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BAYESIAN DECISION STRATEGIES APPLIED TO PRODUCTION AND MARKETING DECISIONS FOR COW-CALF FARMS IN THE SHENANDOAH AREA OF VIRGINIA

Y. C. Chiang, R. B. Jensen, D. E. Kenyon, and R. G. Kline

The main objective of this study is to derive economic strategies or decision rules for beef cow-calf farmers making production and marketing decisions under uncertain beef prices and pasture conditions. The problem analyzed relates to decisions concerning alternative beef systems for a 400-acre beef farm in the Shenandoah area of Virginia. At the beginning of the fall season, given the level of corn production and cow herd size, a beef farmer, faced with uncertain pasture conditions and uncertain feeder and slaughter prices for the coming year, must decide whether to sell his weaned calves or to keep them for sale later. At this time the farmer decides the amount of corn to be harvested as grain and as silage and the amount of corn to sell.¹

A Bayesian decision technique² is used for the analysis of this problem. Linear programming (LP) is used to derive the data needed to develop payoff matrices. Formulation of the model, description of data development, and the results of both prior and posterior analyses are given below.

MODEL FORMULATION

Two types of models are analyzed: one with only a beef farmer's prior probability distribution on the states of nature — historical patterns of cattle prices and pasture (weather) conditions; and one with additional information regarding projected cattle prices available for a beef farmer to revise his prior

probabilities. The first model exemplifies a situation in which a beef farmer (decision maker), seeking to maximize expected monetary gain,³ determines appropriate production and marketing decisions based upon 1962-1971 average beef prices and historical (prior) probability distribution of beef prices and weather conditions. The second model utilizes projected prices to revise the prior probability distribution of the occurrence of different states of nature. The posterior distribution is used in the Bayesian model to determine production and marketing decisions of the beef farmer.

The effect of herd size on the sell-or-keep decision and the net returns position of the beef farm operator is investigated by modeling two typical herd sizes (360 and 180 cows per farm). The decision to sell or keep animals is an all-or-none decision; that is, the farm operator sells all or none of the cattle at a particular decision point. Additionally, the models exclude the possibility of buying calves or feeders during the year.

DATA REQUIREMENTS

The main data required for Bayesian decision models are the payoff matrices and the probability distributions of the states of nature affecting alternative actions. In this study the sell-or-keep decision is modeled for a "representative" large beef farm.

Y. C. Chiang is associate professor of agricultural economics at National Taiwan University; R. B. Jensen, D. E. Kenyon, and R. G. Kline are assistant professors and professor, respectively, of agricultural economics at Virginia Polytechnic Institute and State University.

This research is based on the senior author's Ph.D. thesis and is part of the Regional Research Project S-67, "Evaluation of the Beef Production Industry in the South." For a detailed description of the problem analyzed, see [2].

¹The planning year is Sept. 1 to Sept. 1 with the assumption that livestock inventory at the end of the year is the same as the beginning inventory.

²The theoretical framework of the Bayesian decision technique can be found in [3, 4, 5, 6, 7, and 9].

³It is assumed that the objective of the beef farmer is to maximize the returns to his fixed resources including his own labor, land, management, and equity capital. The results of this study assume utility is linear in expected dollars, thus maximizing returns also maximizes utility.

In accordance with Regional Project S-67, the "representative" large beef farm (i.e., the optimal size of farm when selling weaned calves) consists of 400 acres of open land and 360 beef cows and an appropriate complement of fixed non-land resources.⁴ The prior probability distribution of the states of nature was developed from historical data. The posterior probability distribution was calculated by incorporating price projections and the prior probability distribution of pasture conditions.⁵ With owned resources and herd size specified, returns for alternative beef systems (i.e., the payoff matrices) under various states of nature are determined by a maximization LP model.

Alternative beef systems are defined in terms of the length of time the weaned calves are kept by the farm operator. In early fall (Sept. 1) it is assumed the beef operator has four alternative actions (four beef systems) among which to choose. System 1 is to sell weaned calves on Sept. 1 when steer calves weigh about 500 lbs. and heifer calves weigh about 470 lbs. System 2 is to feed the calves to sell as medium feeders: the weaned calves are fed largely forage until March 31 to weights of 852 and 800 lbs. for steers and heifers, respectively. System 3 is to finish the beef calves as slaughter calves on dry lot: the steers will weigh 990 lbs. on March 31 and the heifers will weigh 880 lbs. on March 18 when marketed as slaughter calves. System 4 is to finish the beef calves as heavy yearling slaughters: the animals are first fed as medium feeders and then put on dry lot. The steers are sold on July 28 at 1,174 lbs. and the heifers on June 30 at 1,032 lbs.⁶ Expected pasture conditions during the year are important with all systems, as the cost of finishing medium feeders and maintaining the

cow-herd and replacements is directly affected by the pasture available.

