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ABSTRACT

Relationships between identifiable feeder calf characteristics and inherent or derived calf value were examined through a bioeconomic simulation model used to represent feeding and slaughter of cattle of various characteristics. Simulations represented cattle slaughtered at economically optimal times on an individual and on a pen-mean basis. Feed costs and carcass prices were artificially varied by 20 percent above and below base levels to analyze effects on derived calf values. Regression analysis of results of the simulated feedings revealed that some initial feeder calf characteristics have substantial impacts on calf value. Feeder calf weight had a negative effect on derived feeder calf value per hundredweight under most price and cost conditions. The negative effects were larger as feed costs decreased. Derived feeder calf value per hundredweight declined as initial fatness increased. Angus-Hereford cross cattle showed higher derived feeder calf values per hundredweight than did other breeds. Derived value of feeder calves was positively related to frame size. Initial muscling score of feeder calves had no significant relationship to derived calf value within the beef-type animals included in this study.

EFFECTS OF FEEDER CALF CHARACTERISTICS ON INHERENT CALF VALUE UNDER DIFFERENT CARCASS PRICES AND FEED COSTS

Introduction

The beef industry may be divided into five interlocking segments: commercial cow-calf producers, stocker operators, feedlot operators, packers and processors, and retailers. Demand and expectations for beef originate with retail consumers and are passed back through each segment of the industry by the price system. According to economic theory, animal or product flow through the segments is determined in response to consumer demand and is initiated by calf producers. The inherent value of calves offered by producers, over time, is a residual derived from carcass value less the costs of growing and feeding the animals (Purcell and Holmes 1978).

Relative prices received for calves are determined from describable characteristics of calves known or perceived to be related to the costs of growing and feeding the animals and to the characteristics of the final carcass and, thus, to the inherent value of the calf. Among such calf characteristics are weight, frame size, and degree of muscling — the bases of the current USDA feeder grade system (USDA 1979). In addition, calf condition or fatness has been related to subsequent performance (Butts et al. 1980a,b) and found to be used by feedlot managers in purchasing decisions (Anderson 1980).

This study examines the contributions of identifiable feeder calf characteristics to inherent or derived calf value at different carcass prices and feed costs. It also examines the effects of feeder calf characteristics on feedlot performance and on carcass characteristics of the animals at slaughter.

The work required modelling the relationships between calf characteristics and (a) the cost of feeding and (b) the value of carcasses produced. Hence, a bioeconomic simulation model was developed to predict feeding costs and carcass values for individual animals.

Price and cost information used in the simulation model were developed over two different time periods: 1983–84 and 1986–87. The prices and costs from these two time periods reflect the times at which the two analyses were actually accomplished — 1986 for the first analysis and 1988 for the second. Within these two time periods, feed costs and carcass prices used in the analysis were artificially increased and decreased to investigate the sensitivity of the results to changing price and cost. All analyses were made with cattle slaughtered at times representing maximum net return. For the 1983–84 simulations, the animals were assumed to be slaughtered at their individual points of maximum net revenue, while for the 1986–87 simulations, the animals were assumed to be slaughtered when the pen or group of animals reached its point of maximum net revenue.

Method of Analysis

Concepts of the Model

The bioeconomic model developed for this study consists of a sequence of mathematical equations that represent the progress of *individual* animals through the feedlot finishing process.* The set of equations describes aspects of the purchase, feeding, growth, and selling process for individual animals in the analysis. Coefficients for growth — in terms of weight, fat thickness, feed consumption, yield grade, marbling

*More details on methods used in this study may be found in Ferguson (1986).

score, and salable carcass weight — were developed separately by regression analysis and used as inputs for the simulation model. Net returns to the individual animals were calculated for every five days on feed, and the optimal slaughter point for each animal was selected by identifying the point of maximum net return from the animal. This point was identified as the number of days on feed at which the marginal net revenue of another day's feeding was zero. Feedlot performance, carcass characteristics, and inherent or derived calf value (from the simulations under different prices and costs) were correlated with initial feeder calf characteristics through multiple regressions. The results provide estimates of the inherent or derived value of the feeder calf's initial characteristics.

Sources of Biological Data

Biological data used to develop the model were obtained from three animal experiments. Two of the studies used similar feeding and management techniques in their experimental procedures. The first was conducted from September 1975 through August 1977, and entailed the feeding and individual slaughter of 350 steers at an estimated subcutaneous fat thickness of 12 mm (Butts et al. 1980 a,b). The second study, conducted from September 1977 through August 1980, involved the feeding of 630 steers (Butts et al. 1984). Individual animals in this experiment were serially slaughtered on assigned dates ranging from 62 to 293 days on feed.

Animals in both experiments consisted of Angus, Hereford, Angus-Hereford cross, and Charolais-cross calves. Calves were purchased annually in late September and early October from Tennessee graded feeder calf sales and included the range in frame size and maturing rate representative of the area.

After arrival at the University of Tennessee Agricultural Experiment Station in Knoxville, calves were penned in groups of six or seven for approximately 30 days, during which they received a diet of corn silage fed *ad libitum* and limited grain.

Subjective measures of feeder calf characteristics were made at the end of the stabilization period by a live animal evaluator with approximately 30 years of experience. The scores reflected individual animal differences in frame size and muscle expression. Scores were expressed on a scale of 1 to 15, with greater exhibition of a trait receiving a higher score. Frame scores represented estimates of structural dimension associated with expected slaughter weights. A low score indicated a relative structural dimension associated with an expected smaller slaughter weight. For example, frame scores of 4, 5, and 6 represented relative structural sizes associated with anticipated slaughter weights of 890 to 1,000 pounds. Scores of 7, 8, and 9 denoted structural sizes representative of slaughter weights between 1,000 and 1,100 pounds (Butts et al. 1980b).

Muscle scores reflect the individual animal's natural thickness and body shape. Butts and others noted that the factors that influenced subjective muscle scores included "thickness and shape of the quarter, 'expression' down the top, prominence of muscle in the stifle and forearm, and width of walk" (1980b). Animals that were characterized as flat-quartered and narrow-fronted received low scores, while thick-quartered, wide-fronted animals received high scores.

Throughout each study, ultrasonic measurements of fat thickness were made over the twelfth rib of the animal. Measurements were made by the same operator with a Branson Model 12 Sonoray.

The feeder animals in the two experiments were assigned to diet treatments representing high or medium levels of energy, with approximately half of the animals finished on each diet. The high level, or constant energy (concentrate) diet was fed *ad libitum* and was composed of 59 percent shelled corn, 20 percent cottonseed hulls, 10 percent cottonseed meal, 5 percent molasses, 3 percent dehydrated alfalfa meal, 2 percent animal fat, 0.5 percent ground limestone, and 0.5 percent salt. The medium level, or variable energy (silage-concentrate) diet consisted of corn silage offered *ad libitum* and a concentrate mixture composed of 86 percent corn and 14 percent cottonseed meal. The rate at which the concentrate mixture was fed varied during the feeding process. Initially, the mixture was fed at a daily rate of 1.25 percent of body weight (pen mean) and was increased to 1.40 and 1.55 percent when the animals reached a pen average of 8 and 10 mm of subcutaneous fat, respectively.

The concentrate and silage-concentrate diets were fed twice daily, and the concentrate was fed on top of the silage for the medium energy diet. Animals receiving the silage-concentrate diet were also offered a free choice mixture of salt and dicalcium phosphate (Butts et al. 1980a).

Animals in both studies were weighed and subcutaneous fat thickness was estimated (ultrasonic measurement) at 28-day intervals for the initial two months of the experiments and at 14-day intervals thereafter. The animals in the initial study were randomly assigned to feeding groups of six steers each. Second-order polynomials were fitted to initial and biweekly fat thickness estimates of individual steers each time they were weighed, and their fat thickness at the next weigh date was predicted. Individual animals that reached 12 mm of subcutaneous fat thickness or were predicted to reach 12 mm before the next weigh date were slaughtered (Butts et al. 1980a,b).

Animals in the serial slaughter data set were assigned to feeding groups of seven or eight animals of similar maturity. Animals within breed were ranked from earliest- to latest-maturing by predicting the number of days needed to reach 12 mm of fat from information obtained in a previous study (Butts et al. 1980a). Once grouped by maturity, the steers were randomly assigned to serial slaughter groups with slaughter dates ranging from 62 to 293 days on feed. Animals from each maturity group were assigned to each slaughter group resulting in a range in physiological maturity within and among slaughter dates.

Hot carcass weights were taken immediately after slaughter for animals in both data sets. Additional carcass data were collected after a 48-hour chilling period. The chilled carcass data included measures of external fat thickness, rib eye area, marbling, and kidney-pelvic-heart fat.

A third data set was utilized exclusively to develop the feed consumption equation included in the simulation model. This experiment was conducted over a five-year period and consisted of 113 Angus cow-calf pairs. Cows were selected from Tennessee Agricultural Experiment Station herds and exhibited variation in cow size as well as maternal ability (Butts et al. 1984).

Cows were bred to calve in March, April, and May, and the cow-calf pairs were fed in individual pens until weaning. After weaning, calves were individually fed (*ad libitum* until slaughter) a growing-finishing diet containing approximately 67 percent total digestible nutrients (TDN). During the feeding process, biweekly measures of weight, subcutaneous fat, and feed consumption were obtained on the feeder animals. Biweekly feed consumption was converted to TDN by nutrient composition values of feeds published by the National Research Council (1982). This conversion resulted in individual calves' feed consumption being represented by biweekly as well as cumulative measures of TDN.

Development of the Simulation

Equations representing individual animals in the simulation were based on biweekly weights and ultrasonic estimates of subcutaneous fat thickness of individual steers over the feeding period. Primary consideration in developing the equations was given to obtaining an accurate depiction of changes in the specific animals used in the study over the range in days on feed simulated. Validation of the various equations predicting performance, costs, and values for use on animals other than the ones included in this study was not attempted. Animals simulated were from the 12 mm fat thickness data set and the serial slaughter data set (the first two sets described above). Two criteria were established to determine which animals from the data sets would be simulated. Individual animals were to be fed a minimum of 100 days and to attain a minimum 10 mm of subcutaneous fat thickness. These criteria were necessary to provide a sufficient number of biweekly weight and fat observations on each animal to estimate the nonlinear regressions with acceptable accuracy over the range in time simulated. All animals in the 12 mm fat thickness data set met the criteria, while 434 animals in the serial slaughter set satisfied the requirements, resulting in a total of 784 animals simulated.

The 784 animals simulated consisted of 388 animals fed on the high-energy, concentrate diet and 396 animals on the medium-energy, silage-concentrate diet. Two hundred thirty-five of the animals were Angus, 223 were Hereford, 237 were Charolais cross, and 89 were Angus-Hereford cross. Average initial weight of the feeder animals was 558.62 pounds. Mean initial fat thickness was 2.01 mm. The mean frame size and muscling scores were 6.29 and 8.36, respectively. **Table 1** shows standard deviations and ranges for these characteristics.

Weight Equations

A logistic function was utilized to estimate individual daily weight changes for the 784 animals in the study (Nair 1954; Brown et al. 1976; and Fitzhugh 1976). The individual nonlinear regressions of biweekly weight observations on days on feed for *each* animal separately were of the form

$$(1)\quad WT_t = \frac{\beta_1}{1 + e^{\beta_2 + \beta_3 DOF_t}}$$

where:

WT_t = biweekly weight (pounds) at t ($t = 1, 14, 28, \ldots T$),
DOF_t = number of days on feed at t,
$\beta_1, \beta_2,$ and β_3 = parameters to be estimated (β_1 represents the upper asymptote),
e = 2.71828 . . . .

This form results in a function of the shape shown in **Figure 1**. Estimation of the parameters from the logistic equation enabled the prediction of individual animal's live weight at any number of days on feed. Examinations of plots of predicted live weight against days on feed, between 0 and 400 days, for individual animals revealed that the estimated regression line was primarily representative of the portion of the logistic curve between the inflection point and the upper asymptote (B and C, respectively, in **Figure 1**). This portion of the curve is characteristic of animals in feedlot situations where weight is increasing at a decreasing rate as the animal matures.

Plots of actual and predicted live weights against days on feed for the individual animals revealed that the nonlinear equations were accurate representations of the animals' actual weight change during the feeding process. The conventional concept of an R^2 value can be utilized to represent the proportion of the variation in the dependent variable explained by the nonlinear regression. Thus, as a measure of degree of fit for the individual nonlinear regressions, the proportion of the variation in live weight explained by the regression was represented by

$$(2)\quad 1 - \frac{\Sigma(WT - \hat{WT})^2}{\Sigma(WT - \bar{WT})^2}$$

Table 1. Means, Standard Deviations, Minimum and Maximum Values of Feeder Calf Characteristics for the 784 Cattle Used in the Simulations

Characteristic	Mean	Standard Deviation	Minimum Value	Maximum Value
Initial weight (lb)	558.62	50.22	403.00	757.00
Initial fat thickness (mm)	2.01	1.03	1.00	6.00
Subjective frame size[a]	6.29	3.25	1.00	15.00
Subjective muscle thickness[a]	8.36	1.60	4.00	14.00

[a]Subjective frame size and muscle thickness scores were assigned on a scale of 1 to 15, with higher scores reflecting greater manifestations of the trait.

where:

$\hat{WT}$ = weight predicted by the individual animal's estimated regression equation,

$\overline{WT}$ = mean of the observations on weight for each animal.

The proportion of explained variation of the individual regressions was calculated for a random sample of 50 animals from the 784 used in the study. This "R^2-like" value was equal to 0.999 or more in every case.

