The producer would be better off to retain ownership of the calves or to market those calves through some alternative means (e.g., direct sales to a cattle feeder with knowledge of the cattle's performance potential) to receive a price that more accurately reflects their potential value.

Carcass Data and Pricing Model

Data Description

A dataset of 2,763 calves fed in the Mississippi Farm-to-Feedlot program from 26 different farms over the period from 1993 to 2002 was evaluated in this study. Animals placed in the program were fed at a commercial feeding facility according to current industry management practices. Data included placement weight, slaughter weight, carcass weight, quality grade, and yield grade. Animals that died during the feeding phase or had incomplete carcass data were removed from the set. Farms consigning fewer than 50 head to the program over the time period were also removed from the analysis, leaving 2,320 head from 12 farms.

For establishing cattle values, mean October feeder steer prices at Georgia auction markets from 1996 through 2004 reported by USDA-AMS are used. Summary price information is reported in Table 1. Feeder calf prices are taken from the year before harvest to reflect the fact that all calves in the Farm-to-Feedlot program were placed on feed in the fall for harvest in the following spring.

The grid base price for each animal was based on the animal's hot carcass weight and the monthly USDA boxed beef Choice cutout values.[3] This time period covers a wide range of grid prices, as illustrated in Table 2. The boxed beef cutout value is used as a base by some packers, is recommended by economists (Ward et al.), and is used in other grid pricing simulations (Anderson and Zeuli). All price

[3] The USDA-AMS Choice boxed beef cutout values were collected from Report LM_xb459.txt for the years in the study. Over the time period of study, the AMS changed carcass weight ranges were reported, and each calf was classified into an appropriate weight range on the basis of time frame. From January 2004 to April 2005, the carcass weight range for the cutout value was 600 to 900 lbs. The two carcass weight ranges for January 1999 to December 2003 were 600–750 and 750–900 lbs. From November 1996 to December 1998, the cutout was reported on carcass weight ranges of 550–700 and 700–850 lbs.

Table 1. Mean Georgia Feeder Calf Values by Year and Weight Class 1996–2004

	Feeder Calf Value ($/cwt)								
Weight Class (lbs.)	1996	1997	1998	1999	2000	2001	2002	2003	2004
300–350	61.38	98.95	83.75	103.38	115.24	114.00	102.95	119.35	144.10
350–400	59.45	91.68	78.56	96.19	107.22	105.30	94.85	113.90	133.10
400–450	57.70	86.33	74.78	90.88	98.69	95.85	87.03	106.95	123.85
450–500	55.45	82.55	71.06	85.06	92.54	89.20	81.88	100.28	115.88
500–550	53.58	77.95	66.88	79.60	88.18	83.70	77.13	94.10	108.53
550–600	52.30	73.90	63.34	77.16	83.67	80.38	74.28	90.80	104.31
600–650	51.75	71.28	61.59	74.06	80.44	76.55	71.95	88.21	100.35
650–700	51.23	69.45	60.03	70.97	77.68	74.08	70.00	85.94	96.96
700–750	50.68	67.97	58.19	68.69	74.95	72.30	68.07	83.57	93.92
750–800	49.97	65.19	56.82	67.66	72.48	70.42	67.25	81.69	90.75
800–850	49.97	65.19	56.82	67.66	72.48	70.42	67.25	81.69	90.75

Source: Livestock Marketing Information Center.

data were obtained from the Livestock Marketing Information Center.