By combining three pasture conditions (good, normal, and poor)⁷ with three price levels (high, average, and low)⁸ in each weight category, nine states of nature are defined. Table 1 illustrates the joint probabilities of various price levels and weather conditions.⁹ For example, normal pasture conditions occur about 53 percent of the time, and average slaughter calf prices (\$30.05 to \$32.86 per cwt) occurred about 24 percent of the time; thus, the prior joint probability of normal pasture conditions and an average slaughter calf price occurring is .1246 as shown on Table 1.

Additionally, it is assumed that on Sept. 1, corn production (120 acres with a 360-cow herd, 150 acres with a 180-cow-herd) which can be harvested for grain and/or silage is given and is at one of three possible levels — good, normal, or poor.¹⁰ The three levels of corn production result in different payoffs for each combination of pasture condition, beef price, and feeding system. That is, differing amounts of corn will be harvested for grain or silage depending upon pasture conditions and the feeding system under consideration. Unutilized grain is sold and additional grain can be purchased. Thus, each level of corn production results in a different expected return for each combination of the states of nature. An annual discount rate of 7 percent is used to discount future receipts to a present value basis in order to more accurately compare production and marketing decisions.

Linear regression is used to project national beef price levels from Sept. 1. Virginia prices are determined by simple regression equations of Virginia

⁴ The optimal-sized farm was determined by selecting that size farm and herd size that would provide at minimum annual cost an annual return of \$7,000 with 100 percent operator equity.

⁵ This process is explained in more detail later in this paper.

⁶ Initially, allowance was made for another decision on April 1 if System 2 were chosen. However, since System 2 was never selected as the optimal decision on Sept. 1, discussion of the prior and posterior models for the April 1 decision is omitted.

⁷ Pasture condition probabilities for the Shenandoah area were developed from the monthly pasture index for the years 1955 to 1971 reported by the Virginia Crop Reporting Service. This index ranges from 100 to 35. A pasture condition index of 100 means exceptionally good weather conditions for pasture production, whereas a condition index of 35 means extreme drought. The actual index used was the seasonal average. For this study three class intervals were used: from 75-85 (normal (N) pasture conditions), over 85 (good (G) pasture conditions), and below 75 (poor (P) pasture conditions).

⁸ In accordance with Regional Project S-67, the historical 1962-1971 average price plus 5 percent of the average price was assumed to be the average (A). Any price \$1.50 per cwt greater than the average price was assumed to be a high (H) price, and any price \$1.50 per cwt less than the average price was assumed to be a low (L) price. All prices were inflated to the 1971 price level.

⁹ Since the correlation coefficients between the pasture condition index and beef cattle prices at each level are very low, the probabilities of beef cattle prices and weather conditions are assumed to be independent. Thus, the joint probabilities of various price levels and weather conditions are just the products of their corresponding marginal probabilities (see Table 1 for the joint probabilities).

¹⁰ Under normal weather conditions, the yield of corn grain was estimated to be 98 bushels per acre. The coefficient of variation of the yield for corn grain, based on data from 1958 to 1971, with approximately 16 percent variation was added to and subtracted from the normal yield (98 bushels per acre) to obtain the good and poor yields of corn grain under the good and poor weather conditions, respectively. The same procedure was used to obtain normal, good, and poor yields per acre for corn silage.

Table 1. PRIOR PROBABILITY DISTRIBUTION ON SEPT. 1 OF THE STATES OF NATURE FOR VARIOUS BEEF PRODUCTION SYSTEMS

States of Nature ^a		Beef production system			
Pasture condition	Price level	sell weaned calves ^b	sell medium feeders	sell slaughter calves	sell heavyweight slaughters
G	H		.0865	.0865	.0865
G	A	.2941	.1038	.0692	.1557
G	L		.1038	.1384	.0519
N	H		.1558	.1557	.1557
N	A	.5294	.1868	.1246	.2803
N	L		.1868	.2491	.0934
P	H		.0519	.0519	.0519
P	A	.1765	.0623	.0415	.0934
P	L		.0623	.0831	.0312

^aG, N, and P stand for good, normal, and poor pasture conditions, respectively; H, A, and L stand for high, average, and low beef cattle price levels, respectively.

