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A COMPARISON OF CATTLE FEEDING PROFIT VARIANCE INDICATED BY PRIVATE VERSUS PUBLIC DATA

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Abstract

A COMPARISON OF CATTLE FEEDING PROFIT VARIANCE

INDICATED BY PRIVATE VERSUS PUBLIC DATA

The variance of net profits calculated from USDA fixed coefficient budgets and from industry variable production coefficient pen closeout data were found to be equal. The industry variance was not higher because the variations of the prices and quantities whose products form the components of net profit are negatively correlated.

A COMPARISON OF CATTLE FEEDING PROFIT VARIANCE INDICATED BY PRIVATE VERSUS PUBLIC DATA

Net returns from cattle feeding have generally been concluded to be relatively volatile. Discussions among laymen generally warn that cattle feeding is a risky business that should not be ventured into by those who don't have ample risk capital. Data available to researchers to verify these opinions has largely been restricted to public data. Specifically the most readily available data are the cattle feeding budgets published by the USDA in the "Livestock and Poultry Outlook and Situation Report." The procedure for developing these budgets is to assume a given feeding system, i.e. a fixed ration, placement weight, slaughter weight, growth weight, feed conversion rate, etc. and to then proceed to calculate monthly feeding profits based upon changing price conditions.

Assuming the technical parameters used in the USDA budgets are representative of "a typical" feedlot, it seems logical to believe the USDA budgets accurately reflect the level and direction of change in feedlot profits over time. However the variation in feedlot profits reflected in these budgets would appear to be subject to question. Production volatility as well as price/market volatility contribute to profit variation. By holding the physical production coefficients of the budgets constant it would appear that a major source of profit volatility is being ignored by the USDA budgets.

Consideration of the question of what is the appropriate volatility to inject into the technical/quantity coefficients of the budgets to reflect the "actual" variance of feedlot profits leads to another question. What, if any, correlation would be expected between the price and quantity series used in the budgets? The answer is that in most cases negative correlation would be expected. For example, lighter weight feeder cattle generally bring price

premiums relative to heavier feeder cattle (see Buccola and Marsh). Likewise overweight or heavy slaughter animals generally sell at a discount. High ration costs lead to feeders taking action to reduce feeding cost by changing ration compositions or by placing animals at heavier weights and feeding them for shorter periods. Hence consideration of natural market relations and rational management practices lead to the conclusion that many of the price and quantity series, whose products form the cost and revenues of the USDA budgets, may be negatively correlated. Bohrnstedt and Goldberger have shown that negative correlation between two variables reduces the variance of their product. The question in this case becomes "is it possible the negative correlation between price and quantity is strong enough to reduce the variance of their products enough to make it equal to or less than the product of an assumed constant technical coefficient and a variable price series?" To resolve this question and to determine whether the USDA budgets properly estimate the mean, and more critically the variance of actual feedlot profits, the USDA's budget data will be compared to a set of private industry "pen closeout sheets."

The Data

Monthly data from the USDA and from the records of a private consulting company over the period from September of 1978 to July of 1985 are used in this study. Over this period 82 monthly observations are available. The USDA data series used was the budget series for the Great Plains cattle feeding region. This data series was chosen since it was the most comparable to the private data available. The nature of this series is well documented in the "Livestock and Poultry Outlook and Situation Report" and will not be discussed in detail here. The consulting company from which private data was obtained provides a number of services to its feedlot clients, one of which is to

provide comparative performance records by regions of the country. To provide this service the consulting firm collects the "closeout sheets" for all the pens of cattle sold by its customer feedlots. These closeout sheets are aggregated and summarized to determine an average pen closeout sheet. An example of the form of this average closeout sheet is given in Table 1. In addition to the data presented in the closeout sheet itself, the average value for a number of other technical coefficients underlying the closeout sheet are also available. They include feed conversion rates, ration price per ton, days on feed, growth rate per day, death rate and labor cost per head.

Table 1. Representative USDA Monthly Budgets and Industry Closeout Sheets

Industry Closeout Sheet	
Cost in (756 lbs. @ $0.6015)	$454.73
Cost of Gain (397 lbs. @ $0.5118)	203.18
Interest @ 12.5% (on 1/2 the feed and all of the feeder cattle cost)	28.39
TOTAL COSTS	$686.30
Sale (1,153 lbs. @ $0.6539)	$753.95
NET PROFIT PER HEAD	$ 67.65
NET PROFIT PER DAY ON FEED	$ 0.53

One of the regions the consulting firm summarizes data for is called the "Central Plains." This region roughly encompasses an area within a one-hundred mile radius of the center of the Oklahoma panhandle. Over the time period considered here an average of about forty feedlots were served by the consulting company in this area. On average, the sales of cattle by these forty feedlots constituted about 15 percent of the total fed cattle sold in the states of Colorado, Kansas, Texas and Oklahoma. Hence it is felt that the consulting company's data provides a sample that is sufficiently large to give a realistic representation of the nature of cattle feeding profits in the High Plains region. Equally important is the fact that the consulting company's

data reflects actual production records which contain both price variation and technical production coefficient variation.

