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Effect of Risk Aversion on Feeder Cattle Prices

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Abstract

This paper determines the effects of cattle feeders' risk aversion on feeder cattle prices using pen data of Kansas feedlots. Higher profit risk results in lower feeder cattle prices. The elasticity of feeder cattle price with respect to profit risk was small (-0.013). The risk elasticity estimated here is similar to risk elasticities in previous studies and thus, the use of pen-level data does not seem to add much to the study of risk.

Key Words: feedlot pen data, price expectations, hedonic price, price risk, risk aversion.

Because of production lags, most agricultural producers make input decisions without knowing the price they will receive for their product (Antonovitz and Green, 1990). As a result, farm production decisions often depend on known input prices but uncertain output prices and uncertain output levels. Many studies have extended neoclassical production theory to include agents that maximize expected utility of returns under price or revenue uncertainty (Holt and Aradhyula, 1991).

Most previous econometric studies of risk have used aggregate rather than farm level data. Feedlot pen data which are disaggregate data are used here. Input demand and output supply cannot be directly estimated with feedlot pen data. The imputed price of feeder cattle in fed cattle production can be derived and estimated. The imputed price is also referred to as the hedonic price (Wilson). A hedonic price function is a regression of a commodity's price against its quality attributes (Brorsen et al., 1984). In agriculture, hedonic price analyses have been applied previously to cotton (Ethridge and Davis, Ethridge and Neeper), rice (Brorsen et al., 1984), barley (Wilson),

potatoes (Carl et al.), corn (Ladd and Martin), and parcels of rural land (Pardew et al.). None of these previous studies considered a measure of risk.

The objective of this paper is to determine the response of feeder cattle price to fed cattle profit risk. Pen data from Kansas feedlots are used. The lagged average absolute deviations of actual profit and expected profit of fed cattle is used as a measure of fed cattle profit risk. An imputed feeder cattle price is then estimated as a function of risk.

Theoretical Model

Most feeder cattle are obtained through either auctions or private treaty sales. Private treaty sales often have the characteristics of a telephone auction. Based on work by McAfee and McMillan, (Bailey, et al.), define a theoretical model of bidding in feeder cattle auctions. Their model is appropriate here. They argue that the selling price will be equal to the value of marginal product (*VMP*) of the second highest bidder.

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The profit (π) of a cattle feeder can be defined as

$$\pi = P(P^e, QT) * Q(Z, QT) - r' * Z \quad (1)$$

where $Q(Z, QT)$ is fed cattle production which is defined as a function of a vector of inputs denoted as Z and a vector of variables for cattle characteristics denoted as QT , the price of fed cattle is $P(P^e, QT)$ which denotes a function of QT and the aggregate expected price (P^e), and r denotes a $k \times 1$ vector of input prices. Feeder cattle and feed are major inputs into the production of fed cattle (Shonkwiler and Hinckley). In this paper, therefore, Z includes feeder cattle and the feed they consume. Assume that r_1 is the price of feeder cattle. The marginal profit from a given load of feeder cattle defines the bid function $r_1 = f(QT, P^e, r_2, \dots, r_k)$.

Fed cattle production has a lag between the time input decisions are made and output actually reaches the market. When feeder cattle are procured, the sale price about five to eight months later is unknown (Antonovitz and Green). Price risk could be reduced by hedging, but Antonovitz and Roe estimate that less than 2 percent of all cattle marketed are hedged in the futures market; for that reason, hedging is not considered. Most enterprise costs are comprised of direct costs of feeder cattle and feed (Antonovitz and Green). Thus, feeder cattle and feed prices as inputs for fed cattle production, should adjust in response to changes in cattle feeding profit risk.

Let U stand for utility and π for profit. Then the firm's utility function is given by

$$U = U(\pi) \quad (2)$$

Now, assume feedlots maximize expected utility of profit. For a risk-averse firm, the utility function is increasing and concave: $U'(\pi) > 0$, $U''(\pi) < 0$. Producer decisions now depend on expected marginal utility rather than VMP. The hedonic input prices are still functions of input characteristics, but also depend on the probability distribution of π :

$$r_1 = f(\text{Weight, Feed price, Heifers, the probability distribution of } \pi). \quad (3)$$

Hedonic price equations are reduced form equations since they represent the equilibrium of supply and demand. If short-run supply of feeder cattle is perfectly inelastic the hedonic price function will represent cattle feeder's bid functions.