Fat Thickness Equation

The logistic equation was also used to estimate individual subcutaneous fat thickness levels for the simulated animals. Jeske's study (1982) estimated fat thickness for 66 steers by means of the logistic equation. His results suggested that it was desirable, for purposes of predicting outside the range of data for an individual animal, to fix β_1 at a constant value of 50, which forces all the curves to become

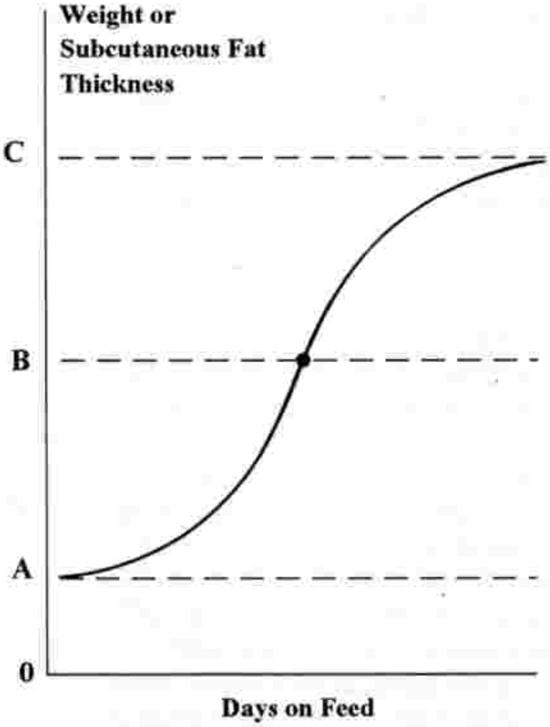

Figure 1. Representative shape of the logistic curve. A, B, and C are the lower asymptote, inflection point, and upper asymptote, respectively.

asymptotic at 50 mm of fat. Thus, the rate and number of days on feed at which the maximum of 50 mm occurred was determined by the estimates obtained for β_2 and β_3. The individual nonlinear regressions of biweekly ultrasonic fat thickness estimates on days on feed for each animal were of the form

$$(3)\quad FT_t = \frac{50}{1 + e^{\beta_2 + \beta_3 DOF_t}}$$

where:

FT_t = biweekly ultrasonic estimate of subcutaneous fat (mm),
DOF_t = number of days on feed at t ($t = 1, 14, 28, \ldots T$),
50 = upper asymptote in mm (β_1 of the logistic equation),
β_2 and β_3 = parameters to be estimated,
e = 2.71828 . . . .

As with the weight equations, the estimates of the parameters from the nonlinear fat equations for each of the 784 animals enabled the prediction of an animal's subcutaneous fat thickness at any number of days on feed.

Plots of predicted fat thickness against days on feed for individual animals showed that the estimated regression line was characteristic of the portion of the logistic curve between the lower asymptote and the inflection point (A and B, respectively, in **Figure 1**). This is representative of the deposition of subcutaneous fat because most animals deposit fat at an increasing rate throughout the normal length of the feeding process.

Examination of plots of actual and predicted fat thickness against days on feed revealed that the nonlinear fat equations were accurate representations of the actual changes in individual animals' subcutaneous fat thickness levels. The proportion of explained variation for the individual fat thickness regressions was calculated in a manner analogous to expression (2) for a random sample of 50 animals. These "R^2-like" values ranged from 0.914 to 0.997.

Carcass Grade Equations

Equations to estimate marbling score and yield grade were developed from the serial slaughter data set (the second data set described above). These 630 animals were serially slaughtered at intervals from Standard to Prime quality grade resulting in a wide variation in carcass characteristics. The animals in the constant 12 mm fat thickness data set were not utilized to develop the carcass grade equations because of the narrow range of carcass characteristics resulting from slaughter at a constant fatness endpoint. Preliminary inspection of the serial slaughter data suggested that days on feed and subcutaneous fat thickness were related to marbling scores as reported by Jeremiah et al. (1970), Kaufman et al. (1968), and Zinn et al. (1970). Further, the relationship between days on feed and marbling score was nonlinear with marbling score asymptotically approaching a limit as days on feed increased. Also, because animals on the lower energy silage-concentrate diet marbled more slowly than those on the concentrate diet, separate regressions were necessary for the two diets used in the study. The regression of marbling score on subcutaneous fat and, in nonlinear form, on days on feed gave the following relationships:*

(4) Concentrate Diet:

$$\begin{aligned} MS = {} & \underset{(0.90335)}{6.45639} + \underset{(0.01478)}{0.03047}FT \\ & - \underset{(0.74424)}{4.56038}\,e^{\underset{(0.00419)}{-0.00714}DOF} \end{aligned}$$

N = 289

*For each regression equation in the report, standard errors of estimated parameters are shown in parentheses.

(5) Silage-Concentrate Diet:

$$MS = \underset{(53.5445)}{13.43711} + \underset{(0.01620)}{0.11007}FT$$

$$- \underset{(52.98941)}{11.11982}e^{\underset{(0.00494)}{-0.00081}DOF}$$

$$N = 284$$

where:
MS = marbling score,
FT = subcutaneous fat thickness (mm) at slaughter,
DOF = days on feed.

As an indication of degree of fit, the percentage variation in marbling score explained by the nonlinear regressions was determined by the equation

$$(6) \quad 1 - \frac{\Sigma(MS - \hat{MS})^2}{\Sigma(MS - \bar{MS})^2}$$

and was equal to 0.958 for the concentrate equation and 0.963 for the silage-concentrate equation. Examination of plots of actual versus predicted marbling scores indicated that the marbling score equation provided accurate estimates of actual scores. During the simulation process, an individual animal's marbling score for a given diet was estimated by the relationships shown in equation (4) or (5) after the animal's subcutaneous fat thickness at slaughter was estimated by equation (3). Marbling scores were converted to carcass quality grades according to **Table 2**.

The equation to predict USDA yield grade was also developed from the serial slaughter data set. The simple linear form was used to regress yield grade on subcutaneous fat thickness. This relationship was chosen because fat thickness is the principal determinant of yield grade (Abraham et al. 1980; Crouse and Dikeman 1976; and Taylor 1984), and, in this data set, other available information did not explain significant additional variation in yield grade. The simple linear regression of yield grade on subcutaneous fat thickness resulted in the following relationship:

$$(7) \quad YG = \underset{(0.03205)}{1.20875} + \underset{(0.00262)}{0.13735}FT$$

$$N = 559$$

$$R^2 = 0.83$$

where:
YG = carcass yield grade,
FT = subcutaneous fat thickness (mm) at slaughter.

Yield grades for individual animals in the simulation were estimated by the relationship shown in equation (7) after the animal's subcutaneous fat thickness at slaughter was estimated by equation (3). For pricing purposes, yield grades less than 3.0 were considered to be 2, grades from 3.0 to 3.99 were considered to be 3, and those 4.0 or greater were considered to be 4.

Carcass Weight Equation

The equation to predict hot carcass weight was developed from the serial slaughter data set. Slaughter weights were available for 196 animals purchased in the fall of 1977 and slaughtered at dates varying from 77 to 257 days on feed. Slaughter weight and fat thickness were chosen as appropriate explanatory variables based on results from Raikes and others (1979). The estimated regression equation is contained in equation (8). A 4 percent shrink was assumed to adjust hot carcass weight to salable carcass weight. For animals in the simulation, salable carcass weight was determined by the following relationship, which consists of the estimated regression equation and the 4 percent shrink factor:

Table 2. Conversion of Marbling Score to Quality Grade for "A" Maturity Carcasses

Marbling Score	Degree of Marbling	Quality Grade
2.0–3.9	Practically devoid Traces	Standard
4.0–4.9	Slight	Good
5.0–7.9	Small Modest Moderate	Choice
8.0 and above	Slightly abundant Moderately abundant Abundant	Prime

$$(8) \quad SCWT = \underset{(10.2)}{0.96(-59.7} + \underset{(0.403)}{1.69FT} + \underset{(0.0116)}{0.641WT)}$$

$$N = 196$$

$$R^2 = 0.94$$

where:

$SCWT$ = predicted salable carcass weight (pounds),

FT = predicted subcutaneous fat thickness (mm) at slaughter — from Equation (3),

WT = predicted live weight (pounds) at slaughter — from Equation (1).

Feed Consumption Equations

In order to estimate costs of feeding for each of the 784 animals in the simulation, a method for estimating feed consumption for each animal was required. The third data set, described previously, consisting of 113 individually fed steers and heifers, was utilized to develop a feed consumption equation. Biweekly measures of weight, fat thickness, and feed consumption were obtained for each of the 113 feeder animals. Biweekly feed consumption was converted to a total digestible nutrient (*TDN*) basis from nutrient composition values for the feed components in the animals' diet. Cumulative *TDN*, at biweekly measurement points, was regressed on days on feed (*DOF*) for each of the 113 animals. The 113 simple linear regressions were of the form

$$(9) \quad CTDN_t = \propto + \beta_1 DOF_t$$

where:

$CTDN_t$ = cumulative *TDN* (pounds) at time t,

DOF_t = days on feed at time t,

t = 1, 14, 28, . . . T.

The R^2 values for the regressions ranged from 0.981 to 0.999, which indicates that cumulative *TDN* is a continuous linear function of days on feed. Daily *TDN* consumption for each animal is indicated by the regression coefficient β_1 for that animal and is constant over *DOF*. However, daily consumption (β_1) differs among animals.

Lofgreen and Garrett (1968) showed that net energy requirements for maintenance and weight gain increased with individual animal weight. Also, earlier-maturing animals require more energy per day per pound of body weight because they tend to deposit fat at a higher rate than do later-maturing animals (Young 1981). An animal's rate of maturing can be represented by the number of days on feed required to reach a given level of fat thickness. Thus, to develop an equation to represent feed consumption, daily *TDN* should be expressed as a function of animal weight and days on feed to reach a given level of fat thickness for the 113 animals. To obtain daily estimates of weight, biweekly weight measurements were regressed on days on feed for each of the 113 animals using the logistic form [equation (1)] described earlier. Likewise, to obtain daily estimates of fat thickness, biweekly measurements of fatness were regressed on days on feed using the logistic form [equation (3)]. These estimated equations for each animal were used to derive days on feed and weight estimates at 12 mm of fat thickness for each of the 113 animals. These estimates were then used in a regression of daily *TDN* consumption [β_1 from equation (9)] on days on feed and animal weight at 12 mm fat thickness:

$$(10)\quad DTDN = \underset{(1.04913)}{9.65204} - \underset{(0.00443)}{0.02367}\, \hat{DOF}12 + \underset{(0.00086)}{0.01100}\, \hat{WT}12 - \underset{(0.24163)}{0.40982}\, Y_0 + \underset{(0.19039)}{0.19689}\, Y_1 + \underset{(0.21090)}{0.73077}\, Y_2 + \underset{(0.19429)}{0.20897}\, Y_3 - \underset{(0.28604)}{0.72680}\, Y_4$$

$$N = 113$$

$$R^2 = 0.661$$

where:

$DTDN$ = daily *TDN* consumption (pounds) — β_1 from equation (9),

$\hat{DOF}12$ = predicted days on feed at 12 mm of fat — from equation (3),

$\hat{WT}12$ = predicted weight (pounds) at 12 mm fat — from equation (1),

$Y_0 - Y_4$ = a set of zero, one, and minus one dummy variables representing the 5 years the study was conducted (Pindyck and Rubinfeld 1991).

The set of dummy variables was included to account for year to year variations in animal performance due to environmental conditions. The dummy variables ($Y_0 - Y_4$) were omitted from the equation when the equation was used to estimate daily feed consumption for the 784 animals in the simulation. A binary variable differentiating sex of animal was also included in a trial estimation of equation (10) but was deleted due to a lack of statistical significance ($\propto = 0.10$).

Carcass Grade and Weight Price Differentials

In order to price carcasses produced in the simulation process, it was necessary to develop relationships between carcass characteristics and the value of the carcass. Separate analyses were conducted based on carcass values for 1983–84 and for 1986–87. In both cases the analyses were based on data that represented weekly average prices for the Omaha and Los Angeles markets taken from the USDA's *Livestock Meat Wool Market News* weekly booklets (1983–87). Price differentials for carcass quality and yield grades and carcass weight were developed based upon these data. The price data represented USDA yield grades 2, 3, and 4 as well as Good (Select) and Choice quality grades. Carcass weight categories were 500–599, 600–699, 700–799, and 800–899 pounds for the 1983–84 data and 500–599, 600–699, and 700 plus pounds for the 1986–87 data.

Regression analysis was used to develop equations for pricing carcasses produced in the simulation procedure. The regression equations expressed the weekly price for each category of carcass (as a ratio of the base price) as a function of a set of dummy variables representing the various carcass grade and weight categories. The equation for the 1983–84 data was as follows:

$$(11)\quad I_{ijk} = \frac{P_{ijk}}{P_{c36}}$$

$$= \underset{(0.0615)}{97.1058} - \underset{(0.0992)}{3.2924Q} + \underset{(0.0636)}{3.7421Y_2}$$

$$+ \underset{(0.0526)}{3.1218Y_3} - \underset{(0.0730)}{6.8639Y_4} + \underset{(0.1011)}{0.0444W_5}$$

$$+ \underset{(0.0602)}{0.0647W_6} - \underset{(0.0713)}{0.0605W_7} - \underset{(0.0935)}{0.0486W_8}$$

$N = 1691$

$R^2 = 0.866$

where:

- I_{ijk} = index of price for carcasses of the *i*th quality grade, *j*th yield grade, and *k*th weight category based on the price of Choice, Yield Grade 3, 600–699 pound steer carcasses;
- P_{ijk} = weekly average price per hundredweight for steer carcasses of *i*th quality grade, *j*th yield grade, and *k*th weight category;
- P_{c36} = weekly average price for Choice, Yield Grade 3, 600–699 pound steer carcasses;
- Q = a zero-one dummy variable differentiating Good (1) and Choice (0) quality grades;
- Y_j = a set of zero, one, minus-one dummy variables differentiating Yield Grades 2, 3, and 4;
- W_k = a set of zero, one, minus-one dummy variables differentiating carcass weight categories from 500–599 to 800–899 pounds.

The analogous equation for the 1986–87 data was

$$(12)\quad I_{ijk} = \frac{P_{ijk}}{P_{c36}}$$

$$= \underset{(0.1369)}{95.7061} - \underset{(0.2246)}{6.1450Q} + \underset{(0.1484)}{4.3115Y_2}$$

$$+ \underset{(0.1142)}{3.9360Y_3} - \underset{(0.1314)}{8.2475Y_4} - \underset{(0.1490)}{0.4184W_5}$$

$$+ \underset{(0.0852)}{0.3166W_6} + \underset{(0.1443)}{0.1018W_7}$$

$N = 1721$

$R^2 = 0.765$

As an illustration of how equations (11) and (12) are used, the index value for a Choice, Yield Grade 3, 600–699 pound steer carcass according to equation (12), using 1986–87 data, would be

$$(13)\quad I_{C36} = 95.7061 + 3.9360 + 0.3166 = 99.9587.$$

Equation (11), using 1983–84 data, would yield a similar result (100.2923). With the Choice, Yield Grade 3, 600–699 pound carcass as a base, Good or Select carcasses were discounted 3.29 percent for 1983–84 and 6.15 percent for 1986–87. Yield Grade 2 carcasses sold at a premium of 0.62 percent in 1983–84 and 0.38 percent in 1986–87, while Yield Grade 4 carcasses sold at a discount of 9.98 percent in 1983–84 and 12.18 percent in 1986–87. There were no statistically significant ($\alpha = 0.05$) differences in the price index due to carcass weight for the 1983–84 data. However, for 1986–87, carcasses in the 500–599 pound class were discounted 0.74 percent below the base class of 600–699 carcasses.