^bOn Sept. 1, calf price is certain, so only the pasture conditions (which affect the cost of maintaining the cow herd and replacements the remainder of the year) will affect the farm operation.

prices regressed upon the corresponding national prices. The projected prices are used to revise the prior probability distribution of the states of nature which in turn alters the payoff matrices of the posterior analysis. The projection equations are shown in the Appendix.

PRIOR ANALYSIS RESULTS

The results of Bayesian decision strategies using historical probabilities are presented in this section. The annual expected returns for both a 360- and 180-cow herd are shown in Table 2. These expected returns are weighted averages calculated by multiplying the prior probability of each possible outcome times the respective expected value (payoff) of each outcome.

With a 360-cow herd and a linear utility function, the beef operator should feed his calves for sale as slaughter calves for all levels of corn production to maximize his expected returns to his labor, land, management, and fixed resources. For a herd size of 180 cows, the beef operator should feed his calves for sale as heavyweight slaughters if corn production is either good or normal. If corn

production is poor, he should feed his calves for sale as slaughter calves. The reasons for these differences for a 180-cow herd as compared to the 360-cow herd are: (1) with the 180-cow herd there is less total feed requirement, and since more of the cropland is used for corn production, more feed is available to feed the animals to a heavier weight, and (2) since the price of corn is lower when corn production is good, it will be worthwhile for the farmer to keep more corn (grain and/or silage) for feed. Thus, with good or normal corn production it will be profitable for the farmer to keep the beef cattle longer and sell them as heavyweight yearling slaughters with a 180-cow herd.

POSTERIOR ANALYSIS RESULTS

In general, if there is additional information available about the decision environment at the time a decision is to be made, a better decision is possible. Additional information regarding future beef prices is obtained by utilizing the price projection equations shown in the Appendix. While normally Bayes' theorem is used to revise the prior probabilities, in this case the new probabilities were calculated directly from the price projection equations. The

Table 2. SUMMARY OF EXPECTED RETURNS DERIVED FROM THE PRIOR PROBABILITY DISTRIBUTION FOR ALTERNATIVE LEVELS OF CORN PRODUCTION AND FOR HERD SIZES OF 360 AND 180 COWS GIVEN AN AVERAGE CALF PRICE LEVEL ON SEPT. 1

Corn Production Level	Beef Systems					
	sell weaned calves		sell medium feeders		sell slaughter calves	sell heavyweight slaughters
	Expected Pasture Conditions					
	Good	Normal	Poor	Normal ^a	Normal ^a	Normal ^a
-----360-Cow Herd-----						
Good	25,665	26,289	25,737	27,691	<u>37,755</u>	33,236
Normal	23,614	24,258	24,052	21,150	<u>31,072</u>	23,194
Poor	20,579	21,043	20,797	15,092	<u>22,988</u>	14,840
-----180-Cow Herd-----						
Good	15,672	16,554	16,477	19,358	23,671	<u>24,563</u>
Normal	17,773	18,687	18,471	20,178	23,725	<u>23,909</u>
Poor	18,412	19,352	18,752	19,919	<u>22,731</u>	22,142

^aOnly the normal pasture condition case is included in these systems, since the expected returns from the other two pasture conditions are not significantly different from the normal case.

prices estimated using the projection equations are the expected or average price for each weight category. Following the procedures of S-67, a projected high price was assumed to be \$3 per cwt greater than the average price, and a projected low price was assumed to be \$3 per cwt below the average price. In this manner three price levels are projected, thus allowing the payoff tables to be developed for high, average, and low prices. The calculation of the probabilities of high, average, and low prices is made by assuming a normal distribution of prices about the projected average price and by utilizing information on the error in estimating the parameters and the error of the random disturbance during the projection period¹¹ and the students' t distribution.¹²

For illustrative purposes, suppose a price of \$30 per cwt was estimated as the March price for slaughter calves. Thus, the payoff table is developed by using prices of \$33, \$30 and \$27 for the high, average, and low prices, respectively, for slaughter calves.¹³ Given a standard error of the projected price of \$1.75, the probability of the average price falling within \$1.50 of either side of the projected price was determined by calculating the t statistic (in this case $t = .857$ ($1.50/1.75$)) and by observing the appropriate probability in a table containing the t distribution (the probability associated with $t = .857$ and 16 degrees of freedom is .20). Since the t distribution is symmetrical, the probability of the actual price falling between \$31.50 and \$28.50 is .4,

¹¹See [8, pp. 48-49].