Estimation Models and Procedure

The profit per head on a given pen of cattle (π_{ij}) is calculated as

$$\begin{aligned} \pi_{ij} = & P_{ij} Q_{ij} (1 - DL_{ij}) - Px_{ij} \text{Weight}_{ij} - Py_{ij} * Z_{2ij} \\ & - (Px_{ij} \text{Weight}_{ij} + P_{ij} Z_{2ij}) \\ & * \text{Feed Days}/365 * \text{interest rate} \end{aligned} \quad (4)$$

where

P_{ij} = observed fed cattle price per pound (total sales divided by total fed cattle payweight sold for fed cattle price) at closeout time t in i th observed pen of j th feedlot,

Px_{ij} = feeder cattle price per pound (total costs of purchasing feeder cattle divided by total feeder cattle payweight purchased) at placement in i th pen of j th feedlot,

Py_{ij} = price per pound of feed of i th pen of j th feedlot,

Weight_{ij} = average feeder cattle payweight per head purchased in pounds in i th pen of j th feedlot,

Heifers = 1 if the cattle are heifers, otherwise heifers = 0,

DL_{ij} = percent death loss of pen i of j th feedlot, and

Feed Days = average days per head of fed cattle on feed in a feedlot.

Define the difference between actual and expected profit (ϵ_{ij}) as

$$\varepsilon_{ij} = \pi_{ij} - E(\pi_{ij}) \quad (5)$$

Cattle are assumed to yield a normal return and thus $E(\pi_{ij})$ is zero. The profit risk is defined as

$$RISK_i = \frac{\left(\left| \sum_{i_t} \sum_{j_t} \varepsilon_{i_t, j_t} \right| \right)}{N_i} \quad (6)$$

where N_i = number of observations in cross section at time t and i_t and j_t are the lots sold at time t .

The hedonic price of feeder cattle defined in equation (3) is

$$Px_{ij} = f(\text{Weight}_{ij}, P^e_{ij}, Py_{ij}, \text{Heifers}_{ij}) \quad (7)$$

where P^e_{ij} = expected fed cattle price per pound¹ in i th pen of j th feedlot and $Risk_{ij}$ is the *Risk*, calculated in the month prior to the purchase of the feeder cattle.

Equation (7) is estimated using random components (Greene, pp 474-479). The error components model was estimated using the LIMDEP statistical software package which uses feasible generalized least squares. The one-way random component is associated with time. The random component model separates the error term into two components, one associated with each month and one associated with each observation.

Data

This paper uses monthly pen level data from Professional Cattle Consultants (PCC), a private feedlot consulting firm. Monthly placement reports, collected by PCC for each feedlot on each pen of cattle, contains a feedlot identification number, pen placement date, average pen placement weight, head placed per pen, a sex code, purchase price, and shrink allowance. The monthly closeout report, collected by PCC for each feedlot on each pen of cattle sold during the month, contains a feedlot identification number, pen closeout date, average pen closeout weight, head closed per pen, average days on feed, a sex code, sales price, feed conversion, and feed efficiency.

The data used in this paper consist of monthly cattle placement and closeout information for pens in feedlots located in Kansas from October, 1986 through November, 1992. For feeder cattle and fed cattle prices, unit values (costs per pound) are used.

Feedlot operators may use live cattle futures prices for the period when fed cattle will be marketed as their expectation of fed cattle prices (Gardner). Therefore, live cattle futures prices are expected to represent fed cattle prices at time t from placement time. Closing futures prices of live slaughter cattle on the middle day of the month are obtained from the "Daily Information Bulletin" (Agricultural Futures-Cash Markets, Fundamentals), Chicago Mercantile Exchange. The interest rate used is the high of the range reported for the prime interest rate in *Economic Report of the President*. The feed price data are the price of finish ration in cents per pound of dry matter from the *Professional Cattle Consultants Newsletter*. Prices for southern or central plains are used depending on the location of the feedlot.

Empirical Results

Summary statistics are reported in Table 1 and empirical results are presented in Table 2. All estimated coefficients were significantly different from zero at the 5 percent level. The null hypothesis of no random components is soundly rejected.

The coefficient of profit risk was negative. This result indicates that higher fed cattle price risk results in lower feeder cattle price. If producers are risk averse, they should reduce production when risk increases (Antonovitz and Green, 1990). In this context, the negative coefficient of profit risk implies that higher risk results in lower fed cattle supply and reduced feeder cattle demand. As a result, feeder cattle prices decrease with increasing risk. The calculated elasticity with respect to risk was -0.013. Thus, the effect of risk is small.