Reported Means and Variances

Table 2 reports the means and variances of the net income, costs, and revenues reported by the industry and estimated by the USDA. Statistical tests were conducted to determine which of the means and variances reported were significantly different at the 5 percent level. The results are reported in the bottom half of Table 2. An F-test was used to test for equality of variances with no assumptions imposed as to whether the means of the two populations were equal or not. The variance of the net income reported by the USDA and the industry were found to be equal. The variances of all the major subcomponents of net income were also found to equal, except for the variance of feedlot cost where the USDA variance was found to be higher.

Table 2. Means and Variances for the USDA and Industry Data

	USDA		Industry	
	Mean	Variance	Mean	Variance
Revenue from Sales	695.64	2,269	719.12	2,306
Total Costs	738.93	3,334	725.87	3,760
Feeder Animal Cost	412.30	2,121	469.42	2,328
Feedlot Cost	287.55	968	219.74	402
Interest Cost	39.07	99	36.71	64
Net Income	-43.29	4,231	-6.75	3,724

Tests for Equality of the Means and Variances[a/]

	Means	Variances
Revenue from Sales	USDA < Industry	Equal
Total Cost	Equal	Equal
Feeder Animal Cost	USDA < Industry	Equal
Feedlot Cost	USDA > Industry	USDA > Industry
Interest Cost	Equal	Equal
Net Income	USDA < Industry	Equal

[a/] All tests are at the 5 percent significance level. Two tailed equality tests were conducted first followed by one tailed tests if the two tailed test failed.

Examination of the covariances and correlation coefficients of the variables in Table 2 is insightful. These values are reported in Table 3 for both the USDA and industry data. First it is observable that a modest positive correlation exists between total costs and total revenue. One would likely expect this in a competitive market which continually pressures profits toward zero. Given net income is the difference of these two variables, their positive correlation causes the variance of net income to be less than the sum of the variances for revenue and total cost, i.e. $Var(Y-X) = Var(Y) + Var(X) - 2xCov(YX)$.

Secondly it is noted that the covariances between the cost components are different for the USDA data versus the industry data, but in general positive. The general positive correlations result in the variance of the total cost being greater than the sum of the variances of the three cost subcomponents. Again, this follows since the variance of a sum is $Var(Y + X) = Var(Y) + Var(X) + 2xCov(YX)$.

Underlying Differences in the USDA and Industry Variance Data

Despite the fundamental difference in the way the USDA and industry data series are developed, the previous tests of the variance of the net income for each series and the variances of the major components of net income showed that in all but one case the variances of the variables in question were same. Why? As pointed out earlier it might intuitively seem that the product of two random numbers should have a greater variance than the product of one random number and a constant. Reasons for why this is not the case will be examined in detail in the following sections.

Differences in Price Series Used

There are reasons to suspect that the USDA price series might be less volatile than those reported by the industry feedlots. The USDA basically

Table 3. Variance, Covariance and Correlation Coefficients Between Costs and Revenue for USDA and Industry Data

	Revenue	Feeder Cost	Feedlot Cost	Interest Cost	Total Cost
	----------USDA Data----------				
Revenue	2,269	634	-21 [a/]	72	685
	1.0	.289	-.014 [a/]	.151	.249
Feeder Cost		2,121	-136 [a/]	77 [a/]	1,425
		1.0	-.095 [a/]	.168 [a/]	.536
Feedlot Cost			968	132	1,392
			1.0	.428	.775
Interest Cost				99	309
				1.0	.537
Total Cost					3,334
					1.0
	----------Industry Data----------				
Revenue	2,306	776	149 [a/]	111	1,035
	1.0	.356	.164 [a/]	.307	.374
Feeder Cost		2,328	197	227	2,751
		1.0	.204	.589	.930
Feedlot Cost			402	57	657
			1.0	.358	.534
Interest Cost				64	349
				1.0	.711
Total Cost					3,760
					1.0

[a/] Insignificant at the .05 level of confidence. The correlation coefficient must exceed .19 to be significant at the .05 level.

uses average monthly prices paid and received by farmers series. The industry data on the other hand is the average of actual prices paid by the feedlots surveyed. In the case of feeder cattle and slaughter cattle prices, variation in the industry data can be caused both by changes in the market price in general and by purchases and sales at different weights and qualities. Likewise industry ration price variation could be due to changes in feed prices as well as changes in ration compositions.