Prices were not available from the USDA weekly reports for carcasses with a quality grade of Standard or for carcasses weighing less than 500 pounds. A telephone survey of three packer buyers provided the necessary information to estimate price differentials for Standard and less than 500-pound carcasses. The average discount below Choice indicated by the packers for Standard carcasses was 15.38 percent in 1984 and 15.33 percent in 1987. For carcasses weighing less than 500 pounds the average discount below 600–699 pound carcasses was 4.5 percent in 1984 and 5.94 percent in 1987. These percentage discounts were used to augment equations (11) and (12) to provide a system for valuing carcasses produced at various points in time in the simulation process. This system is represented in **Table 3** for the 1983–84 data and in **Table 4** for 1986–87 data.

In order to value the carcasses during the simulation process, a base price for Choice, Yield Grade 3, 600–699 pound carcasses was required. The mean prices for this category of carcasses from each of the price data sets were used for this purpose. The mean for the 1983–84 data set was $100.42 per hundredweight (cwt.) of chilled carcass, while the mean for the 1986–87 data set was $95.31 per cwt. Utilizing these base prices and the indices from **Tables 3 and 4**, carcasses of any grade and weight characteristics could be assigned a value. For example, based on the 1983–84 data **(Table 3)**, the price of a Good, Yield Grade 2, 700–799 pound carcass would be $97.91 per cwt. (0.975 × $100.42). The base price of $100.42 for 1983–84 and $95.31 for 1986–87 could be varied to reflect higher or lower overall carcass price levels.

Feeder Calf Costs

Purchase prices per hundredweight for the 784 feeder animals in the simulation were determined by weight class and by feeder grade (frame size and muscle score). Initial weight and subjective frame and muscle scores determined when the animals were put on feed (as described earlier) were used to assign per hundredweight prices for each animal. Frame size and muscle scores were based on a scale of 1 to 15. Small frame animals had scores of 1 to 6, while medium and large frame animals were depicted by scores of 7 to 12 and 13 to 15, respectively. Number 1 muscled animals were represented by scores of 6 to 15; Number 2 and Number 3 animals were represented by scores of 3 to 5 and 1 to 2, respectively.

Annual average prices for given grade-weight categories of feeder animals on Tennessee auction markets were obtained for 1984 and for 1987 from *Tennessee Agricultural Statistics* (Tennessee Crop Reporting Service) and other sources.* The resulting prices by grade and weight are shown in **Table 5** for 1984 and in **Table 6** for 1987. Prices for Number 3 muscled animals are not shown because no animals were in that category among the 784 in the simulation.

A death loss allowance of 1 percent was added to the individual animal's purchase cost shown in **Tables 5 and 6**. In addition, a procurement charge of $5.28 per head was added to represent transportation (400 miles) to the feedlot (Ray and Walch 1985; USDA *Livestock and Poultry Situation and Outlook Report*, October 1985, and August 1987).

Feed Costs

Representative USDA feed prices for Corn Belt cattle feeders for 1984 and for 1987 were used to develop feed costs for the individual animals in the simulations (*Livestock and Poultry Situation and Outlook Report*, October 1985, and August 1987). The resulting costs are shown in **Table 7**. The component costs were combined to arrive at costs for each of the diets used in the simulations. The cost of the concentrate diet was developed based on six parts corn and one part protein supplement. This resulted in a cost of $122.54 per metric ton for 1984 and $87.92 per metric ton in 1987. The primary reason for the reduction in cost from 1984 to 1987 was the reduction in corn price.

The price of the silage-concentrate diet was based on a combination of silage and concentrate components. The concentrate was a mixture of 86 percent corn and 14 percent protein supplement, resulting in a price of $122.14 per metric ton in 1984 and $87.19 in 1987. Silage was priced at $25.01 per metric ton for 1984 and $17.27 for 1987. The cost per ton of the silage-concentrate diet varied during the simulated feeding period

*Additional details regarding the pricing of feeder animals in the simulation are available from Ferguson (1986) pp. 56–60.

because the amount of concentrate in the diet was varied based on the fat thickness of the animal. As discussed earlier, concentrate was fed at a daily rate of 1.25 percent of body weight up to 8 mm of fat thickness, 1.40 percent of body weight between 8 and 10 mm of fat, and 1.55 percent of body weight thereafter. Silage was fed *ad libitum* throughout the simulations involving the silage-concentrate diet.

To calculate the daily cost of feed consumed by an animal on the *concentrate* diet, daily *TDN* consumption (pounds) for the animal during that

Table 3. Index of Steer Carcass Prices by Weight, Yield, and Quality Grade, Based on Choice, Yield Grade 3, 600–699 Pound Prices, 1983–84

Carcass Weight (lb)	Standard		Good			Choice		
	YG2	YG3	YG2	YG3	YG4	YG2	YG3	YG4
400–499	81.03	80.41	93.12	92.50	82.51	96.41	95.79	85.81
500–599	85.51	84.89	97.60	96.98	86.99	100.89	100.27	90.29
600–699	85.53	84.91	97.62	97.00	87.01	100.91	100.29	90.31
700–799	85.41	84.79	97.50	96.88	86.89	100.79	100.17	90.19
800–899	85.42	84.80	97.51	96.89	86.90	100.80	100.18	90.20

Table 4. Index of Steer Carcass Prices by Weight, Yield, and Quality Grade, Based on Choice, Yield Grade 3, 600–699 Pound Prices, 1986–87

Carcass Weight (lb)	Standard		Select			Choice		
	YG2	YG3	YG2	YG3	YG4	YG2	YG3	YG4
400–499	79.06	78.69	88.25	87.87	75.69	94.39	94.02	81.84
500–599	84.27	83.89	93.45	93.08	80.90	99.60	99.22	87.04
600–699	85.00	84.63	94.19	93.82	81.63	100.33	99.96	87.78
700 plus	84.79	84.41	93.97	93.60	81.42	100.12	99.75	87.57

Table 5. Feeder Steer Purchase Prices ($/cwt.) by Frame Size, Muscle Thickness, and Weight Class, 1984[a]

Initial Weight (lb)	Small Frame		Medium Frame		Large Frame	
	No. 1 Muscle	No. 2 Muscle	No. 1 Muscle	No. 2 Muscle	No. 1 Muscle	No. 2 Muscle
	($/cwt.)					
400–499	58.30	49.62	67.14	59.86	63.90	56.62
500–599	52.55	46.48	63.18	56.72	59.94	55.48
600–699	48.70	44.04	59.33	54.28	56.09	51.04

[a]Purchase prices for No. 3 muscled steers were not included because none of the 784 animals in the simulation was classified in that grade.

Table 6. Feeder Steer Purchase Prices ($/cwt.) by Frame Size, Muscle Thickness, and Weight Class, 1987[a]

Initial Weight (lb)	Small Frame		Medium Frame		Large Frame	
	No. 1 Muscle	No. 2 Muscle	No. 1 Muscle	No. 2 Muscle	No. 1 Muscle	No. 2 Muscle
	($/cwt.)					
400–499	69.74	62.95	81.73[b]	73.77	81.73[b]	66.88
500–599	65.42	58.77	75.44	67.77	75.44	61.38
600 plus	64.10	58.40	69.75	63.55	69.75	61.38

[a]Purchase prices for No. 3 muscled steers were not included because none of the 784 animals in the simulation was classified in that grade.

[b]No price distinction was made between medium and large cattle by Tennessee market reporters in 1987.

Table 7. Feed Costs for 1984 and 1987

	1984	1987
Components		
Corn	$2.63/bu.	$1.50/bu.
Corn silage	$25.01/mton	$17.27/mton
Protein supplement	$10.81/cwt.	$11.85/cwt.
Concentrate diet	$122.54/mton	$87.76/mton
Silage-concentrate diet		
Concentrate	$122.14/mton	$87.19/mton
Silage	$25.01/mton	$17.27/mton

stage of its growth was obtained from equation (10) and converted to actual pounds of feed based on the nutrient composition of the feed components in the concentrate diet (National Research Council 1982). The resulting pounds of feed were then multiplied by the cost of the feed per pound to determine daily feed cost.

To calculate the daily cost of feed consumed by any animal on the *silage-concentrate diet*, the daily *TDN* consumption (pounds) for that animal during that stage of its growth was obtained from equation (10). The *TDN* available from the concentrate part of the diet was calculated based on the amount of the concentrate fed to the animal (discussed above) and on the nutrient composition of the feed components in the concentrate. The *TDN* available from the concentrate was then subtracted from the daily *TDN* consumed, and the remaining *TDN* was converted to pounds of silage. The resulting pounds of concentrate and pounds of silage were multiplied by their respective costs and added together to obtain daily feed cost.

Other Costs

Costs for other inputs for 1984 were based on estimates from Ray and Walch (1985) and from USDA for Corn Belt cattle feeding (*Livestock and Poultry Situation and Outlook Report*, October 1985). For the 1987 simulations, other costs were based on estimates from the University of Tennessee and from USDA for Corn Belt cattle feeding (*Livestock and Poultry Situation and Outlook Report*, August 1987). The resulting costs are shown in **Table 8**. Costs for machinery, minerals, and labor and management are shown on a per head per day basis. A one-time per head charge was included for veterinary services. Interest costs are shown on an annual basis. For each day the animal was on feed, interest was calculated on the total purchase cost of the feeder animal plus the sum of the feed and other costs accumulated up to that point in the simulated feeding period. At the end of the feeding period, a one-time per head charge was included for marketing and transportation of the finished animal.

Revenue, Cost, and Optimization Concepts

The total revenue obtained from an individual animal in the simulation was determined on a carcass weight basis. The final carcass value or total revenue for each animal in the simulation

Table 8. Other Costs of Feeding

Cost Item	1984	1987
Machinery ($/head/day)	0.0289	0.0194
Minerals ($/head/day)	0.00445	0.0045
Labor and management ($/head/day)	0.131	0.131
Veterinarian ($/head)	5.32	5.28
Interest (percent/annum)	13.55	11.00
Marketing and transportation ($/head)	5.66	5.66

was represented by the following expression:

$$(14)\quad TR = (P_{c36})(I_{ijk})(S\hat{C}WT) - 5.66$$

where:

TR = total revenue ($),
P_{c36} = predetermined price per cwt. for Choice, Yield Grade 3, 600–699 pound carcasses ($),
I_{ijk} = index of price for carcasses of the *i*th quality grade, the *jth* yield grade, and the *k*th weight class based upon the price of P_{c36} carcasses — from equation (11) or (12),
$S\hat{C}WT$ = predicted salable carcass weight converted to cwt. — from equation (8),
5.66 = marketing and transportation expense ($).

Total cost for each animal was represented by the sum of the costs for feeder animal purchase, feed, machinery, minerals, labor and management, veterinary services, and interest. Once feeding began, feeder animal purchase cost and veterinary services cost were fixed. The other costs increased as days on feed increased. Total costs may be represented as

$$(15)\quad TC = (LBF)(FP) + PC + MC + SC + LMC + VC + IC$$

where:

TC = total cost,
LBF = pounds of feed converted from predicted daily TDN consumption — from equation (10),
FP = feed price per pound,
PC = purchase cost of the animal,
MC = machinery cost,
SC = minerals cost,
LMC = labor and management cost,
VC = veterinary cost,
IC = interest cost.

The net revenue (NR) for an individual animal was the difference between total revenue and total cost:

$$(16)\quad NR = TR - TC.$$

The optimal slaughter point* during the feeding process for each animal was identified

*A second analysis using the model and data presented here was conducted on the assumption that the animal slaughter points were chosen so as to maximize net revenue to the feedlot rather than the animal [see Faris (1960); Nelson and Purcell (1972)]. Because that analysis led to the same conclusions as the analysis presented here (Ferguson 1986), it is not included in this report.

as the number of days on feed where net revenue to the animal was maximized. At this point the cost of another day's feeding exactly equaled the revenue from that day's feeding. Prior to this point, revenue from a day's feeding exceeded cost, and after this point, cost from a day's feeding exceeded revenue.

Inherent or derived value (*DV*) of the feeder animal was determined by the relationship:

$$(17) \quad DV = NR + PC.$$

This *DV* represents the finished animal's carcass value when slaughtered at the point of maximum net revenue for the animal, minus the cost of gain during the feeding process. That is, it is intended as a measure of the inherent value of the feeder animal at the beginning of the feeding process. DV may be expressed on a per hundredweight basis by dividing by the initial weight (*IWT*) of the feeder animal. A summary of the bioeconomic simulation model used in this study is shown in **Table 9**.

Table 9. Summary of the Bioeconomic Simulation Model

Variable	Relationship[a]	Equation no.
Live weight	$WT = f(DOF)$	1
Subcutaneous fat thickness	$FT = f(DOF)$	3
Marbling score[b]	$MS = f(FT, DOF)$	4 or 5
Yield grade	$YG = f(FT)$	7
Salable carcass weight	$SCWT = f(FT, WT)\ (0.96)$	8
Feed consumption[c]	$DTDN = f(DOF12, WT12)$	10
Carcass price index	$I = f(Q, YG, SCWT)$	11 or 12
Total revenue	$TR = (P_{c36})\ (I)\ (SCWT) - 5.66$	14
Total cost	$TC = (LBF)\ (FP) + PC + MC + SC + LMC + VC + IC$	15
Net revenue	$NR = TR - TC$	16

[a]Variable names and abbreviations are defined in the text.

[b]Marbling scores (*MS*) were converted to quality grades (*Q*) according to Table 2.

[c]Daily *TDN* (*DTDN*) was converted to pounds of feed (*LBF*) according to the nutrient composition values of feeds published by the National Research Council.

Changes in Feed Costs and Carcass Prices

To explore the effects of changes in the fundamental cost and revenue parameters in the model, feed costs and carcass prices were adjusted up and down by 20 percent for additional simulations. The 20 percent changes are illustrated in **Table 10** along with the base values. Increases in feed costs and decreases in carcass prices were expected to reduce net revenues and derived values of the feeder animals and to reduce the number of days on feed at which animals reached their maximum net revenue. Conversely, decreases in feed costs and increases in carcass prices were expected to increase net revenues and derived values of the feeder animals and to increase the number of days on feed at which animals reached their maximum net revenue.