Elasticities of supply with respect to risk, estimated in previous studies are presented in Table 3. Most of these elasticities are also small with Hurt and Garcia's study of sow farrowing having the largest elasticity. Brorsen, et al. (1987) and

Table 1. Summary Statistics of Variables in Hedonic Cattle Price Model using Feedlot Pen Data for September 1986 to March 1993.

Variables	N	Mean	Std. Dev	Min	Max
Risk (\$/hd.)	15713	28.74	25.55	0.64	111.10
Weight (lb.)	15713	720.34	89.21	400.40	950.00
Feeder Price (P_{xy}) (¢/lb.)	15713	81.51	8.12	50.00	117.90
Feed Price (P_{yij}) (¢/lb.)	15713	6.18	0.76	3.00	9.66
Futures Price (P^e_{ij}) (¢/lb.)	15713	70.78	4.93	54.20	77.82
Heifers (%)	15713	0.44	0.49	0.00	1.00

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Table 2. Estimates of Hedonic Cattle Price Models^a**Estimates of Feeder cattle price.**

$$\begin{aligned}
 Px_{ij} = & 66.85 - 0.02915 X_{ij} + 0.54 P_{yij} - 0.038 Risk_{ij} \\
 & (30.21) \quad (-67.58) \quad (17.66) \quad (-3.53) \\
 & + 0.14 P_{yij} + -5.35 Heifers_{ij} \\
 & (2.54) \quad (-71.27)
 \end{aligned}$$

Lagrange Multiplier Test of Random Components^b=108167.7

No of observation = 15713

^a *t*-values are in parentheses.^b The statistic has a chi-squared distribution with one degree of freedom under the null hypothesis of no random components.

Holt both found risk had a much greater effect on margins than on supply. Thus, the demand for feeder cattle is expected to be much more affected by risk than the supply of feeder cattle. Holt and in some cases Antonovitz and Green found positive risk elasticities in short-run beef cattle supply. Short-run beef supply can be downward sloping since producers must keep more heifers to increase the size of their cow herds. Most of the elasticities in Table 3 are larger in absolute value than the elasticity found here. The elasticities presented in Table 3 are structural elasticities, while the elasticity estimated here is a reduced form elasticity. Given that the demand for most agricultural products is inelastic, these supply elasticities suggest an even larger effect on price.

The coefficient on expected fed cattle price was positive. This result indicates that higher expected fed cattle prices result in higher fed cattle production and thus more use of feeder cattle. As a result, feeder cattle demand increases which makes feeder cattle price go up.

The coefficient of weight per head of feeder cattle was negative. During the observation period the price of fed cattle was considerably above the cost of gain and thus feeder cattle price should decrease as weight increases. The coefficients of heifers was negative as expected. The estimated coefficient of feed price was positive.

Summary and Conclusions

This paper determined the hedonic price of feeder cattle in response to profit risk. Higher profit risk results in lower feeder cattle price. Such a finding is consistent with cattle feeders being risk averse. Unlike most previous studies on price risk analysis which have used aggregate data, pen data of feedlots (i.e., disaggregated data) have been used in this paper. But, like previous studies that used much different data and methods the elasticity with respect to risk was small (-0.013).

The results are disappointing in that pen-level data yields similar conclusions to aggregate

Table 3. Risk Elasticities Estimated in Previous Studies

Authors	Dependent Variable	Type of Risk	Other Commodity Risk	Own Risk Elasticity
Holt	Beef Supply	Price	None	0.014
Holt	Beef Farm-Retail Margin	Price	None	0.088
Antonovitz and Green	Fed Cattle Supply	Price	None	-0.145 to 0.102
Holt and Aradhyula	Broiler Supply	Price	None	-0.03
Tronstad and McNeill	Sow Farrowing	Price	Corn	-0.164 to 0.005
Brorsen, et al. (1987)	Rice Acreage	Income	None	-0.0589 to -0.0077
Brorsen, et al. (1985)	Farm-Wholesale Margin	Price	None	0.45
Brorsen, et al. (1985)	Wholesale-Retail Margin	Price	None	Insignificant
Hurt and Garcia	Sow Farrowing	Price	Corn	-0.56 to 0.47
Nieuwoudt, et al.	Corn Acreage	Income	Soybeans	-0.0146
Lin	Wheat Acreage	Gross Returns	None	-0.06

time series data. Thus, the contribution of pen-level data to what is known about risk is small. The only risk that changes over time is likely aggregate price

risk. Aggregate price risk can be captured with aggregate time-series data and that may be why the use of pen-level data made so little difference.

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Endnotes

1. Futures prices of live cattle are used as cattle feeders' price expectation.