¹²This process, while conforming to S-67 objectives, is tedious when investigating the decision process over time. That is, new payoff tables and posterior probabilities need to be calculated for each new price projection. The reader should see [1] for a method of investigating the decision over time by employing predicted price changes.

¹³Projected high, average, and low prices for the other cattle weights are also utilized in developing the payoff table.

Table 3. POSTERIOR PROBABILITY DISTRIBUTION ON SEPT. 1 OF THE STATES OF NATURE FOR VARIOUS BEEF PRODUCTION SYSTEMS GIVEN AN AVERAGE LEVEL OF PRICE PROJECTION

States of Nature ^a		Beef production system			
Pasture condition	Price level	sell weaned ^b calves	sell medium feeders	sell slaughter calves	sell heavyweight slaughters
G	H		.0546	.0565	.0581
G	A	.2941	.1849	.1812	.1778
G	L		.0546	.0565	.0581
N	H		.0983	.1016	.1047
N	A	.5294	.3328	.3261	.3201
N	L		.0983	.1016	.1047
P	H		.0328	.0339	.0349
P	A	.1765	.1109	.1087	.1067
P	L		.0328	.0339	.0349

^aG, N, and P stand for good, normal, and poor pasture conditions, respectively; H, A, and L stand for high, average, and low beef cattle price levels, respectively.

^bOn Sept. 1, calf price is certain, so only the pasture conditions (which affect the cost of maintaining the cow herd and replacements the remainder of the year) will affect the farm operation.

and the probability of the actual price being greater than \$31.50 is .3, as is the probability of the actual price being less than \$28.50. Other probabilities associated with projected prices were calculated in a similar manner.

In the posterior analysis this additional information on projected cattle prices is incorporated with the prior probability distribution of pasture conditions to obtain the posterior probability distribution of the states of nature. These are shown in Table 3 for each beef production system.

In order to investigate the impact of the level of the price projections on the production and marketing decision, posterior probabilities and payoff tables were developed for two additional levels of price projections. The returns associated with a high level of price projection were developed by setting the prices for all weights of cattle \$3 per cwt higher

than the projected prices; the returns associated with a low level of price projection were developed by setting the prices \$3 per cwt lower than the projected prices.¹⁴ While this \$3 shift was arbitrarily imposed, it does allow the investigation of how the decision rules change as the entire price structure shifts with differing levels of the predetermined variables in projection equations.¹⁵ The payoff tables associated with the three levels of projected prices and the posterior probabilities for three levels of corn production are summarized in Table 4 for a 360-cow herd and Table 5 for a 180-cow herd.

On Sept. 1, the production and marketing decision rules will depend upon the projected level of beef prices (the additional information), the level of corn production, and the herd size. Given the high projected price level, the decision rules for the farmer with a 360-cow herd (Table 4) will be as follows: (1)

¹⁴New probabilities associated with the additional price levels were also estimated.

¹⁵Shifts in the price structure are realistic in that normally the prices for differing weights of cattle tend to move in the same direction. It is recognized, however, that the prices for heavier weights of cattle tend to increase or decrease less than the prices for lighter weights of cattle; thus, this method only serves as an approximation of investigating the impact of differing levels of price projection on the production and marketing decision.

Table 4. SUMMARY OF EXPECTED RETURNS ON SEPT. 1 DERIVED FROM THE POSTERIOR DISTRIBUTION FOR ALTERNATIVE LEVELS OF CORN PRODUCTION, PROJECTED PRICE LEVELS, AND EXPECTED PASTURE CONDITIONS FOR A HERD OF 360 COWS

Projected Price Level	Corn Production Level	Beef Systems					
		sell weaned calves		sell medium feeders	sell slaughter calves	sell heavyweight slaughters	
		Expected Pasture Conditions					
		Good	Normal	Poor	Normal ^a	Normal ^a	Normal ^a
High	Good	29,475	30,099	29,547	30,735	44,048	<u>44,905</u>
	Normal	27,424	28,068	27,862	24,194	<u>37,365</u>	34,863
	Poor	24,388	24,853	24,599	18,136	<u>29,281</u>	26,515
Average	Good	25,665	26,289	25,737	24,526	<u>36,955</u>	36,722
	Normal	23,614	24,258	24,052	17,985	<u>30,272</u>	26,680
	Poor	20,579	21,043	20,797	12,038	<u>22,188</u>	18,321
Low	Good	21,836	22,479	21,927	18,318	<u>29,862</u>	28,537
	Normal	19,804	20,448	20,244	11,777	<u>23,179</u>	18,495
	Poor	<u>16,769</u>	<u>17,233</u>	<u>16,987</u>	5,719	15,095	7,648