Simulated Grouping and Slaughter Points

The simulations conducted using the 1983–84 price and cost data were done under the assumption that each of the animals was slaughtered individually when that animal reached its point of maximum net revenue. However, the simulations

Table 10. Carcass Prices and Feed Costs for Alternative Simulations

Item	Base Price or Cost	20 Percent Increase	20 Percent Decrease
Choice, YG3, 600–700 lb steer carcass ($/cwt.)			
1983–84	$100.42	$120.50	$80.34
1986–87	$95.31	$114.37	$76.25
Concentrate diet ($/metric ton)			
1985	$122.54	$147.05	$98.03
1987	$87.76	$105.31	$70.21
Silage-concentrate diet ($/metric ton)			
Concentrate			
1985	$122.14	$146.57	$97.71
1987	$87.19	$104.63	$69.75
Silage			
1985	$25.01	$30.01	$20.00
1987	$17.27	$20.72	$13.82

conducted using the 1986–87 price and cost data were done under the assumption that the feeder animals were grouped or penned according to initial weight, frame size, and fatness as well as by diet (concentrate or silage-concentrate). Weight categories were less than 525 pounds, 525 to 600 pounds, and greater than 600 pounds. Frame size categories were small, medium, and large as defined earlier. Fatness categories were 1 mm or less, 2 mm, and 3 mm or more.* This grouping system resulted in a total of 27 different groups or pens for each diet. All of the animals in a single pen were slaughtered as a group when the average net revenue for that pen as a whole was maximized. This approach was adopted for the 1986–87 data in order to more accurately represent practices in commercial feedlots, where animals are typically sorted into reasonably consistent types and managed as a group rather than individually.

Results and Analysis

The results consist of information on (a) the biological and economic aspects of feedlot performance and carcass characteristics of the animals simulated in the study and (b) the relationships between the animals' feedlot performance and carcass characteristics and their characteristics at the beginning of the feeding process. Of particular interest is the relationship between the animal's initial characteristics and the derived value of the feeder animal. Results of the simulations using 1983–84 price and cost data will be presented separately from results using 1986–87 data because, to some extent, the approaches used in analyzing the results were different.

Results from 1983–84 Data

Feedlot and Carcass Characteristics

Descriptive statistics for feedlot performance and carcass characteristics for the 784 animals in the simulation are shown in **Table 11**. These statistics represent values at the optimal (maximum net revenue) slaughter points for the animals. The results under the different price and cost situations discussed earlier are shown separately in **Table 11** for comparison purposes. In the high and low carcass price simulations, the base costs were used, while in the high and low feed cost simulations the base carcass prices were used. Results are presented for the concentrate and silage-concentrate diets combined.

The base price and cost simulation indicated that the mean optimal slaughter point for the 784 animals was at 175.63 days on feed with an average final live weight of 929.15 pounds and an average fat thickness of 10.27 mm (0.4 inches). Mean values were 2.62 for yield grade and 5.11 for marbling score. These results indicate that the premium prices associated with Yield Grade 2 and Choice quality grade carcasses (marbling score of 5.0 or more) were influential in determining optimal slaughter points. Mean feed costs were $183.20 per head, while net revenue averaged negative $41.98 per head. Negative net revenue reflects the fact that, under the base price and cost situation, net returns to the feeding process simulated here were negative. Derived value for the feeder animals in the simulation averaged $50.12 per hundredweight.

The simulation using 20 percent higher carcass prices ("High Carcass Price") resulted in higher days on feed (202.91) and heavier live weights (978.16 pounds). Also, fat thickness, yield grade, marbling score, and feed cost were higher, although yield and quality grade were still within the premium range. Net revenue was positive $68.21 per head, while derived feeder value increased to $69.97 per cwt., on average.

With 20 percent lower carcass prices ("Low Carcass Price") the average number of days on feed and live weight at the optimal slaughter point declined from the base price and cost situation. Quality grade declined into the Good grade due to the shorter feeding period. Net revenue was reduced, and the derived value of the feeder animal was only $32.09 per cwt.

*Fat thickness measurements on the feeder animals were made ultrasonically and ranged from 1 to 6 mm.

Table 11. Means, Standard Deviations,Minimum and Maximum Values of Feedlot and Carcass Characteristics at Optimal Slaughter Points, 1983–84 Price-Cost Data

Characteristic	Mean	Standard Deviation	Minimum Value	Maximum Value
Base prices and costs				
Days on feed	175.63	51.33	100.00	340.00
Final live weight (lb)	929.15	128.60	684.57	1,775.46
Final fat thickness (mm)	10.27	3.92	3.07	25.59
Yield grade	2.62	0.54	1.63	4.72
Marbling score	5.11	0.61	4.00	7.11
Feed cost ($/hd.)	183.20	56.74	75.51	488.75
Net revenue ($/hd.)	-41.98	44.68	-181.36	112.26
Derived feeder value ($/cwt.)	50.12	6.62	20.04	72.44
High carcass price				
Days on feed	202.91	57.58	100.00	340.00
Final live weight (lb)	978.16	142.22	689.57	1,800.03
Final fat thickness (mm)	11.99	4.24	3.37	27.16
Yield grade	2.86	0.58	1.67	4.94
Marbling score	5.45	0.63	4.01	7.18
Feed cost ($/hd.)	212.72	63.63	75.51	496.04
Net revenue ($/hd.)	68.21	52.32	-111.44	237.88
Derived feeder value ($/cwt.)	69.97	8.98	31.61	104.41
Low carcass price				
Days on feed	135.85	32.81	100.00	340.00
Final live weight (lb)	850.91	101.37	684.57	1,775.46
Final fat thickness (mm)	8.03	3.08	2.29	25.59
Yield grade	2.31	0.42	1.52	4.72
Marbling score	4.60	0.53	4.00	7.04
Feed cost ($/hd.)	140.42	38.64	75.51	488.75
Net revenue ($/hd.)	-142.06	39.85	-257.01	-21.57
Derived feeder value ($/cwt.)	32.09	4.92	8.46	49.97
High feed cost				
Days on feed	147.76	39.66	100.00	340.00
Final live weight (lb)	875.13	108.97	684.57	1,775.46
Final fat thickness (mm)	8.69	3.38	2.50	25.59
Yield grade	2.40	0.46	1.55	4.72
Marbling score	4.76	0.58	4.00	7.04

Table 11. (continued)

Characteristic	Mean	Standard Deviation	Minimum Value	Maximum Value
Feed cost ($/hd.)	183.94	54.06	90.62	586.50
Net revenue ($/hd.)	-76.64	43.97	-215.26	68.45
Derived feeder value ($/cwt.)	43.83	6.16	14.41	64.75
Low feed cost				
Days on feed	201.04	57.09	100.00	340.00
Final live weight (lb)	974.90	141.50	684.57	1,803.00
Final fat thickness (mm)	11.88	4.20	3.37	25.59
Yield grade	2.84	0.58	1.67	4.72
Marbling score	5.42	0.63	4.01	7.18
Feed cost ($/hd.)	168.59	50.70	60.41	396.83
Net revenue ($/hd.)	-1.06	46.63	-147.46	156.06
Derived feeder value ($/cwt.)	57.53	7.52	25.65	86.14

Table 11 also shows that the simulation using 20 percent higher feed costs ("High Feed Cost") resulted in shorter optimal feeding periods and lighter live weights than the base price and cost situation. Fat thickness, yield grade, and marbling scores were lower. Feed cost was unchanged despite the 54-day shorter feeding period. Net revenue declined, and derived value of the feeder animal fell to $43.83 per cwt. because of higher feed cost.

Lowering the feed cost by 20 percent ("Low Feed Cost") resulted in the expected longer average days on feed and heavier live weight at the optimal slaughter point. Mean fat thickness, yield grade, and marbling score increased, but mean yield grade remained below the threshold for the Yield Grade 3 discount. Average feed cost was lower and net revenue and derived value of the feeder animal were higher compared to the base price and cost situation.

Each of the alternative price and cost situations discussed above resulted in the expected changes in feedlot performance and carcass characteristics when compared to the base price and cost situation. This result provides evidence that the simulation model performed its intended function on average in a reasonably accurate fashion.

Effects of Feeder Calf Characteristics

As discussed earlier, each animal in the simulations was represented by an individual set of feeder cattle characteristics. These characteristics included initial weight, initial fat thickness, frame size, muscle score, and breed. Statistics on these characteristics for the 784 animals were given in **Table 1**. One of the primary objectives of this study was to analyze the effects of these feeder animal characteristics on economically important feedlot and carcass characteristics of the finished animals (discussed in the immediately preceding section) and to examine the relationship between feeder animal characteristics and derived value of the feeder animal. These relationships were analyzed using multiple linear regression procedures.

Each of the feedlot and carcass characteristics for the 784 animals was regressed on the individual sets of feeder animal characteristics for each price-cost condition considered. These regressions were of the general form

$$(18)\quad CH = \alpha + \beta_1 IWT + \beta_2 IFT + \beta_3 DIET + \beta_4 BRD_A + \beta_5 BRD_H + \beta_6 BRD_{CX} + \beta_7 BRD_{AH} + \beta_8 IFS + \beta_9 IMS$$

where:

- CH = dependent variable representing either of the feedlot or carcass characteristics,
- IWT = initial weight (pounds) of the feeder calf,
- IFT = initial subcutaneous fat thickness (mm) of the feeder calf,
- $DIET$ = a zero-one dummy variable representing concentrate (1) and silage-concentrate (0) diets,
- BRD_j = a set of zero, one, minus-one dummy variables representing breed with A = Angus, H = Hereford, CX = Charolais-cross, and AH = Angus–Hereford cross,
- IFS = initial frame score (1–15) of the feeder calf,
- IMS = initial muscle thickness score (1–15) of the feeder calf.

Equation (18) resulted in a total of 40 regressions (8 feedlot or carcass characteristics × 5 price-cost conditions) for the 1983–84 price-cost situation. Because the animal was the observational unit in these regressions, the number of observations for each regression was 784. R^2 values for these equations ranged from 0.109 to 0.445. The occurrence of some relatively low R^2 values may be attributable to the fact that the data were cross-section, but it suggests that there are omitted variables that have substantial effects on the feedlot and carcass characteristics or that the relationships that are included are nonlinear. That is, the observable initial feeder calf characteristics used in this study should account for less than half of the overall variation in the feedlot and carcass characteristics among animals in this study when the effects are restricted to be linear. Estimation of nonlinear relationships was not attempted in this analysis.

To facilitate analysis of the regression coefficients developed from equation (18), coefficients for each of the initial feeder calf characteristics were grouped into single tables. That is, **Tables 12–19** show the effects of each feeder calf characteristic on all feedlot and carcass characteristics for all of the price-cost situations. This allowed consideration of each feeder calf characteristic separately. In analyzing the results in these tables, coefficients were judged to be statistically significant if they were at least twice as large as their standard error shown in parentheses.

The effects of a change in Initial Weight (*IWT*) of the feeder animal on each of the feedlot and carcass characteristics are summarized in **Table 12**. For example, a one-pound increase in *IWT* was associated with a 0.3101-day decrease in days on feed under the base price-cost situation. *IWT* had a statistically significant negative effect on days on feed and a positive effect on final live weight under all price- cost situations. However, the effect of *IWT* on final fat thickness and yield grade were not significant under most situations. *IWT* had a significant negative effect on marbling score under all situations. This can probably be attributed to the fact that *IWT* had a negative effect on days

Table 12. Regression Coefficients Associated with the Explanatory Variable Initial Weight (lb), 1983–84 Data[a]

	Cost-Price Conditions				
Dependent Variable	Base Prices and Costs	High Carcass Price	Low Carcass Price	High Feed Cost	Low Feed Cost
Days on feed	-0.3101 (0.0343)	-0.2910 (0.0378)	-0.1960 (0.0226)	-0.2512 (0.0271)	-0.3002 (0.0374)
Final live weight (lb)	0.2835 (0.0868)	0.3377 (0.0925)	0.4865 (0.0666)	0.3654 (0.0729)	0.3175 (0.0919)
Final fat thickness (mm)	-0.0048 (0.0027)	-0.0058 (0.0030)	0.0017 (0.0019)	-0.0012 (0.0021)	-0.0066 (0.0029)
Yield grade	-0.0007 (0.0004)	-0.0008 (0.0004)	0.0002 (0.0003)	-0.0002 (0.0003)	-0.0009 (0.0004)
Marbling score	-0.0030 (0.0004)	-0.0027 (0.0004)	-0.0017 (0.0003)	-0.0023 (0.0003)	-0.0028 (0.0004)
Feed cost ($/hd.)	-0.1985 (0.0400)	-0.1605 (0.0438)	-0.1040 (0.0269)	-0.1862 (0.0378)	-0.1377 (0.0349)
Net revenue ($/hd.)	0.0773 (0.0291)	0.1102 (0.0357)	0.0368 (0.0244)	0.1174 (0.0280)	0.0359 (0.0314)
Derived feeder value ($/cwt.)	-0.0122 (0.0044)	-0.0429 (0.0057)	0.0141 (0.0033)	0.0070 (0.0042)	-0.0336 (0.0048)

[a]Standard errors of the regression coefficients are shown in parentheses.

on feed, and days on feed in turn affected marbling score positively through equations (4) and (5). The effect of *IWT* on feed cost per head was negative and significant in all price-cost situations. *IWT* had a positive and significant effect on net revenue per head in three of the five price-cost situations. *IWT* had a negative and significant effect on derived feeder animal value per hundredweight under the base, high carcass price, and low feed cost situations. Under the low carcass price situation the effect of *IWT* on derived value per hundredweight was positive and significant, while under the high feed cost situation the effect was positive but not significant.