Total feeding costs were calculated for each animal by summing average Mississippi Farm-to-Feedlot feed costs, interest on 50% of the feed cost for the feeding period, freight, and any individual medication or treatment costs incurred during the feeding phase. Annual

Table 2. Descriptive Statistics for Value-Based Grid Used in Simulation

	Average	SD	Minimum	Maximum
Quality grade premiums and discounts				
Prime	$5.99	$1.20	$4.09	$9.87
Choice	$0.00	$0.00	$0.00	$0.00
Select	($8.50)	$3.92	($23.14)	($2.38)
Standard	($17.59)	$3.25	($29.23)	($12.03)
Carcass program	$1.48	$0.61	$0.36	$4.69
Yield grade premiums and discounts				
<2.0	$2.35	$0.59	$1.67	$4.01
2.0–2.5	$1.25	$0.42	$0.71	$2.10
2.5–3.0	$1.06	$0.25	$0.38	$1.60
3.0–3.5	($0.11)	$0.05	($0.17)	$0.01
3.5–4.0	($0.20)	$0.12	($0.33)	$0.00
4.0–5.0	($14.08)	$1.98	($19.21)	($11.33)
>5.0	($19.39)	$1.76	($24.21)	($16.83)
Weight range discounts				
<500 lbs.	($21.92)	$1.81	($26.47)	($15.15)
500–550 lbs.	($15.97)	$2.75	($21.55)	($2.98)
550–900 lbs.	$0.00	$0.00	$0.00	$0.00
900–950 lbs.	($0.47)	$0.55	($1.61)	$0.00
950–1,000 lbs.	($11.86)	$4.62	($18.42)	($4.67)
>1,000 lbs.	($19.48)	$2.64	($24.25)	($14.40)
Base price as determined by choice boxed beef cutout				
Total	$117.70	$16.49	$94.05	$173.35

Note: Summary of monthly data from November 1996 to April 2005

Source: Livestock Marketing Information Center.

Table 3. Average Annual Feedlot Total Costs for Mississippi Farm-to-Feedlot Program

Year	Avg. Cost ($/head)
1996	350.01
1997	335.01
1998	268.15
1999	221.44
2000	211.40
2001	264.82
2002	315.17
2003	317.40
2004	279.42

Mississippi Farm-to-Feedlot feeding costs are summarized in Table 3. The interest rate used in the calculation of interest charges is a simple feeding period average of the Federal Reserve Bank Prime Rate.

Methods

Historic prices and observed feeding costs are used to evaluate the difference between the market value of each feeder calf and its value derived from returns to finishing and grid pricing. This difference in values represents a risk premium. Risk premiums are calculated for each animal in each year of a 9-year period between 1997 and 2005. Nominal values of the risk premium are converted to real values with the GDP implicit price deflator for personal consumption expenditures (U.S. Department of Commerce). Equation (8) shows the calculation of the risk premium (*RP*) for the *i*th animal marketed in the *j*th year,

$$(8)\quad RP_{ij} = FEDV_{ij} = FDRV_{ij},$$

where *FEDV* and *FDRV* are the feeder calf values as determined by returns from the grid marketing system and by feeder calf market value, respectively. Note that in relation to the conceptual model presented earlier, *FEDV* is an estimate of the VMP of a given feeder calf (i.e., the change in total value product attributable to the finishing and grid pricing of the individual feeder calf being considered). Average real risk premiums (i.e., averaged across all feeder cattle in the dataset) are tested for significant difference from zero with a two-sided *t*-statistic. These risk premiums are also evaluated at the farm level (i.e., averaged across all feeder cattle from the same farm) to illustrate how individual producers might use this information in making decisions related to retained ownership of their calves.

The market value of feeder calves (*FDRV*) is a figure calculated to represent the opportunity value of the feeder calves, and it includes not only the income the producer would receive if the animal was sold as a feeder (*INVAL*) but also the foregone interest the producer would have earned (*INT*) if the calf was sold and the money placed in an alternative investment.[4] Equation (9) shows the calculation of *FDRV* for the *i*th animal marketed in the *j*th month,

$$(9)\quad FDRV_{ij} = INVAL_{ij} + INT_{ij}.$$

INVAL is calculated for each animal with the animal's weight at placement and a weight-appropriate feeder calf price. *INT* is charged on the animal's initial value at the prime rate for the length of time that the animal was on feed.