^aOnly the normal pasture condition case is included in these systems, since the expected returns from the other pasture conditions are not significantly different from the normal case.

if the corn crop is good, finish calves to heavyweight slaughters, and (2) if the corn crop is normal or poor, finish calves to slaughter calves. The decision rule for the farmer with a 180-cow herd (Table 5) will be to finish the calves to heavyweight slaughters for all levels of corn production.

Given the average projected price level, the decision rule for the farmer with a 360-cow herd will be to finish the calves for sale as slaughter calves for all levels of corn production; for a farmer with a 180-cow herd, finish the calves for sale as heavyweight slaughters for all levels of corn production. Finally, given the low projected price level, the decision rules for a farmer with a 360-cow herd will be: (1) if the corn crop is good or normal, finish the calves as slaughter calves, and (2) if the corn crop is poor, sell the weaned calves regardless of the expected pasture conditions. The decision rule for a farmer with a 180-cow herd will be to finish the calves as heavyweight slaughters.

If the prices of feeders, slaughter calves, and heavy slaughters are projected at different levels, the decision will depend upon the relative projected prices among these animals. For instance, using the 360-cow herd as an example, if for some reason the prices of feeders and slaughter calves are projected to be at an average level, but the price of heavyweight slaughters is projected to be at a high level, then growing calves for sale as heavyweight slaughters is the optimal action for all three levels of corn production and weaned calf prices.

Other combinations of projection levels can be investigated similarly. While the payoff tables presented were developed for prices consistent with the period of the data base (1955-1971), new payoff tables would need to be developed as new price levels arise.

IMPLICATIONS AND CONCLUSIONS

Additional information provided by regression

Table 5. SUMMARY OF EXPECTED RETURNS ON SEPT. 1, DERIVED FROM THE POSTERIOR DISTRIBUTION FOR ALTERNATIVE LEVELS OF CORN PRODUCTION, PROJECTED PRICE LEVELS, AND EXPECTED PASTURE CONDITIONS FOR A HERD OF 180 COWS

Projected Level	Corn Level	Beef Systems					
		sell weaned calves			sell medium feeders	sell slaughter calves	sell heavyweight slaughters
		Expected Pasture Conditions					
		Good	Normal	Poor	Normal ^a	Normal ^a	Normal ^a
High	Good	17,584	18,466	18,389	20,883	26,828	<u>30,413</u>
	Normal	19,685	20,599	20,383	21,703	26,883	<u>29,758</u>
	Poor	20,323	21,264	20,664	21,443	25,889	<u>27,991</u>
Average	Good	15,672	16,554	16,447	17,768	23,269	<u>26,307</u>
	Normal	17,773	18,687	18,471	18,588	23,324	<u>25,652</u>
	Poor	18,412	19,352	18,752	18,328	22,330	<u>23,885</u>
Low	Good	13,760	14,642	14,565	14,652	19,711	<u>22,201</u>
	Normal	15,861	16,775	16,559	15,472	19,766	<u>21,546</u>
	Poor	16,495	17,440	16,840	15,209	18,772	<u>19,779</u>

^aOnly the normal pasture condition case is included in these systems, since the expected returns from the other two pasture conditions are not significantly different from the normal case.

equations to project cattle prices gives information concerning optimal choice of beef systems. The farm's decision rules will depend upon the relative price levels of feeders and slaughters projected, the probability of their occurrence and the level of corn production. Based upon the results of this study, some implications can be pointed out for decision-making considerations.

If the projected prices of feeders and slaughters are at an average level, the beef farmer with a large cow herd should keep his weaned calves and finish them as slaughter calves. If, on Sept. 1, the prices of feeders and slaughters are projected to be at a high level, the best decision will be to finish to heavyweight slaughters if corn production is good, rather than finish as slaughter calves. For normal or poor corn crops the best decision is to finish the weaned calves for sale as slaughter calves. If the prices of feeders and slaughters are projected to be at a low level, the best decision is to sell weaned calves if the

corn yield is low and to keep the calves for sale as slaughter calves if the corn yield is normal or good. The best decision for a beef farmer with a small herd is to always finish the calves for sale as heavyweight slaughters.