Table 13. Regression Coefficients Associated with the Explanatory Variable Initial Fat Thickness (mm), 1983-84 Data[a]

	Cost-Price Conditions				
Dependent Variable	Base Prices and Costs	High Carcass Price	Low Carcass Price	High Feed Cost	Low Feed Cost
Days on feed	-5.7180 (1.7565)	-8.9952 (1.9315)	-4.0161 (1.1562)	-5.0939 (1.3870)	-8.8604 (1.9136)
Final live weight (lb)	-20.5812 (4.4403)	-27.8397 (4.7310)	-15.4886 (3.4059)	-17.6038 (3.7302)	-27.9795 (4.6986)
Final fat thickness (mm)	0.6215 (0.1358)	0.4528 (0.1517)	0.6911 (0.0965)	0.6750 (0.1096)	0.4499 (0.1500)
Yield grade	0.0855 (0.0186)	0.0623 (0.0208)	0.0950 (0.0133)	0.0928 (0.0150)	0.0618 (0.0206)
Marbling score	-0.0014 (0.0213)	-0.0317 (0.0229)	0.0095 (0.0152)	-0.0019 (0.0176)	-0.0308 (0.0227)
Feed cost ($/hd.)	-6.2293 (2.0460)	-9.9170 (2.2422)	-4.3400 (1.3764)	-6.5476 (1.9340)	-7.8373 (1.7844)
Net revenue ($/hd.)	-5.0854 (1.4871)	-8.3148 (1.8285)	-2.5495 (1.2483)	-3.6935 (1.4334)	-6.8548 (1.6063)
Derived feeder value ($/cwt.)	-0.8903 (0.2233)	-1.4653 (0.2937)	-0.4356 (0.1700)	-0.6426 (0.2125)	-1.2026 (0.2470)

[a]Standard errors of the regression coefficients are shown in parentheses.

Significant negative effects in the relationship between *IWT* and derived value per hundredweight reflect the fact that at typical or lower feed cost levels, cost of gain in feedlots is relatively low, leading to higher values per hundredweight for lighter feeder cattle. The insignificant relationship between *IWT* and derived value per hundredweight in the high feed cost situation reflects the fact that feeder animal weight takes on a more neutral effect on feeder animal value as the cost of gain in the feedlot becomes higher.

Table 14. Regression Coefficients and Standard Errors Associated with the Zero-One-Minus-One Explanatory Variable Breed (1 = Angus), 1983–84 Data[a]

	Cost-Price Conditions				
Dependent Variable	Base Prices and Costs	High Carcass Price	Low Carcass Price	High Feed Cost	Low Feed Cost
Days on feed	-4.6501 (2.8844)	-3.4781 (3.1718)	-3.6274 (1.8987)	-4.4082 (2.2776)	-3.7193 (3.1424)
Final live weight (lb)	-24.2364 (7.2916)	-24.0793 (7.7691)	-20.0246 (5.5930)	-21.6809 (6.1256)	-23.9969 (7.7159)
Final fat thickness (mm)	-0.0044 (0.2230)	0.0835 (0.2491)	-0.0252 (0.1585)	-0.0594 (0.1799)	0.0949 (0.2464)
Yield grade	-0.0007 (0.0306)	0.0111 (0.0342)	-0.0035 (0.0218)	-0.0082 (0.0247)	0.0127 (0.0338)
Marbling score	-0.0384 (0.0350)	-0.0249 (0.0375)	-0.0314 (0.0249)	-0.0432 (0.0288)	-0.0267 (0.0372)
Feed cost ($/hd.)	-7.0535 (3.3599)	-6.3874 (3.6820)	-5.6740 (2.2602)	-7.8125 (3.1760)	-5.2370 (2.9303)
Net revenue ($/hd.)	-6.6543 (2.4421)	-10.2453 (3.0026)	-3.2664 (2.0498)	-5.1788 (2.3539)	-8.2916 (2.6379)
Derived feeder value ($/cwt.)	-1.5047 (0.3667)	-2.1225 (0.4822)	-0.9125 (0.2791)	-1.2510 (0.3489)	-1.7803 (0.4056)

[a]Standard errors of the regression coefficients are shown in parentheses.

The effects of a change in Initial Fat Thickness (*IFT*) of the feeder animal on economically important important feedlot and carcass characteristics are summarized in **Table 13**. For example, a 1-mm increase in *IFT* resulted in a decrease of 5.7180 days on feed at the optimal slaughter point under the base price-cost situation. All of the effects shown by the coefficients in **Table 13** were significant, except for the effects of *IFT* on marbling score, none of which was significant. *IFT* was negatively related to days on feed, final live weight, and feed cost per head, reflecting the

Table 15. Regression Coefficients and Standard Errors Associated with the Zero-One-Minus-One Explanatory Variable Breed (1 = Hereford), 1983–84 Data[a]

	Cost-Price Conditions				
Dependent Variable	Base Prices and Costs	High Carcass Price	Low Carcass Price	High Feed Cost	Low Feed Cost
Days on feed	-4.4598 (2.9904)	-3.3066 (3.2884)	-2.9851 (1.9684)	-2.6007 (2.3613)	-3.9795 (3.2578)
Final live weight (lb)	-11.0107 (7.5595)	-9.4512 (8.0545)	-8.8233 (5.7984)	-7.0633 (6.3506)	-10.6948 (7.9994)
Final fat thickness (mm)	0.3487 (0.2312)	0.5198 (0.2582)	0.1964 (0.1643)	0.3110 (0.1866)	0.4652 (0.2555)
Yield grade	0.0481 (0.0317)	0.0717 (0.0355)	0.0271 (0.0226)	0.0428 (0.0256)	0.0642 (0.0351)
Marbling score	-0.0396 (0.0363)	-0.0015 (0.0389)	-0.0134 (0.0258)	-0.0146 (0.0299)	-0.0095 (0.0386)
Feed cost ($/hd.)	-5.1078 (3.4833)	-3.8391 (3.8173)	-3.3291 (2.3433)	-3.5776 (3.2927)	-3.7071 (3.0379)
Net revenue ($/hd.)	-2.0856 (2.5318)	-3.3088 (3.1129)	-1.1862 (2.1251)	-1.4942 (2.4404)	-2.9656 (2.7348)
Derived feeder value ($/cwt.)	-0.1366 (0.3801)	-0.3834 (0.4999)	0.0419 (0.2894)	-0.0209 (0.3617)	-0.3127 (0.4205)

[a]Standard errors of the regression coefficients are shown in parentheses.

fact that fatter animals took less time on feed to reach the optimal slaughter point. Yield grade and final fat thickness were positively affected by *IFT*. Each additional millimeter of *IFT* was associated with between 0.45 and 0.69 mm of additional fat thickness at the optimal slaughter point. Net revenue per head and derived feeder value per hundredweight were negatively affected by *IFT*, indicating that fatter animals were worth less per hundredweight and that the prices actually charged for the fatter feeder animals in the simulation were too high relative to their inherent value.

Table 16. Regression Coefficients and Standard Errors Associated with the Zero-One-Minus-One Explanatory Variable Breed (1 = Charolais Cross), 1983–84 Data[a]

	Cost-Price Conditions				
Dependent Variable	Base Prices and Costs	High Carcass Price	Low Carcass Price	High Feed Cost	Low Feed Cost
Days on feed	7.1924 (3.7063)	11.4213 (4.0756)	4.9629 (2.4397)	3.9600 (2.9266)	11.8278 (4.0377)
Final live weight (lb)	11.6333 (9.3692)	21.0026 (9.9828)	6.4473 (7.1866)	4.1886 (7.8709)	21.1627 (9.9144)
Final fat thickness (mm)	-1.3073 (0.2865)	-1.1779 (0.3200)	-1.1643 (0.2036)	-1.3185 (0.2312)	-1.1369 (0.3166)
Yield grade	-0.1792 (0.0393)	-0.1613 (0.0440)	-0.1596 (0.0280)	-0.1808 (0.0318)	-0.1556 (0.0435)
Marbling score	-0.0195 (0.0450)	0.0041 (0.0482)	-0.0404 (0.0320)	-0.0554 (0.0371)	-0.0128 (0.0479)
Feed cost ($/hd.)	6.3238 (4.3172)	10.9335 (4.7312)	3.8834 (2.9042)	3.2484 (4.0809)	9.1316 (3.7652)
Net revenue ($/hd.)	-5.1266 (3.1379)	-3.3507 (3.8582)	-5.3478 (2.6339)	-5.8040 (3.0247)	-3.2161 (3.3895)
Derived feeder value ($/cwt.)	-0.6032 (0.4711)	-0.2600 (0.6196)	-0.6700 (0.3587)	-0.7357 (0.4483)	-0.2497 (0.5211)

[a]Standard errors of the regression coefficients are shown in parentheses.

An additional millimeter of *IFT* was associated with a $0.43 to $1.47 per cwt. decrease in derived feeder value. These results are consistent with the notions that fatter feeder animals are less efficient in the feedlot and that they produce carcasses of lower value per pound (higher yield grade) at optimal slaughter points.

The effects of Breed (*BRD*) on economically important feedlot and carcass characteristics at optimal slaughter points are summarized in **Tables 14–17**. The *BRD* effects represent differences between the specific breed and the

Table 17. Regression Coefficients and Standard Errors Associated with the Zero-One-Minus-One Explanatory Variable Breed (1 = Angus-Hereford Cross), 1983-84 Data[a]

	Cost-Price Conditions				
Dependent Variable	Base Prices and Costs	High Carcass Price	Low Carcass Price	High Feed Cost	Low Feed Cost
Days on feed	1.9175 (4.0304)	-4.6365 (4.4320)	1.6496 (2.6530)	3.0489 (3.1825)	-4.1290 (4.3908)
Final live weight (lb)	23.6138 (10.1885)	12.5279 (10.8557)	22.4006 (7.8150)	24.5557 (8.5582)	13.5290 (10.7814)
Final fat thickness (mm)	0.9629 (0.3116)	0.5746 (0.3480)	0.9931 (0.2214)	1.0668 (0.2514)	0.5768 (0.3443)
Yield grade	0.1317 (0.0428)	0.0785 (0.0478)	0.1360 (0.0304)	0.1462 (0.0345)	0.0787 (0.0473)
Marbling score	0.0975 (0.0489)	0.0224 (0.0524)	0.0852 (0.0348)	0.1132 (0.0403)	0.0235 (0.0520)
Feed cost ($/hd.)	5.8375 (4.6947)	-0.7070 (5.1449)	5.1197 (3.1582)	8.1417 (4.4378)	-0.1875 (4.0944)
Net revenue ($/hd.)	13.8665 (3.4123)	16.9048 (4.1955)	9.7984 (2.8642)	12.4769 (3.2891)	14.4733 (3.6858)
Derived feeder value ($/cwt.)	2.2444 (0.5123)	2.7659 (0.6738)	1.5406 (0.3900)	2.0075 (0.4876)	2.3406 (0.5667)

[a]Standard errors of the regression coefficients are shown in parentheses.

average over all breeds included in the simulation. Angus cattle were associated with significantly lower final live weights, lower net revenues per head from feeding, lower derived feeder animal value per hundredweight, and, in most situations, lower feed costs per head **(Table 14)**. The effects of Angus on days on feed, final fat thickness, yield grade, and marbling score were not significant. Hereford cattle were associated with almost no significant differences for any of the feedlot or carcass characteristics **(Table 15)**. Charolais-cross cattle were associated with consistently

Table 18. Regression Coefficients and Standard Errors Associated with the Explanatory Variable Subjective Frame Size Score (1–15), 1983–84 Data[a]

Dependent Variable	Cost-Price Conditions				
	Base Prices and Costs	High Carcass Price	Low Carcass Price	High Feed Cost	Low Feed Cost
Days on feed	2.6638 (0.6957)	3.4329 (0.7650)	1.2836 (0.4579)	1.7537 (0.5493)	3.3879 (0.7579)
Final live weight (lb)	9.8434 (1.7586)	12.1933 (1.8738)	5.6654 (1.3489)	7.1254 (1.4774)	12.1818 (1.8609)
Final fat thickness (mm)	-0.0971 (0.0538)	-0.0645 (0.0601)	-0.1516 (0.0382)	-0.1246 (0.0434)	-0.0627 (0.0594)
Yield grade	-0.0134 (0.0074)	-0.0089 (0.0082)	-0.0209 (0.0052)	-0.0172 (0.0060)	-0.0087 (0.0081)
Marbling score	0.0157 (0.0084)	0.0211 (0.0091)	0.0057 (0.0060)	0.0105 (0.0070)	0.0203 (0.0090)
Feed cost ($/hd.)	3.2795 (0.8103)	4.2907 (0.8880)	1.6463 (0.5451)	2.6295 (0.7660)	3.3854 (0.7067)
Net revenue ($/hd.)	-4.8363 (0.5890)	-3.3966 (0.7242)	-5.8676 (0.4944)	-5.4271 (0.5677)	-4.0085 (0.6362)
Derived feeder value ($/cwt.)	0.2881 (0.0884)	0.5487 (0.1163)	0.0987 (0.0673)	0.1783 (0.0842)	0.4385 (0.0978)

[a]Standard errors of the regression coefficients are shown in parentheses.

lower final fat thickness and yield grade **(Table 16)**. They also showed significantly more days on feed, higher feed cost per head, and heavier final live weights under the high carcass price and low feed cost situations, but not under the other situations. The effects of Charolais on marbling score, net revenue per head, and derived feeder value per hundredweight were not significant. Angus-Hereford-cross cattle showed significant, positive differences in net revenue per head and derived feeder animal value per hundredweight for all price-cost situations **(Table 17)**. Days on feed

Table 19. Regression Coefficients and Standard Errors Associated with the Explanatory Variable Subjective Muscle Thickness Score (1–15), 1983–1984 Data[a]

	Cost-Price Conditions				
Dependent Variable	Base Prices and Costs	High Carcass Price	Low Carcass Price	High Feed Cost	Low Feed Cost
Days on feed	-1.7349 (1.0812)	-1.4251 (1.1890)	-0.6343 (0.7117)	-0.9498 (0.8538)	-1.4681 (1.1779)
Final live weight (lb)	-5.8796 (2.7332)	-5.7463 (2.9122)	-3.1819 (2.0965)	-3.9043 (2.2962)	-5.4538 (2.8923)
Final fat thickness (mm)	-0.1270 (0.0836)	-0.1057 (0.0934)	-0.0482 (0.0594)	-0.0628 (0.0675)	-0.1025 (0.0924)
Yield grade	-0.0175 (0.0115)	-0.0146 (0.0128)	-0.0068 (0.0082)	-0.0087 (0.0093)	-0.0142 (0.0127)
Marbling score	-0.0224 (0.0131)	-0.0154 (0.0141)	-0.0092 (0.0093)	-0.0146 (0.0108)	-0.0162 (0.0140)
Feed cost ($/hd.)	-2.6323 (1.2594)	-2.4896 (1.3802)	-1.3408 (0.8472)	-2.0444 (1.1905)	-1.9894 (1.0984)
Net revenue ($/hd.)	-2.3845 (0.9154)	-3.1105 (1.1255)	-1.8786 (0.7684)	-2.0195 (0.8824)	-2.9205 (0.9888)
Derived feeder value ($/cwt.)	-0.1346 (0.1374)	-0.2704 (0.1808)	-0.0397 (0.1046)	-0.0664 (0.1308)	-0.2332 (0.15201

[a]Standard errors of the regression coefficients are shown in parentheses.

and feed cost per head were not significantly different from average for Angus-Hereford-cross cattle. The Angus-Hereford crosses also showed positive and significant differences in final live weight, final fat thickness, yield grade, and marbling score for the base, low carcass price, and high feed cost situations, but not for the other price-cost situations.