The value of a feeder calf on the basis of returns from grid pricing the finished animal (*FEDV*) equals the difference between the gross value of the animal marketed in a grid system (*GFEDV*) and the total expenses incurred from placement to harvest (*TOTEXP*);

$$(10)\quad FEDV_j = GFEDV_{ij} - TOTEXP_{ij}.$$

The gross finished animal value was calculated for each animal in each marketing period with the use of a grid-based carcass price applied to the attributes of each carcass. Grid prices were derived from the USDA-AMS *Weekly Cattle Premiums and Discounts for Slaughter Steers and Heifers Report*. For each carcass, a grid carcass price was determined annually by applying the reported premiums and discounts according to the calculated yield grade, quality grade, program, and hot carcass weight classification and then

[4] Fausti et al. provide a useful discussion of the importance of including foregone interest income as opportunity cost in evaluating the riskiness of retained ownership.

Table 4. Summary Statistics on Feeder Calf Market Value, Input Value into Finishing Grid System, and Risk Premiums on 2,320 Head

	2005	2004	2003	2002	2001	2000	1999	1998	1997	9-yr Avg.
Feeder calf market value (*FDRV*)										
FDRV Avg.	654.06	573.67	469.14	501.13	533.01	488.83	407.97	474.86	346.26	494.33
FDRV SD	39.50	40.43	33.08	30.94	30.33	29.21	27.13	30.66	31.51	32.45
Grid-based feeder calf value (*FEDV*)										
FEDV Avg.	768.07	680.22	573.50	518.18	665.58	591.88	440.80	316.24	336.67	543.46
FEDV SD	134.08	146.44	119.30	97.32	114.29	111.97	95.11	86.22	89.40	108.27
Nominal risk premium (*RP*)										
RP Avg.	114.01	106.55	104.36	17.05	132.57	103.05	32.83	−158.62	−9.59	49.13
RP SD	125.95	142.37	114.12	87.71	105.34	106.70	91.06	83.06	83.70	102.08
Real risk premium (*RRP*)[a]										
RRP Avg.[b]	102.26	98.32	98.83	16.46	129.86	103.05	33.65	−165.27	−10.09	45.23
RRP SD	112.97	131.37	108.07	84.71	103.18	106.70	93.32	86.54	88.00	99.33

[a] Nominal values were converted to real values with the use of an implicit price deflator for personal consumption expenditures from the Bureau of Economic Analysis (2000 = 100).
[b] All risk premiums are statistically significantly different from zero at $p < .01$.

adding the figure to the base price. Thus, the gross finished animal value in a value-based marketing system is determined by current market prices, and the characteristics of the individual animal as represented in Equation (11) for the ith animal marketed in the jth year is

$$(11) \qquad GFEDV_{ij} = BP_j + YPD_{ij} + QPD_{ij} + WPD_{ij} + PP_{ij},$$

where BP_j is the base price in year j, YPD_{ij} is yield grade premium or discount received by animal i in year j; QPD_{ij} is the quality grade premium or discount received by animal i in year j; WPD_{ij} is the hot carcass weight premium or discount received by animal i in year j; and PP_{ij} is the program premium (e.g., certified angus), if any, received by animal i in year j.

The total expenses (*TOTEXP*) are the sum of feeding costs (*FEED*), interest costs (*INT_FEED*), freight charges (*FRGT*), and individual animal health expenses (*VET*). Equation (12) represents the calculation of total expenses for the ith animal in the jth year:

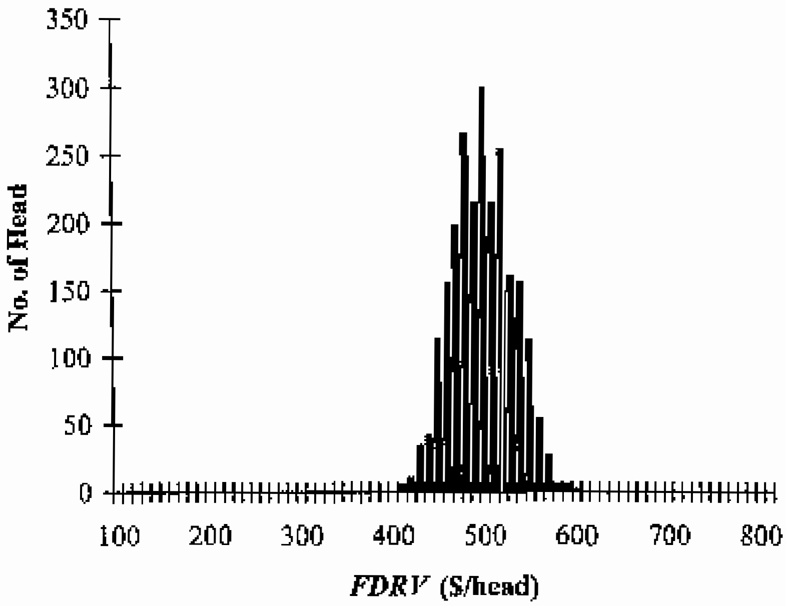
$$(12) \qquad TOTEXP_{ij} = FEED_j + INT\_FEED_{ij} + FRGT + VET_i.$$

The feeding costs ($FEED_j$) in dollars per head were calculated as the same for each calf on the basis of the marketing year. Interest costs (INT_FEED_{ij}) were based on 50% of the feed cost over the length of the feeding period. The freight cost (*FGT*) is estimated at $35 per head for all marketing periods. Health costs (VET_i) represent the actual treatment charges for each animal and are constant between marketing periods.

Results and Discussion

Risk Premium Results

The average risk premiums (*RP*) for each year from 1997 through 2005 were calculated with Equation (8) and the data described above. These numbers were used to determine whether average risk premiums for this set of calves were statistically different from zero. The results for each year and the 9-year averages are presented in Table 4. The average difference between feeder cattle market values and grid-based values was statistically significant (both nominal and real values) in each year evaluated here.



Note: Data include 2,320 feeder calves consigned to Mississippi State University's Farm-to-Feedlot Program from 1993 through 2002.

Figure 1. Distribution of Feeder Calf Market Value (*FDRV*, $/head)

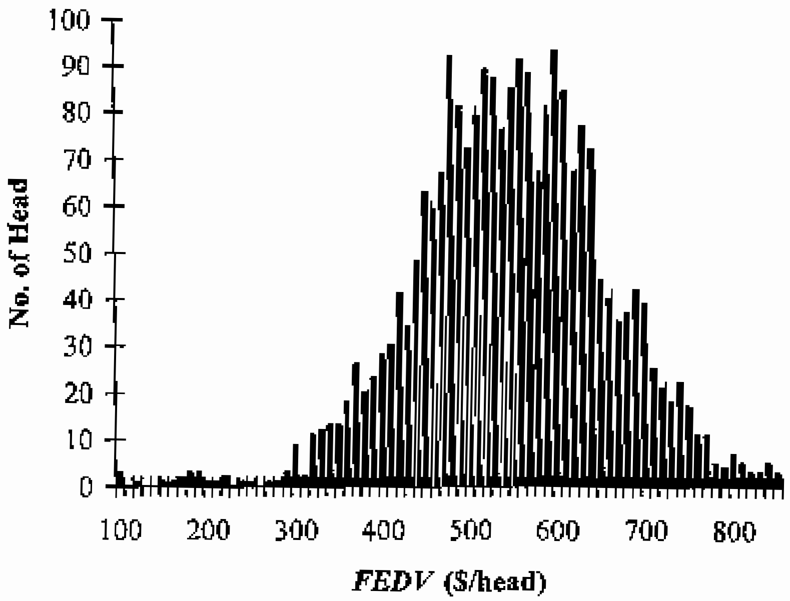
In addition, grid-based feeder cattle values were much more variable than feeder cattle market values. The average feeder calf market value displays relatively little variation with a 9-year average standard deviation of $32.45/cwt. Comparatively, the feeder calf value, as determined by the grid pricing system, was highly variable, with a 9-year average standard deviation of $108.27/cwt.