If different price levels are predicted for feeders, slaughter calves, and heavy slaughters, then the relative predicted price levels among these animals become a very important factor in choosing the optimal strategy.

This study shows that for a large beef farm in the Shenandoah area of Virginia, in most cases, finishing slaughter systems appear to be more profitable than the beef cow-calf system or feeder systems. Actual data show that selling weaned calves is used by most of the beef farms in the Shenandoah area. This study indicates that selling weaned calves is the optimal strategy only if: (1) the herd size is relatively large, (2) the projected prices of feeders and slaughters are low, and (3) corn production is poor. However,

according to the past data, this combination of events does not occur very frequently. If there is a diversion between the predicted response and actual behavior, as it is in this case, either the model or the decision makers can be in error. If risk aversion on the part of the decision maker were assumed, which may be very

likely, the predicted response and actual behavior would be more similar. On the other hand, this study suggests that the development of additional finishing systems in Virginia is likely as producers adjust their operations.

REFERENCES

- [1] Bullock, J. Bruce, and Samuel H. Logan. "An Application of Statistical Decision Theory to Cattle Feedlot Marketings." *American Journal of Agricultural Economics*, Vol. 52, No. 2, pp. 234-241, May 1970.
- [2] Chiang, Y. C. "Economic Strategies for Beef Cattle Production Applied to the Shenandoah Area of Virginia." Unpublished Ph.D. thesis, Virginia Polytechnic Institute and State University, 1973.
- [3] Degroot, M.H. *Optimal Statistical Decisions*. New York: McGraw-Hill, 1970.
- [4] Fishburn, P. C. *Utility Theory for Decision Making*. New York: Wiley, 1970.
- [5] Good, I. J. *Probability and the Weighting of Evidence*. London: Griffith, 1950.
- [6] Hadley, G. *Introduction to Probability and Statistical Decision Theory*. San Francisco: Holden-Day, 1967.
- [7] Halter, A. N., and G.W. Dean. *Decision Under Uncertainty with Research Applications*. Cincinnati: South-Western, 1971.
- [8] Hu, Teh-wei. *Econometrics: An Introductory Analysis*. Baltimore: University Park Press, 1973.
- [9] Savage, L. J. *The Foundations of Statistics*. New York: Dover Publications, Inc., 1972.

APPENDIX

Beef Cattle Price Projection Equations for the Decision Problem on Sept. 1

Equation Number	1	2	3	4	5	6
Predetermined Variables ^a	Medium Steer Feeder (Mar) ^b	Medium Heifer Feeder (Mar) ^b	Steer Calf Slaughter (Mar) ^b	Heifer Calf Slaughter (Mar) ^b	Steer Heavyweight Slaughter (Jul) ^b	Heifer Heavyweight Slaughter (Jun) ^b
Constant term	-14.960 (-2.094) ^c	-11.950 (-1.682)	10.090 (3.090)	10.520 (3.775)	5.471 (2.414)	0.445 (0.161)
Price of medium steer feeder in the previous month (August)	0.8498 (3.555)					
Price of medium heifer feeder in the previous month (August)		0.7359 (3.964)				
Per capita income in 1000 dollars in the previous month (August)	10.639 (2.755)	11.344 (1.742)	16.938 (4.642)	16.340 (5.246)	12.719 (6.151)	17.795 (7.063)
Hog price in the previous month (August)	0.5559 (1.925)	0.8301 (2.144)	0.5169 (2.446)	0.5036		
Cattle on feed in 1000 head						
500-699 lbs. on last July 1	-0.0136 (-2.339)					
500-899 lbs. on last July 1		-0.0061 (-1.618)				
Less than 899 lbs. on last April 1			-0.0067 (-3.728)	-0.0066 (-4.300)		
Less than 699 lbs. on last July 1					-0.0076 (-3.818)	-0.0128 (-5.252)
R ^b : Coefficient of determination	0.8943	0.8835	0.8101	0.8347	0.9348	0.9182
SEE: Standard error of estimate	1.563	1.610	1.668	1.424	0.950	1.158

^aAll the price variables are in units of dollars per hundred weight.

^bMar = Projected March price, Jul = Projected July price, and Jun = Projected June price.

^cThe numbers in parentheses are t values.