The effects of changes in Initial Frame Score (*IFS*) on economically important feedlot and carcass characteristics are summarized in **Table 18**. For example, a one unit increase in *IFS* was associated with an increase of 2.6638 days on feed at the optimal slaughter point. *IFS* had positive and statistically significant effects on days on feed, final live weight, and feed cost per head in all price-cost situations. Net revenue per head was negatively and significantly affected by increases in *IFS*, while derived value per hundredweight of the feeder animal was positively related to *IFS*. These two effects together indicate that *IFS* should positively affect the value per hundredweight of the feeder animal, but that the feeder animal prices used in the simulation overvalued large frame animals. An increase in *IFS* of one unit was associated with an increase of between \$0.10 and \$0.55 per cwt. in derived feeder animal value. The effects of *IFS* on final fat thickness, yield grade, and marbling score were not consistently significant.

The effects of changes in Initial Muscle Thickness Score (*IMS*) on economically important feedlot and carcass characteristics are summarized in **Table 19**. For example, an increase of one unit in *IMS* was associated with a decrease in net revenue of \$2.3845 per head. *IMS* had negative and significant effects on net revenue per head from feeding in all price-cost situations. This suggests that the prices charged for feeder animals showing greater muscle thickness in the simulation were too high relative to the animal's inherent value per hundredweight. *IMS* showed only two other significant effects on any of the feedlot and carcass characteristics in any of the price-cost situations. *IMS* had no significant effects on derived feeder value.

Results from 1986–87 Data

For the 1986–87 price and cost data, the number of days on feed at which animals were slaughtered was determined by the optimal point for the group or pen to which the animal was assigned based on the animal's initial feeder animal characteristics. This simulation recognized the fact that animals are not typically managed individually, but rather are sorted into relatively consistent pens and managed by pen. Characteristics used in sorting were initial weight, frame size, and initial fat thickness as discussed earlier. To make this grouping system practical, the animals also had to be separated by diet because the animals on the less energy-dense silage-concentrate diet required substantially more days on feed to reach their optimal slaughter points.

Feedlot and Carcass Characteristics

Descriptive statistics for feedlot performance and carcass characteristics for the 784 animals in the simulation are shown in **Table 20** for the animals on the concentrate diet and in **Table 21** for those on the silage-concentrate diet. These statistics represent values at the optimal (maximum net revenue) slaughter points for the groups of animals. In addition to the characteristics shown earlier in **Table 11** for the 1983–84 data, the 1986–87 simulations also analyzed the cost per pound of live weight gained in the feedlot.

The base price and cost simulation indicated that the mean number of days on feed at optimal slaughter points for the concentrate diet was 188.23 days **(Table 20)**, while it was 234.51 days for the silage-concentrate diet **(Table 21)**. Higher feed costs and lower carcass prices led to fewer days on feed to reach optimal slaughter points for both diets. These reactions were due to increases in the cost of an additional day's feeding or to decreases in the revenue produced by another day's feeding, respectively. Conversely, lower feed costs and higher carcass prices led to increases in days on feed to reach optimal slaughter points for both diets because of corresponding reductions in daily costs and increases in daily revenue. Average final live weights were 962.46 and 979.54 pounds on the concentrate and silage-concentrate diets, respectively, for the base price-cost situation. Fat thickness averaged 12.89 mm for the concentrate diet and 12.25 mm (approximately 0.5 inches) for the silage-concentrate diet. As with the simulations based on the 1983–84 data, mean optimal yield grades remained below the 3.0 threshold for the base price-cost situation and for the low carcass price and high feed cost situations. However, for the low feed cost and high carcass price situations, mean yield grades were slightly above 3.0. Average marbling scores were all in the low

Table 20. Means, Standard Deviations, Minimum and Maximum Values of Feedlot Performance and Carcass Characteristics at Optimal Slaughter Points, 1986–87 Price-Cost Data — Concentrate Diet

Characteristic	Mean	Standard Deviation	Minimum Value	Maximum Value
Base prices and costs				
Days on feed	188.23	26.24	145.00	270.00
Final live weight (lb)	962.46	103.97	747.85	1,344.13
Final fat thickness (mm)	12.89	4.17	3.97	35.94
Yield grade	2.97	0.57	1.75	6.15
Marbling score	5.64	0.26	5.03	6.81
Feed cost ($/hd.)	149.37	23.74	94.06	237.29
Cost of gain ($/lb)	0.54	0.09	0.37	1.20
Net revenue ($/hd.)	-86.27	47.60	-280.85	62.47
Derived feeder value ($/cwt.)	55.09	7.88	27.75	81.05
High carcass price				
Days on feed	204.35	30.33	170.00	340.00
Final live weight (lb)	987.73	113.50	747.85	1,344.13
Final fat thickness (mm)	14.19	4.46	5.00	42.75
Yield grade	3.15	0.61	1.90	7.08
Marbling score	5.81	0.26	5.30	7.26
Feed cost ($/hd.)	162.16	26.93	113.52	267.54
Cost of gain ($/lb)	0.55	0.10	0.38	1.20
Net revenue ($/hd.)	19.61	58.75	-189.35	194.66
Derived feeder value ($/cwt.)	74.20	10.80	41.67	112.12
Low carcass price				
Days on feed	164.24	12.65	140.00	200.00
Final live weight (lb)	919.97	74.82	739.94	1,149.58
Final fat thickness (mm)	11.02	3.48	3.30	21.38
Yield grade	2.72	0.48	1.66	4.15
Marbling score	5.37	0.17	5.00	5.90
Feed cost ($/hd.)	130.16	11.84	86.53	170.84
Cost of gain ($/lb)	0.52	0.09	0.36	1.03
Net revenue ($/hd.)	-186.93	39.91	-310.91	-69.23
Derived feeder value ($/cwt.)	36.93	5.50	19.62	52.47

Table 20. (continued)

Characteristic	Mean	Standard Deviation	Minimum Value	Maximum Value
High feed cost				
Days on feed	172.83	16.01	140.00	245.00
Final live weight (lb)	935.90	86.85	739.94	1,230.93
Final fat thickness (mm)	11.63	3.60	3.47	23.41
Yield grade	2.81	0.49	1.69	4.42
Marbling score	5.47	0.17	5.00	6.17
Feed cost ($/hd.)	164.50	18.69	112.87	258.39
Cost of gain ($/lb)	0.60	0.10	0.42	1.18
Net revenue ($/hd.)	-114.65	44.18	-251.92	21.47
Derived feeder value ($/cwt.)	49.95	7.05	29.12	71.15
Low feed cost				
Days on feed	201.47	31.23	160.00	340.00
Final live weight (lb)	983.55	114.88	747.85	1,344.13
Final fat thickness (mm)	13.93	4.44	3.97	42.75
Yield grade	3.12	0.60	1.75	7.08
Marbling score	5.77	0.27	5.12	7.26
Feed cost ($/hd.)	127.94	22.25	90.81	214.03
Cost of gain ($/lb)	0.46	0.09	0.31	1.03
Net revenue ($/hd.)	-54.88	50.96	-248.07	101.06
Derived feeder value ($/cwt.)	60.77	8.91	33.54	92.04

Choice range for all price-cost situations. Feed costs per head were lower for the concentrate diet than for the silage-concentrate diet. For the base price-cost simulations, cost of gain was 54¢ per pound and 59¢ per pound for the concentrate and silage-concentrate diets, respectively. These moved up with increasing feed cost and carcass prices and down with decreasing feed costs and carcass prices (range was 46¢ to 66¢). Net revenues per head were negative for both diets in the base price-cost situation, but losses were larger for the silage-concentrate diet. Net revenues showed the expected responses to changes in carcass prices and feed costs. Derived value of the feeder animal averaged $55.09 per cwt. for the concentrate diet and $50.98 for the silage-concentrate diet in the base price-cost simulation. Changes in carcass prices and feed costs had the anticipated effects on the derived feeder animal values (range was $32.36 to $74.20).

Table 21. Means, Standard Deviations, Minimum and Maximum Values of Feedlot Performance and Carcass Characteristics at Optimal Slaughter Points, 1986–87 Price-Cost Data — Silage-Concentrate Diet

Characteristic	Mean	Standard Deviation	Minimum Value	Maximum Value
Base prices and costs				
Days on feed	234.51	22.42	195.00	291.00
Final live weight (lb)	979.54	93.01	740.31	1,300.66
Final fat thickness (mm)	12.25	3.88	4.21	38.33
Yield grade	2.89	0.53	1.79	6.47
Marbling score	5.58	0.43	4.74	8.72
Feed cost ($/hd.)	165.75	19.42	113.38	226.74
Cost of gain ($/lb)	0.59	0.08	0.40	0.98
Net revenue ($/hd.)	-109.94	43.75	-249.11	8.83
Derived feeder value ($/cwt.)	50.98	6.97	33.13	77.82
High carcass price				
Days on feed	255.84	31.18	205.00	340.00
Final live weight (lb)	1,010.40	104.18	767.14	1,381.55
Final fat thickness (mm)	13.71	4.44	4.95	43.11
Yield grade	3.09	0.61	1.89	7.13
Marbling score	5.90	0.54	4.84	9.53
Feed cost ($/hd.)	182.35	25.96	118.56	262.04
Cost of gain ($/lb)	0.60	0.09	0.40	1.03
Net revenue ($/hd.)	-2.25	53.80	-158.62	183.42
Derived feeder value ($/cwt.)	70.32	9.80	47.68	108.83
Low carcass price				
Days on feed	218.94	20.53	190.00	270.00
Final live weight (lb)	956.42	89.20	740.31	1,247.35
Final fat thickness (mm)	11.24	3.40	3.64	32.58
Yield grade	2.75	0.46	1.71	5.68
Marbling score	5.35	0.36	4.63	7.83
Feed cost ($/hd.)	153.81	18.01	106.09	206.94
Cost of gain ($/lb)	0.58	0.08	0.38	0.96
Net revenue ($/hd.)	-213.69	39.39	-317.84	-120.58
Derived feeder value ($/cwt.)	32.36	4.95	17.71	52.61

Table 21. (continued)

Characteristic	Mean	Standard Deviation	Minimum Value	Maximum Value
High feed cost				
Days on feed	222.55	20.88	190.00	285.00
Final live weight (lb)	962.01	90.31	740.31	1,266.63
Final fat thickness (mm)	11.47	3.55	3.96	36.04
Yield grade	2.78	0.48	1.75	6.16
Marbling score	5.41	0.38	4.73	8.36
Feed cost ($/hd.)	187.90	21.84	127.31	256.44
Cost of gain ($/lb)	0.66	0.09	0.43	1.12
Net revenue ($/hd.)	-142.39	42.72	-266.54	-34.13
Derived feeder value ($/cwt.)	45.13	6.40	27.36	72.12
Low feed cost				
Days on feed	253.87	30.46	205.00	315.00
Final live weight (lb)	1,007.69	102.84	754.43	1,381.55
Final fat thickness (mm)	13.58	4.41	4.95	43.11
Yield grade	3.07	0.60	1.89	7.13
Marbling score	5.87	0.53	4.84	9.53
Feed cost ($/hd.)	144.67	20.19	90.70	209.63
Cost of gain ($/lb)	0.52	0.08	0.34	0.88
Net revenue ($/hd.)	-75.06	47.45	-213.38	87.77
Derived feeder value ($/cwt.)	57.27	8.11	38.68	89.35

The differences in the high-energy, concentrate diet and the medium-energy, silage-concentrate diet are apparent in the foregoing discussion. The higher-energy diet resulted in shorter optimal feeding periods, lighter optimal weights, fatter carcasses,* lower feed costs, lower costs of gain, larger net revenues per head, and higher derived feeder animal values per hundredweight. However, the responses of the average feedlot and carcass characteristics to price and cost changes were consistent between the two diets and consistent with logical expectations providing further evidence that the simulation model yielded credible results.

*These results suggest that the higher-energy diet led to higher rates of fat deposition per unit of time. The lower-energy diet resulted in carcasses that were larger but typically carried less fat cover at optimal slaughter points.

Table 22. Regression Coefficients Associated with the Explanatory Variable Initial Weight (lb), 1986–87 Data[a] — Concentrate Diet

	Cost-Price Conditions				
Dependent Variable	Base Prices and Costs	High Carcass Price	Low Carcass Price	High Feed Cost	Low Feed Cost
Days on feed	-0.1175 (0.0001)	-0.1007 (0.0136)	-0.0803 (0.0226)	-0.1024 (0.0001)	-0.1313 (0.0001)
Final live weight (lb)	0.5820 (0.0001)	0.5776 (0.0732)	0.6313 (0.0882)	0.5887 (0.0001)	0.5050 (0.0001)
inal fat thicknes Fs (mm)	-0.0003 (0.9276)	0.0039 (0.0033)	0.0021 (0.0044)	-0.0001 (0.9701)	0.0019 (0.5175)
Yield grade	-0.0004 (0.9321)	0.0005 (0.0004)	0.0002 (0.0006)	-0.0002 (0.9686)	0.0002 (0.5165)
Marbling score	-0.0010 (0.0001)	-0.0008 (0.0002)	-0.0005 (0.0002)	-0.0007 (0.0010)	-0.0012 (0.0001)
Feed cost ($/hd.)	0.0032 (0.8706)	0.0034 (0.0168)	0.0311 (0.0164)	0.0226 (0.2438)	-0.0272 (0.0178)
Cost of gain ($/lb)	0.0006 (0.0001)	0.0007 (0.0001)	0.0006 (0.0001)	0.0006 (0.0001)	0.0006 (0.0001)
Net revenue ($/hd.)	-0.1455 (0.0027)	-0.1328 (0.0441)	-0.1601 (0.0523)	-0.0895 (0.1447)	-0.2036 (0.0001)
Derived feeder value ($/cwt.)	-0.0296 (0.0002)	-0.0182 (0.0071)	-0.0428 (0.0086)	0.0544 (0.0001)	-0.0077 (0.1713)

[a]Standard errors of the regression coefficients are shown in parentheses.