As Figures 1 and 2 show, the distributions of both market (*FDRV*) and grid-based (*FEDV*) feeder calf values appear to be very close to normal. However, the distribution is much wider for *FEDV*, as would be expected because differences in value are largely due to differences in carcass merits and individual animal performance.

FEDV represents the outcome of biological processes with inherent variation. This valuation process results in a wider distribution and more outliers, as judged by the outlier box plot. *FDRV* are very tightly distributed and identify relatively few outliers. Thus, in this analysis, as in feeder calf markets, weight is the primary driver behind differences in market value.

This difference in variability between feeder calf market value and grid-based value is quite large compared with the difference in variability of fed cattle values noted in previous research comparing returns from liveweight and grid marketing of fed cattle (e.g., Anderson and Zeuli; Schroeder and Graff). This result underscores the notion that at the feeder cattle market level, uncertainty related to the "true" carcass value is much greater than at the fed cattle market level, not only because of uncertainty related to feedlot performance and carcass merits but also because of price risk over the feeding period.

A statistically significant average real risk premium ($p < .01$) was observed for each year in the study period. The risk premium is positive in 7 of 9 years. In the 9-year average figures, the average real risk premium charged was $45.23 per head. The calculated risk premium in this study is higher than previously reported in the literature comparing



Note: Data include 2,320 feeder calves consigned to Mississippi State University's Farm-to-Feedlot Program from 1993 through 2002.

Figure 2. Distribution of Value as Input to Finishing Grid Pricing System (*FEDV*, $/head)

pricing methods. Feuz, Fausti, and Wagner (1995) found a risk premium of $6.22 per head when comparing live-weight marketing of fed cattle and grade-and-yield marketing. The higher risk premium is likely associated with the increased uncertainty regarding future performance when comparing a feeder calf with a fed animal. This evidence supports the theory forwarded by Fausti and Feuz that factor price disparity and uncertainty are inversely related.

It is noteworthy that the risk premium was significantly negative in two of the study years. This indicates that both performance and price uncertainty influence the final outcome. Because the simulation was performed with the same animal performance and carcass characteristics for each year of the model, the difference in annual risk premium levels are largely due to market conditions. In 1997 and 1998 (the 2 years with the negative risk premiums), boxed beef cutout values were very low, resulting in low grid-based feeder cattle values.

On average, the grid-based value of feeder calves from this study was $45.23/head greater than their market value. This implies that, on average, these producers are paying a significant risk premium to avoid owning the calves through finishing. However, a key issue that needs to be addressed is the effect of animal characteristics on the magnitude of differences between marketing methods. This is most appropriately viewed on a farm-by-farm basis.

Price-Value Disparity Variation by Farm

As noted above, for the 2,320 calves examined in this study, the average value of individual calves derived from grid pricing returns is significantly higher than the average market value of individual calves. However, as Table 5 illustrates, the difference between the derived value of calves and their market value can vary significantly from farm to farm. Likewise, the level of variability in derived values can be quite different from farm to farm.