Table 4 reports the results of test conducted to determine if the means and variances of the price series used by the USDA and the industry series

Table 4. Means and Variances of USDA and Industry Price Data

	USDA		Industry	
	Mean	Variance	Mean	Variance
Slaughter Steers ($/cwt)	65.82	20.34	64.70	19.88
Feeder Cattle ($/cwt)	67.55	58.94	66.95	47.07
Ration Cost ($/ton)	122.58	216.77	126.52[a/]	171.66
Interest Rate (percent)	14.60	12.77	15.70	6.60

Tests for Equality of Price Means and Variances

	Means	Variances
Slaughter Steers	Equal	Equal
Feeder Cattle	Equal	Equal
Ration Cost	Equal	Equal
Interest Rate	USDA < Industry	USDA < Industry

[a/] Industry feed ration data were reported on a dry matter basis. A 16 percent moisture content was assumed to convert feed prices and quantities to a comparable basis to the USDA data.

reported are the same. Contrary to the issues just raised, the statistical test shows the two data sets to have equal price variances and means, except in the case of interest rates, where the USDA interest rate series is more volatile and has a lower average.

Physical Parameter Variation

Table 5 lists key physical parameters and their variances for the industry data and compares them to assumed constant values used by the USDA. Tests of equality between the assumed USDA values and the average industry data have also been made and reported in Table 5. In general the industry data are significantly different in magnitude than the USDA data. Specifically the industry data indicates cattle are fed for shorter periods, and gain less total weight than assumed by the USDA. The difference in total pounds gained is due to the industry placing cattle approximately 100 pounds heavier than the USDA assumes and slaughtering them only about 50 pounds heavier than the USDA assumes. The reported industry average daily growth

Table 5. USDA and Industry Physical Production Parameters

	USDA	Test for Equality	Industry	
			Mean	Variance
Slaughter Weight	1,056	<	1,111.98	400.31
Placement Weight	600	<	701.54	703.07
Pounds of Gain	456	>	410.44	617.46
Days of Feed	182	>	147.34	96.15
Daily Gain	2.5	=	2.79	.03
Pounds of Feed Fed	4,200	>	3,380.50[a/]	47,252.26
Feed Conversion Rate	9.2	>	8.25[a/]	.49

[a/] Industry feed data was reported on a dry matter basis. A 16 percent moisture content was assumed to convert the industry data to a comparable basis to the USDA data.

rate is greater than the one assumed by the USDA, but not significantly greater.

The industry data in Table 5 show that significant volatility exists in the key physical parameters for cattle feeding. In terms of coefficients of variation (the ratio of the standard deviation to the mean) Table 6 shows that the physical/production variation present in cattle feeding is not as great as the price/market variation.

Table 6. Physical/Production Variance Versus Price/Market Variance

Quantities	Coefficient of Variation	Price	Coefficient of Variation
Slaughter Weight	.018	Slaughter Price	.069
Placement Weight	.038	Feeder Price	.102
Feed Fed	.063	Ration Cost	.104
Pounds Gained	.061	Cost of Gain	.108
Financed Debt	.086	Interest Rate	.164
Daily Gain	.062		
Feed Conversion Rate	.059		

If the price and quantity coefficients of variation reported in Table 6 are weighted according to their contribution to total costs and revenues (as reported in Table 2) and averaged, the average physical/production coefficient of variation is .033 while the average price/market coefficient of variation

is .088. Hence market, or price risk, is estimated to be about two and one-half times greater than physical or production risk.

Price/Quantity Interaction: Variances of Price and Quantity Products

Revenue and cost figures for cattle feeding are derived as products of price and quantity. Bohrnstedt and Goldberger have shown that if two variables are negatively correlated the variance of their product will be less than the sum of their variances. Table 7 shows the variances of the prices and quantities forming the cost and revenue components of industry net profit and the covariances and correlation coefficients between each set of prices and quantities. The table also shows the product of these prices and quantities and the variance of the products. The correlation between each of the price and quantity sets whose products form the components of net profit are negative, except for interest rates and financed capital. These negative correlations are a key factor in explaining why the industry data shows no greater net profit variance than the USDA budget data. The predominately negative correlation shown in Table 7 reduces the variance of the components of industry net profit. In addition, it was previously shown in the variance and covariance matrix in Table 3 that the correlation between total cost and revenue for the industry data was positive. This was noted to reduce the variance of their difference, which is profit. It was argued in the industry portion of this paper that negative price and quantity correlation as well as the positive correlation between cost and revenue is not by chance, but is the result of the market and rational managers working to maximize profit and reduce risk.