Effects of Feeder Calf Characteristics

The regressions of feedlot and carcass characteristics (dependent variables) on feeder calf characteristics (explanatory variables) for the two diets separately were of the form discussed in equation (18). Because the data were divided by diet, the concentrate regressions were based on 388 observations. A total of 90 regression equations were estimated (9 feedlot and carcass characteristics × 5 price-cost situations × 2 diets). R^2 values ranged from 0.060 to 0.765. As for the 1983–84 analysis, the coefficients from these regressions were grouped by feeder animal characteristic to facilitate discussion. This resulted in **Tables 22–37**. In the following discussion, an estimated coefficient will be considered statistically significant if it is at least twice as large as its standard error (in parentheses).

The effects of Initial Weight (*IWT*) of the feeder animals on the feedlot and carcass characteristics are reflected in the regression coefficients in **Table 22** for the concentrate diet and **Table 23** for the silage-concentrate diet. For example, under the base price-cost situation, an increase of one pound of *IWT* was associated with a 0.1175 decrease in days on feed on the concentrate diet and a decrease of 0.2173 days on feed on the silage-concentrate diet to reach the optimal slaughter point. The effects of *IWT* on days on feed to the optimal slaughter point were negative and significant for both diets in all price-cost situations. The effects of *IWT* on live weight were positive and significant for both diets in all price-cost situations. *IWT* had no significant effects on fat thickness or yield grade except for small positive effects for the silage-concentrate diet under the high feed cost and low carcass price situations.

Marbling score was negatively affected by *IWT* in most situations. This probably reflects the negative effect of *IWT* on days on feed. *IWT* had no significant effects on feed cost per head except for negative effects for the silage-concentrate diet in the base, low feed-cost, and high carcass-price situations. However, cost of gain per pound was positively and significantly affected by *IWT* in all diet and price-cost situations. Net revenue per head was negatively and significantly affected by *IWT* in all situations except the high carcass-price situation for both diets. The effects of *IWT* on derived value per hundredweight of the feeder animal were negative and significant in all cases except in the low carcass-price situations. The negative effects were stronger as feed costs decreased, confirming conventional observations that weight discounts on feeder cattle are larger as feed costs decline.

The results for the *IWT* explanatory variable from the 1986–87 price-cost data are consistent with the results from the 1983–84 data discussed earlier, except for the fact that net revenue was positively affected by *IWT* in the earlier situation and negatively affected by *IWT* in the later situation. This discrepancy probably indicates that the weight discounts for feeder cattle used in 1984 **(Table 5)** were small given the cost of gain at that time relative to the weight discounts used for 1987 **(Table 6)** given the cost of gain at that time.

The estimated coefficients showing the effects of Initial Fat Thickness (*IFT*) of the feeder animal on the feedlot and carcass characteristics at the optimal slaughter point are shown in **Tables 24 and 25** for the concentrate and silage-concentrate diets, respectively. For example, an increase of 1 mm of *IFT* was associated with a decrease of 1.1171 days on feed under the concentrate diet and 10.5287 days on feed under the silage-concentrate diet. This substantial difference is probably related to the fact that the optimal number of days on feed was substantially larger for the silage-concentrate diet under all price-cost situations. The effect of *IFT* on days on feed was significant and negative in all situations except one for both diets. The effect of *IFT* on live weight at the optimal slaughter point was negative and significant in all cases. An increase of 1 mm of fat on the feeder animal was associated with a decrease in live weight at slaughter of 13 to 18 pounds for the concentrate diet and 27 to 40 pounds for the silage-concentrate diet. *IFT* was positively and significantly associated with carcass fat thickness and yield grade in all cases except two. A 1-mm increase in *IFT* was associated with up to

Table 23. Regression Coefficients Associated with the Explanatory Variable Initial Weight (lb), 1986–1987 Data[a] — Silage-Concentrate Diet

	Cost-Price Conditions				
Dependent Variable	Base Prices and Costs	High Carcass Price	Low Carcass Price	High Feed Cost	Low Feed Cost
Days on feed	-0.2173 (0.0128)	-0.1584 (0.0109)	-0.3101 (0.0172)	-0.3017 (0.0187)	-0.1581 (0.0104)
Final live weight (lb)	0.4279 (0.0736)	0.5351 (0.0689)	0.2929 (0.0835)	0.3050 (0.0840)	0.5417 (0.0667)
Final fat thickness (mm)	-0.0039 (0.0037)	0.0074 (0.0033)	-0.0026 (0.0042)	-0.0020 (0.0043)	0.0076 (0.0031)
Yield grade	0.0005 (0.0005)	0.0010 (0.0004)	-0.0003 (0.0005)	-0.0002 (0.0005)	0.0011 (0.0004)
Marbling score	-0.0012 (0.0004)	-0.0003 (0.0003)	-0.0025 (0.0005)	-0.0024 (0.0005)	-0.0003 (0.0003)
Feed cost ($/hd.)	-0.0470 (0.0156)	-0.0026 (0.0165)	-0.0861 (0.0157)	-0.1002 (0.0203)	-0.0033 (0.0133)
Cost of gain ($/lb)	0.0006 (0.0001)	0.0007 (0.0001)	0.0004 (0.0001)	0.0005 (0.0001)	0.0006 (0.0001)
Net revenue ($/hd.)	-0.0904 (0.0424)	-0.0826 (0.0411)	-0.1085 (0.0465)	-0.0454 (0.0537)	-0.1479 (0.0352)
Derived feeder value ($/cwt.)	-0.0280 (0.0066)	-0.0155 (0.0062)	-0.0427 (0.0074)	-0.0553 (0.0089)	-0.0037 (0.0049)

[a]Standard errors of the regression coefficients are shown in parentheses.

Table 24. Regression Coefficients Associated with the Explanatory Variable Initial Fat Thickness (mm), 1986–87 Data[a] — Concentrate Diet

	Cost-Price Conditions				
Dependent Variable	Base Prices and Costs	High Carcass Price	Low Carcass Price	High Feed Cost	Low Feed Cost
Days on feed	-1.1171 (0.3099)	-2.8646 (0.6846)	-0.7848 (1.1385)	-3.6429 (0.0007)	-2.2451 (0.0001)
Final live weight (lb)	-13.8868 (0.0013)	-16.5428 (3.6831)	-13.6442 (4.4402)	-17.7658 (0.0001)	-14.7537 (0.0001)
Final fat thickness (mm)	0.7492 (0.0003)	0.5569 (0.1639)	0.7417 (0.2231)	0.4660 (0.0397)	0.5967 (0.0001)
Yield grade	0.1027 (0.0003)	0.0764 (0.0225)	0.1019 (0.0306)	0.0639 (0.0400)	0.0819 (0.0001)
Marbling score	0.0116 (0.3637)	-0.0104 (0.0092)	0.0161 (0.0125)	-0.0174 (0.1363)	-0.0052 (0.5117)
Feed cost ($/hd.)	-1.7890 (0.0788)	-3.5749 (0.8447)	-1.2582 (0.8245)	-3.7797 (0.0001)	-2.3523 (0.0001)
Cost of gain ($/lb)	0.0158 (0.0009)	0.0162 (0.0048)	0.0138 (0.0043)	0.0134 (0.0090)	0.0138 (0.0008)
Net revenue ($/hd.)	-5.3617 (0.0274)	-5.3372 (2.2156)	-5.4873 (2.6317)	-6.8508 (0.0268)	-4.1051 (0.0285)
Derived feeder value ($/cwt.)	-1.0559 (0.0074)	-1.0542 (0.3577)	-1.0574 (0.4338)	-1.3040 (0.0129)	-0.8298 (0.0035)

[a]Standard errors of the regression coefficients are shown in parentheses.

Table 25. Regression Coefficients Associated with the Explanatory Variable Initial Fat Thickness (mm), 1986–87 Data[a] — Silage-Concentrate Diet

	Cost-Price Conditions				
Dependent Variable	Base Prices and Costs	High Carcass Price	Low Carcass Price	High Feed Cost	Low Feed Cost
Days on feed	-10.5287 (0.6645)	-11.6767 (0.5690)	-17.3366 (0.8965)	-16.9189 (0.9712)	-9.6561 (0.5439)
Final live weight (lb)	-30.0048 (3.8171)	-30.6865 (3.5751)	-39.4273 (4.3290)	-38.8417 (4.3568)	-27.6954 (3.4621)
Final fat thickness (mm)	0.6307 (0.1908)	0.5430 (0.1727)	0.1423 (0.2203)	0.1690 (0.2240)	0.6665 (0.1649)
Yield grade	0.0866 (0.0261)	0.0745 (0.0237)	0.0196 (0.0302)	0.0233 (0.0307)	0.0917 (0.0226)
Marbling score	-0.0090 (0.0224)	-0.0283 (0.0200)	-0.1121 (0.0263)	-0.1059 (0.0271)	0.0001 (0.0191)
Feed cost ($/hd.)	-7.6264 (0.8076)	-10.0402 (0.8565)	10.3127 (0.8140)	-12.6171 (1.0546)	-6.8476 (0.6920)
Cost of gain ($/lb)	0.0183 (0.0042)	0.0185 (0.0045)	0.0117 (0.0038)	0.0136 (0.0044)	0.0182 (0.0039)
Net revenue ($/hd.)	-8.2846 (2.1980)	-6.0971 (2.1315)	-9.8460 (2.4135)	-11.9504 (2.7861)	-4.3235 (1.8269)
Derived feeder value ($/cwt.)	-1.2739 (0.3417)	-0.8770 (0.3263)	-1.5630 (0.3880)	-1.9479 (0.4637)	-0.5568 (0.2578)

[a]Standard errors of the regression coefficients are shown in parentheses.

0.75 mm greater subcutaneous fat thickness in the carcass at the optimal slaughter point. Marbling score was not typically affected by *IFT*. Feed costs per head were significantly lowered by increases in *IFT* in all cases except one. However, *IFT* had a positive and significant effect on cost of gain per pound in all cases except one. An increase of 1 mm in *IFT* increased cost of gain by 1¢ to 2¢ per pound of live weight. Net revenue per head was negatively and significantly influenced by *IFT* for all price-cost and diet conditions. Derived value per hundredweight of the feeder animal was negatively and significantly affected by *IFT* in all cases. An increase of 1 mm in *IFT* was associated with a decrease of between $0.55 and $1.95 per cwt. in derived feeder animal value. These results are consistent with the results for the 1983–84 price-cost conditions reported above.

The effects of Breed (*BRD*) of the feeder animal on feedlot and carcass characteristics at optimal slaughter points are shown in **Tables 26–33**. The *BRD* effects represent differences between the specific breed and the average of the breeds in the simulation. Angus cattle were associated with negative and significant effects on live weight, net revenue per head, derived value of the feeder animal per hundredweight, and, in most cases, feed cost per head **(Tables 26 and 27)**. Angus showed significantly higher cost of gain per pound. Hereford showed higher carcass fat thicknesses and yield grades on the concentrate diet, but were not consistently different from the average animal in any other case **(Tables 28 and 29)**.

Charolais-cross cattle were associated with lower carcass fat thicknesses and lower yield grades in all cases and, in most cases, with lower marbling scores **(Tables 30 and 31)**. Charolais-cross was not consistently different from average for the other feedlot and carcass characteristics.

The Angus-Hereford-cross cattle were associated with significantly higher live weight, greater fat thickness, higher yield grade, and, on the silage-concentrate diet, higher marbling scores **(Tables 32 and 33)**. They were also usually associated with significantly higher feed cost per head, but lower cost of gain per pound. Net revenue per head and derived value per hundredweight of the feeder animal were significantly higher for the Angus-Hereford crosses.

The effects of differences in Initial Frame Score (*IFS*) on feedlot and carcass characteristics are summarized in **Tables 34 and 35**. *IFS* was consistently associated with significant positive effects on days on feed and live weight at the optimal slaughter point. Each additional unit of frame score was associated with a 7 to 19 pound increase in slaughter weight depending upon price-cost and diet conditions. Larger frame sizes also consistently led to significantly higher feed costs per head. However, costs of gain per pound were negatively associated with larger frame size in all three cases where the effect was significant. Net revenue per head was negatively affected by frame size, while derived value per hundredweight of the feeder animal increased significantly as frame size increased. This apparent paradox is due to the fact that while frame size is a positive factor in determining inherent value of the feeder calf, larger frame calves were overpriced by the data used to price calves as they entered the simulation. An increase of one unit in frame score was associated with a $0.17 to $0.95 per cwt. increase in derived value of the feeder animal depending upon price-cost and diet conditions. These results are consistent with those for the 1983–84 simulations discussed earlier.

The effects of changes in Initial Muscling Score (*IMS*) of the feeder animal on the economically important feedlot and carcass characteristics are summarized in **Tables 36 and 37**. *IMS* had no significant effects on feedlot and carcass characteristics under the silage-concentrate diet except for a single occurrence. Under the concentrate diet, *IMS* had significant negative effects on feed cost per head in all cases and significant negative effects on live weight and net revenue per head in all cases except two. *IMS* was not significantly related to derived value per hundredweight of the feeder animal.

Table 26. Regression Coefficients Associated with the Zero-One-Minus-One Explanatory Variable Breed (1 = Angus), 1986–87 Data[a] — Concentrate Diet

	Cost-Price Conditions				
Dependent Variable	Base Prices and Costs	High Carcass Price	Low Carcass Price	High Feed Cost	Low Feed Cost
Days on feed	-2.4746	-1.2568	-2.6965	-1.8609	-0.0318
	(0.1718)	(1.1262)	(1.8731)	(0.2911)	(0.7235)
Final live weight (lb)	-24.2558	-19.6636	-24.6079	-23.4161	-16.7041
	(0.0006)	(6.0593)	(7.3048)	(0.0013)	(0.0024)
Final fat thickness (mm)	-0.2807	-0.1975	-0.3004	-0.2296	-0.1389
	(0.4045)	(0.2696)	(0.3671)	(0.5369)	(0.5723)
Yield grade	-0.0387	-0.0271	-0.0415	-0.0318	-0.0193
	(0.4028)	(0.0370)	(0.0504)	(0.5332)	(0.5669)
Marbling score	-0.0324	-0.0203	-0.0291	-0.0195	-0.0090
	(0.1250)	(0.0151)	(0.0206)	(0.3105)	(0.4893)
Feed cost ($/hd.)	-3.8099	-3.3567	-3.3336	-3.5416	-1.8867
	(0.0231)	(1.3897)	(1.3565)	(0.0281)	(0.0475)
Cost of gain ($/lb)	0.0275	0.0276	0.0243	0.0281	0.0237
	(0.0005)	(0.0080)	(0.0072)	(0.0009)	(0.0008)
Net revenue ($/hd.)	-11.5387	-8.1694	-11.2154	-13.9846	-6.2815
	(0.0040)	(3.6449)	(4.3296)	(0.0061)	(0.0415)
Derived feeder value ($/cwt.)	-2.2046	-1.6169	-2.1245	-2.6044	-1.2959
	(0.0007)	(0.5885)	(0.7136)	(0.0026)	(0.0056)

[a]Standard errors of the regression coefficients are shown in parentheses.