Variability in the physical characteristics of cattle, as well as variability in feedlot performance will show up as differences in the grid-

Table 5. Farm-Level Average Feeder Calf Market Values (*FDRV*), Grid-Based Values (*FEDV*), and Real Risk Premiums (*RRP*)

Farm ID	No. of Head	*FDRV* ($/head)		*FEDV* ($/head)		*RRP* ($/head)	
		Avg.	SD	Avg.	SD	Avg.	SD
3	163	491.85	26.12	571.50	89.63	74.87	79.66
4	126	485.57	32.01	520.53	142.90	31.42	125.44
7	302	482.32	30.64	527.09	107.00	40.99	96.44
8	95	486.61	27.60	556.75	90.24	65.58	87.83
10	83	515.36	30.81	589.75	88.08	69.58	83.54
11	470	491.80	33.61	526.60	104.81	31.36	96.94
14	51	499.60	31.25	579.17	82.29	74.93	67.88
18	103	480.40	29.45	526.86	99.57	42.59	96.78
22	154	516.21	29.15	568.08	110.79	47.84	100.14
23	56	511.36	24.55	560.78	118.88	45.19	113.09
24	664	497.65	31.91	545.32	108.59	43.85	102.29
25	53	493.24	30.08	542.92	115.73	45.72	109.44

Note: *RRP* is not equal to the difference between *FDRV* and *FEDV* because *RRP* represents deflated risk premium values.

based feeder cattle values. The less uniform calves from a particular farm are (in terms of their feedlot performance and ultimate carcass merits), the more variability there will be in the farm's grid-based feeder calf values.

The differences between 9-year average real risk premiums between farms can be tested by the Tukey-Kramer honestly significant difference test to detect statistical differences between means. The results of this test are illustrated in Table 6. The findings indicate two significant levels of mean risk premiums between farms. This provides evidence that the magnitude of risk premiums is statistically significantly different between farms. This confirms that retained ownership with grid pricing could be more beneficial for some farms than others.

Table 6. Statistical Comparison of 9-Year Average Risk Premiums (*RP*) by Owner

Owner	Mean *RP* ($/head)
3	74.87 A
14	74.93 AB
10	69.58 AB
8	65.58 AB
22	47.84 AB
25	45.72 AB
23	45.19 AB
24	43.85 B
18	42.59 AB
7	40.99 B
4	31.42 B
11	31.36 B

Note: *RPs* with same letters are not significantly different at $p < .05$.

To determine whether or not retained ownership might be beneficial on the basis of the past performance of the farm's calves, producers can evaluate the probability (on the basis of historic production and price relationships) that feeder calf value derived from grid pricing returns will exceed current market value. Figure 3 illustrates this concept with cumulative distribution functions (CDFs) from 2 of the 13 farms evaluated in this study.[5]

The CDFs in this figure plot the probability that the grid-based value minus market value for a feeder calf will be below a given level. A value greater than zero implies that the owner is paying a risk premium when marketing the animals as feeders rather than retaining ownership.

The CDFs are calculated on a farm basis, and the result is the percentage of animals the farm could expect to be below a specified threshold. For example, over the 9 years considered here, Farm 4 had a mean real risk premium of $31.42 and standard deviation of

[5] CDFs from other farms are available from the authors.

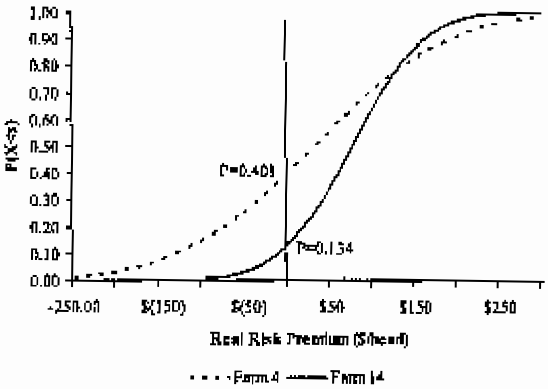


Figure 3. Cumulative Distribution Function of Real Risk Premiums ($/head) by Farm

$125.44. The expectation on the basis of these data is that about 60% of Farm 4's calf crop will have a positive risk premium. Farm 14 had a higher mean real risk premium ($74.93) and lower standard deviation ($67.88), and the CDF illustrates that approximately 87% of the calf crop should have a positive risk premium. Thus, retaining ownership and selling cattle on a grid appears, on the basis of past cattle performance, to be a considerably riskier prospect for Farm 4 than for Farm 14. This is an example of how specific farm-level data can be used as a decision tool for producers by incorporating both the level and variability of expected returns.