An interesting question to ask is "what would the industry data indicate profit volatility to be if all prices and quantities were independent?" This

Table 7. Variances of Industry Price and Quantity Data and Their Products

	Price		Quantity		Product	
	Mean	Variance	Mean	Variance	Mean	Variance
Revenue from Sales	64.71	19.9	1,111.30	400.3	712.12	2,036
Feeder Cattle Cost	66.95	47.1	701.54	703.1	469.42	2,328
Feedlot Cost	53.73	33.4	410.23	617.5	219.66	408
Interest Cost	15.70	6.6	576.09	2,475.0	36.71	64

Covariances and Correlations Between Prices and Quantities

	Correlation	Covariance
Revenue from Sales	-.462	-41.21
Feeder Animal Cost	-.164	-29.83
Feedlot Cost	-.538	-77.35
Interest Cost	+.187	+30.55

question is of interest in two respects. First it gives some perspective upon how management and market activities function to reduce risk, and secondly it sheds some light on the error that is being made in research efforts where random variation is injected into calculations and/or simulations without considering the correlation between these random series.

First consider the variance of the three cost and one revenue products reported in Table 7. They additively form net profit. If the prices and quantities reported in this table were independent, the variances of their products could be determined by Equation 1.

$$(1) \quad [\mu P^2 \times Var(Q)] + [\mu Q^2 + Var(P)] + [Var(P) \times Var(Q)]$$

where μ is the mean and P and Q are price and quantity respectively. Table 8 below reports the results of using Equation 1 to calculate the variance of the products of the prices and quantities in Table 7 assuming independence of price and quantity. The calculated variances assuming independence are greater than the actual variance in each case where negative correlation exists between the price and quantity series. Thus correlation between the

Table 8. Calculated Cost and Revenue Variances Assuming Independence of Price and Quantity Versus Actual Variance

	Calculated Variance Assuming Independent Price and Quantity	Actual Variance	Ratio of Calculated and Actual
Revenue from Sales	2,624	2,036	1.29
Feeder Animal Cost	2,635	2,328	1.13
Feedlot Cost	744	408	1.82
Interest Cost	46	64	.72
Sum	6,049	4,836	1.25

price and quantity variables is concluded to reduce the variance of net profit from 6,047 to 4,836.

If the four costs and revenues were independent, the sum of their variances would equal the variance for net profit. This is not the case. The variance initially reported in Table 2 for industry profit is less than the sum of the variances of the cost and revenue components of net revenue, i.e. the actual net profit variance is 3,724 versus the 4,826 found by adding the variances of the components of net profit. The reason for the difference is due to the correlations between the four subcomponents of net profit. These correlations were reported in the industry variance and covariance matrix in Table 5. The three cost components are positively correlated, thus causing the actual total cost variance to be greater than the sum of the variances for the three components of cost. However the correlation between revenue and total cost is also positive, causing the variance of their difference, which is net profit, to be less than the sum of the variances for costs and revenue. The later reduction effect is greater than the former increasing effect, thus causing the overall variance on net profit to be significantly less than the sum of the variances for the three cost components and one revenue component.

Conclusion

In comparing USDA budget derived estimates of feedlot profit variance with variances estimated from private industry data, no significant difference

was found. This is the case despite the fact that the USDA data considers only price variation and no production coefficient variation, while the industry data contains both price and production coefficient variation. The industry data showed that the ignored production coefficient variation, i.e. production risk, was significant. Based on a comparison of coefficients of variation, production coefficient variation/risk was found to be approximately one-third of that for price variation/market risk.

The reason the industry data did not show a higher variance than the USDA data for net profit is because of the negative correlation between the prices and quantities forming the market and production risk. The products of these prices and quantities form the cost and revenue components of net profit. Because they are negatively correlated their products have lower variances than the sum of the variances of the prices and quantities they are formed from. Furthermore total costs and total revenue are positively correlated, thus making the variance of their difference, which is net profit, less than the sum of the variance for cost and revenue. Thus, while the industry data contains more sources of variation than the USDA data, the interrelationships found between production and marketing risk offset these additional sources of variation.

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