Summary and Conclusions

A great deal of previous research has explored differences between grid-pricing and live-pricing outcomes for fed cattle. In this study, we examined how the value of feeder cattle as an input into a grid pricing system relates to their market value as feeder cattle. Data from Mississippi State University's Farm-to-Feedlot program is used along with historic feeder cattle prices and grid pricing information reported by USDA-AMS to quantify the difference between feeder cattle market value and grid-based value of the same feeder cattle. Results indicate substantial differences in the two values.

The findings of this study are significant in a couple of respects. First, although the relationship between average and individual prices for fed cattle has been widely explored, implications of individual pricing on the feeder cattle market have not been. These results reveal that a statistically significant risk premium is generally charged by buyers when purchasing feeder calves. The magnitude of the risk premium differed significantly between farms in the study. The evidence provides a fairly strong incentive for producers of above average–quality feeder cattle to look for nontraditional marketing alternatives that will reward them for the quality of their cattle.

Second, in this study, we illustrate how feedlot and carcass performance information can be used as a tool for making marketing decisions. From the firm-level perspective, information on the difference between feeder cattle market value and potential value in a grid pricing system represents a potentially useful decision-making tool. The feeder calf model resulted in higher premiums than previous literature comparing live-weight and grid-based fed cattle marketing. The difference is likely related to the level of uncertainty faced by the buyer. At the feeder calf stage, buyers face a higher degree of uncertainty (related to not just future animal performance but also to market volatility) relative to fed cattle marketing.

In this study, we illustrate farm-level differences in the grid-based value of feeder cattle resulting from differences in the feedlot and carcass merit performance of the cattle. A farm manager with knowledge of past cattle performance can use the information to help assess the risk that feeder cattle retained into a feeding/grid pricing program would fail to receive a return equal to or greater than they could receive on the feeder cattle market. Similarly, farm managers who recognize that the value of their cattle in a feeding/grid pricing program is consistently higher than their market value as feeders can use that information to pursue other feeder cattle marketing alternatives (e.g., direct sales to feedlots) in which the cattle could perhaps receive a premium for their potential superior performance.

The findings of this study support previous work by Fausti and Feuz regarding the theory of factor price disparity. Empirical results provide strong evidence that statistically significant risk premiums are charged by feeder cattle buyers. Further work at this level of the market is needed to explore a number of issues. For example, observed risk premiums could be investigated to determine what they indicate about the risk attitudes of feeder cattle producers and buyers. Also, farm-level data on cattle performance could be used to determine how the level of the risk premium is influenced by the consistency and uniformity of cattle. This could provide very useful information for guiding farm-level production decisions.

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References

Anderson, J.D., and K.A. Zeuli. "The Revenue Risk of Value-based Pricing for Fed Cattle: A Simulation of Grid vs. Average Pricing." *International Food and Agribusiness Management Review* 4(2001):275–86.

Cross, H.R., and J.W. Savell. "What Do We Need for a Value-based Beef Marketing System." *Meat Science* 36(1994):19–27.

Fausti, S.W., and D.M. Feuz. "Production Uncertainty and Factor Price Disparity in the Slaughter Cattle Market: Theory and Evidence." *American Journal of Agricultural Economics* 77(1995):533–40.

Fausti, S.W., D.M. Feuz, and J.J. Wagner. "Value Based Marketing for Fed Cattle: A Discussion of the Issues." *International Food and Agribusiness Management Review* 1(1998):73–90.

Fausti, S.W., B. Johnson, W. Epperson, and N. Grathwohl. "Risk and Economic Incentive to Retain Ownership of Steer Calves." Economics Staff Paper 2003-6, Dept. of Economics, South Dakota State University, Brookings, 2003.

Feuz, D.M. "Economic Implications of Show List, Pen Level, and Individual Animal Pricing." *Formula Pricing and Grid Pricing Fed Cattle: Implications for Price Discovery and Variability*, C.E. Ward, D.M. Feuz and T.C. Schroeder, eds. Blacksburg, Virginia: Research Institute on Livestock Pricing, Virginia Tech University, 1999.

Feuz, D.M., S.W. Fausti, and J.J. Wagner. "An Analysis of the Efficiency of Four Marketing Methods for Slaughter Cattle." *Agribusiness* 9(1993):453–63.

———. "Risk and Market Participant Behavior in the U.S. Slaughter-Cattle Market." *Journal of Agricultural and Resource Economics* 20(1995): 22–31.

Gebremeskel, T., and C.R. Shumway. "Farm Planning and Calf Marketing Strategies for Risk Management: An Application of Linear Programming and Statistical Decision Theory." *American Journal of Agricultural Economics* 61(1979):363–70.

Horowitz, I. *Decision Making and Theory of the Firm*. New York: Holt, Rinehart, and Winston Publishing, 1970.

Lambert, D.K. "Calf Retention and Production Decisions over Time." *Western Journal of Agricultural Economics* 14(1989):9–19.

Livestock Marketing Information Center. *Livestock Marketing Information Center*. Internet site: http://lmic.info/ (Accessed March 2, 2005).

Mintert, J. "Beef Feedlot Industry." *Veterinary Clinics of North America: Food Animal Practice* 19(2003):387–95.

National Cattlemen's Association. "The War on Fat!" Final report of the Value-Based Marketing Task Force. Englewood, Colorado: National Cattlemen's Association, 1990.

Rodriguez, A., and R.G. Taylor. "Stochastic Modeling of Short-term Cattle Operations." *American Journal of Agricultural Economics* 70(1988):121–32.

Savell, J.W., and H.R. Cross. "Value Based Marketing: Current Status." *Proceedings of the Annual Reciprocal Meat Conference of the American Meat Science Association*, 1991, pp. 117–20.

Schroeder, T.C., and J.L. Graff. "Estimated Value of Increased Pricing Accuracy for Fed Cattle." *Review of Agricultural Economics* 22(2000):89–101.

Schroeder, T.C., C.E. Ward, J. Lawrence, and D.M. Feuz. *Fed Cattle Marketing Trends and Concerns: Cattle Feeder Survey Results*. Manhattan, KS: Kansas State University Agricultural Experiment Station and Cooperative Extension Service, MF-2561, 2002.

USDA-AMS (U.S. Department of Agriculture, Agricultural Marketing Service). "National Weekly Direct Slaughter Cattle Report—Formulated and Forward Contract." St. Joseph, MO: LM_CT151, various dates, 2005a.

———. "National Weekly Direct Slaughter Cattle Report—Prior Week Slaughter and Contract Purchases." St. Joseph, MO: LM_CT153, various dates, 2005b.

———. "National Weekly Direct Slaughter Cattle Report—Negotiated Purchases." St. Joseph, MO: LM_CT154, various dates, 2005c.

U.S. Department of Commerce, Bureau of Economic Analysis. *National Income and Product Accounts Interactive Tables*. Internet site: http://www.bea.gov/bea/dn/nipaweb/index.asp (Accessed August 3, 2006).

Ward, C.E., T.C. Schroeder, T.L. Wheeler, J. Mintert, and J.S. Drouillard. "Merits of Value Discovery Alternatives for Fed Cattle and Carcasses." Paper presented at the Western Agricultural Economics Association Annual Meeting, Denver, Colorado, July 11–15, 2003.

Whitson, R.E., P.J. Barry, and R.D. Lacewell. "Vertical Integration for Risk Management: An Application to a Cattle Ranch." *Southern Journal of Agricultural Economics* 8(1976):45–50.