Table 27. Regression Coefficients Associated with the Zero-One-Minus-One Explanatory Variable Breed (1 = Angus), 1986–87 Data[a] — Silage-Concentrate Diet

	Cost-Price Conditions				
Dependent Variable	Base Prices and Costs	High Carcass Price	Low Carcass Price	High Feed Cost	Low Feed Cost
Days on feed	-1.0938	-0.5299	-0.6063	0.0432	-0.4497
	(1.0929)	(0.9358)	(1.4745)	(1.5974)	(0.8946)
Final live weight (lb)	-23.3503	-21.9226	-25.4413	-24.7538	-20.8595
	(6.2778)	(5.8798)	(7.1198)	(7.1654)	(5.6940)
Final fat thickness (mm)	0.4505	0.4706	0.5258	0.5706	0.4674
	(0.3138)	(0.2840)	(0.3624)	(0.3684)	(0.2712)
Yield grade	0.0619	0.0645	0.0722	0.0783	0.0640
	(0.0430)	(0.0389)	(0.0497)	(0.0505)	(0.0372)
Marbling score	0.0416	0.0479	0.0538	0.0634	0.0479
	(0.0369)	(0.0329)	(0.0434)	(0.0446)	(0.0314)
Feed cost ($/hd.)	-2.8630	-2.7713	-2.2667	-2.3722	-2.1752
	(1.3282)	(1.4088)	(1.3388)	(1.7345)	(1.1381)
Cost of gain ($/lb)	0.0264	0.0310	0.0266	0.0305	0.0258
	(0.0069)	(0.0074)	(0.0063)	(0.0073)	(0.0065)
Net revenue ($/hd.)	-9.7442	-8.9946	-11.5670	-13.9585	-7.0608
	(3.6151)	(3.5057)	(3.9695)	(4.5822)	(3.0046)
Derived feeder value ($/cwt.)	-1.7800	-1.6490	-2.1182	-2.5457	-1.3062
	(0.5620)	(0.5367)	(0.6382)	(0.7627)	(0.4241)

[a]Standard errors of the regression coefficients are shown in parentheses.

Table 28. Regression Coefficients Associated with the Zero-One-Minus-One Explanatory Variable Breed (1 = Hereford), 1986–87 Data[a] — Concentrate Diet

	Cost-Price Conditions				
Dependent Variable	Base Prices and Costs	High Carcass Price	Low Carcass Price	High Feed Cost	Low Feed Cost
Days on feed	-0.9425 (0.6122)	-0.6431 (1.1574)	1.1308 (1.9251)	1.0676 (0.5554)	-1.4979 (0.1051)
Final live weight (lb)	2.8482 (0.6936)	1.8902 (6.2274)	5.5563 (7.5075)	4.7370 (0.5238)	5.8467 (0.2991)
Final fat thickness (mm)	1.1489 (0.0010)	0.9993 (0.2771)	1.5239 (0.3772)	1.5618 (0.0001)	1.1237 (0.0001)
Yield grade	0.1580 (0.0010)	0.1377 (0.0380)	0.2092 (0.0518)	0.2144 (0.0001)	0.1548 (0.0001)
Marbling score	0.0247 (0.2548)	0.0233 (0.0155)	0.0525 (0.0212)	0.0533 (0.0072)	0.0492 (0.0003)
Feed cost ($/hd.)	0.2878 (0.8669)	0.5006 (1.4283)	1.6211 (1.3941)	1.9364 (0.2417)	2.0501 (0.0362)
Cost of gain ($/lb)	-0.0052 (0.5091)	0.0043 (0.0082)	-0.0032 (0.0072)	-0.0032 (0.7052)	-0.0029 (0.6840)
Net revenue ($/hd.)	1.0517 (0.7974)	0.6905 (3.7461)	0.4164 (4.4497)	-0.1351 (0.9793)	0.4847 (0.8780)
Derived feeder value ($/cwt.)	0.3411 (0.6072)	0.2980 (0.6048)	0.2340 (0.7334)	0.0102 (0.0908)	0.2685 (0.5743)

[a]Standard errors of the regression coefficients are shown in parentheses.

Table 29. Regression Coefficients Associated with the Zero-One-Minus-One Explanatory Variable Breed (1 = Hereford), 1986–87 Data[a] — Silage-Concentrate Diet

	Cost-Price Conditions				
Dependent Variable	Base Prices and Costs	High Carcass Price	Low Carcass Price	High Feed Cost	Low Feed Cost
Days on feed	-1.6343 (1.1316)	-0.9758 (0.9689)	0.4919 (1.5266)	0.0457 (1.6539)	-1.0902 (0.9262)
Final live weight (lb)	-15.1642 (6.5000)	-13.0043 (6.0879)	-12.8057 (7.3717)	-13.7077 (7.4190)	-12.9450 (5.8954)
Final fat thickness (mm)	0.1045 (0.3249)	0.1343 (0.2941)	0.2883 (0.3752)	0.2642 (0.3814)	0.1337 (0.2808)
Yield grade	0.0150 (0.0446)	0.0190 (0.0403)	0.0399 (0.0515)	0.0365 (0.0523)	0.0190 (0.0385)
Marbling score	-0.0002 (0.0383)	0.0081 (0.0341)	0.0355 (0.0449)	0.0295 (0.0462)	0.0071 (0.0325)
Feed cost ($/hd.)	-2.5603 (1.3752)	-2.4439 (1.4586)	-1.0235 (1.3862)	-1.6015 (1.7958)	-2.1398 (1.1784)
Cost of gain ($/lb)	0.0143 (0.0071)	0.0146 (0.0077)	0.0126 (0.0065)	0.0152 (0.0076)	0.0124 (0.0067)
Net revenue ($/hd.)	-8.6920 (3.7430)	-7.3270 (3.6297)	-8.2597 (4.1099)	-9.7334 (4.7443)	-5.7869 (3.1110)
Derived feeder value ($/cwt.)	-1.3148 (0.5819)	-1.0574 (0.5557)	-1.2026 (0.6608)	-1.4692 (0.7897)	-0.7574 (0.4391)

[a]Standard errors of the regression coefficients are shown in parentheses.

Table 30. Regression Coefficients Associated with the Zero-One-Minus-One Explanatory Variable Breed (1 = Charolais-Cross), 1986–87 Data[a] — Concentrate Diet

	Cost-Price Conditions				
Dependent Variable	Base Prices and Costs	High Carcass Price	Low Carcass Price	High Feed Cost	Low Feed Cost
Days on feed	2.0298 (0.3914)	0.8629 (1.4739)	2.3606 (2.4513)	1.6943 (0.4625)	-0.6479 (0.5814)
Final live weight (lb)	-5.1020 (0.5794)	-7.5874 (7.9297)	-2.5873 (9.5597)	-2.7295 (0.7729)	-9.8877 (0.1681)
Final fat thickness (mm)	-2.0015 (0.0001)	-1.8891 (0.3529)	-2.2609 (0.4803)	-2.3694 (0.0001)	-1.8500 (0.0001)
Yield grade	-0.2751 (0.0010)	-0.2596 (0.0485)	-0.3101 (0.0659)	-0.3250 (0.0001)	-0.2545 (0.0001)
Marbling score	-0.0406 (0.1429)	-0.0458 (0.0197)	-0.0504 (0.0271)	-0.0604 (0.0166)	-0.0623 (0.0003)
Feed cost ($/hd.)	-0.6764 (0.7571)	-1.7270 (1.8187)	-0.3263 (1.7752)	-0.9399 (0.6552)	-2.4927 (0.0455)
Cost of gain ($/lb)	0.0052 (0.6096)	0.0078 (0.0151)	0.0041 (0.0094)	0.0032 (0.8232)	0.0058 (0.5272)
Net revenue ($/hd.)	-6.1238 (0.2407)	-7.8268 (4.7701)	-4.5388 (5.6661)	-4.2103 (0.5260)	-6.3934 (0.1125)
Derived feeder value ($/cwt.)	-0.9190 (0.2771)	-1.1859 (0.7702)	-0.6576 (0.9339)	-0.5985 (0.5945)	-0.9340 (0.1256)

[a]Standard errors of the regression coefficients are shown in parentheses.

Table 31. Regression Coefficients Associated with the Zero-One-Minus-One Explanatory Variable Breed (1 = Charolais-Cross), 1986–87 Data[a] — Silage-Concentrate Diet

	Cost-Price Conditions				
	Base Prices	High Carcass	Low Carcass	High Feed	Low Feed
Days on feed	1.9418 (1.3717)	1.3248 (1.1745)	-0.7433 (1.8505)	-1.1327 (2.0048)	2.6720 (1.1227)
Final live weight (lb)	13.9950 (7.8791)	11.9224 (7.3796)	11.7198 (8.9358)	11.4468 (8.9931)	13.4603 (7.1463)
Final fat thickness (mm)	-1.8298 (0.3938)	-1.7361 (0.3565)	-2.1242 (0.4549)	-2.1610 (0.4623)	-1.6429 (0.3404)
Yield grade	-0.2510 (0.0540)	-0.2387 (0.0489)	-0.2912 (0.0624)	-0.2964 (0.0634)	-0.2259 (0.0467)
Marbling score	-0.1877 (0.0464)	-0.1816 (0.0413)	-0.2398 (0.0544)	-0.2465 (0.0560)	-0.1614 (0.0394)
Feed cost ($/hd.)	0.8411 (1.6670)	0.5670 (1.7681)	-0.7215 (1.6803)	-1.2352 (2.1769)	1.3492 (1.4284)
Cost of gain ($/lb)	-0.0117 (0.0086)	-0.0121 (0.0083)	-0.0124 (0.0079)	-0.0161 (0.0092)	-0.0085 (0.0082)
Net revenue ($/hd.)	5.3605 (4.5371)	2.6493 (4.3998)	6.3320 (4.9819)	7.9164 (5.7509)	1.4983 (3.7710)
Derived feeder value ($/cwt.)	1.1566 (0.7053)	0.6746 (0.6736)	1.3787 (0.8010)	1.6908 (0.9572)	0.4389 (0.5322)

[a]Standard errors of the regression coefficients are shown in parentheses.

Table 32. Regression Coefficients Associated with the Zero-One-Minus-One Explanatory Variable Breed (1 = Angus-Hereford-Cross), 1986–87 Data[a] — Concentrate Diet

	Cost-Price Conditions				
Dependent Variable	Base Prices and Costs	High Carcass Price	Low Carcass Price	High Feed Cost	Low Feed Cost
Days on feed	1.3848 (0.5845)	1.0370 (1.5795)	-0.7949 (2.6269)	-0.9011 (0.7153)	-0.5323 (0.6725)
Final live weight (lb)	26.5096 (0.0075)	25.3608 (8.4979)	21.6389 (10.2447)	21.4086 (0.0352)	20.7451 (0.0072)
Final fat thickness (mm)	1.1333 (0.0168)	1.0873 (0.3782)	1.0373 (0.5147)	1.0372 (0.0472)	0.8561 (0.0125)
Yield grade	0.1558 (0.0001)	0.1489 (0.0519)	0.1424 (0.0707)	0.1424 (0.0473)	0.1191 (0.0124)
Marbling score	0.0483 (0.1039)	0.0427 (0.0212)	0.0269 (0.0290)	0.0266 (0.3228)	0.0223 (0.2238)
Feed cost ($/hd.)	4.1986 (0.0739)	4.4831 (1.9491)	2.0388 (1.9024)	2.5450 (0.2595)	2.3293 (0.0809)
Cost of gain ($/lb)	-0.0274 (0.0124)	-0.0312 (0.0113)	-0.0252 (0.0101)	-0.0273 (0.0212)	-0.0266 (0.0075)
Net revenue ($/hd.)	16.6108 (0.0031)	15.3055 (5.1119)	15.3378 (6.0721)	18.3300 (0.0103)	12.1902 (0.0049)
Derived feeder value ($/cwt.)	2.7825 (0.0023)	2.5047 (0.8254)	2.5482 (1.0008)	3.1008 (0.0104)	1.9613 (0.0028)

[a]Standard errors of the regression coefficients are shown in parentheses.

Table 33. Regression Coefficients Associated with the Zero-One-Minus-One Explanatory Variable Breed (1 = Angus-Hereford-Cross), 1986–87 Data[a] — Silage-Concentrate Diet

	Cost-Price Conditions				
Dependent Variable	Base Prices and Costs	High Carcass Price	Low Carcass Price	High Feed Cost	Low Feed Cost
Days on feed	0.7863 (1.5184)	0.1809 (1.3001)	0.8577 (2.0485)	1.0437 (2.2192)	-1.1320 (1.2428)
Final live weight (lb)	24.5205 (8.7218)	23.0045 (8.1689)	26.5271 (9.8916)	27.0146 (9.9549)	20.3443 (7.9106)
Final fat thickness (mm)	1.2748 (0.4236)	1.1312 (0.3946)	1.3100 (0.5035)	1.3261 (0.5118)	1.0417 (0.3768)
Yield grade	0.1740 (0.0598)	0.1552 (0.0541)	0.1791 (0.0691)	0.1814 (0.0702)	0.1428 (0.0517)
Marbling score	0.1464 (0.0513)	0.1255 (0.0458)	0.1504 (0.0603)	0.1534 (0.0619)	0.1064 (0.0436)
Feed cost ($/hd.)	4.5823 (1.8454)	4.6482 (1.9572)	4.0118 (1.8601)	5.2090 (2.4097)	2.9657 (1.5812)
Cost of gain ($/lb)	-0.0289 (0.0096)	-0.0334 (0.0103)	-0.0268 (0.0088)	-0.0295 (0.0102)	-0.0297 (0.0091)
Net revenue ($/hd.)	13.0757 (5.0224)	13.6722 (4.8704)	13.4948 (5.5148)	15.7756 (6.3660)	11.3494 (4.1744)
Derived feeder value ($/cwt.)	1.9382 (0.7808)	2.0318 (0.7456)	1.9421 (0.8867)	2.3242 (1.0596)	1.6248 (0.5892)

[a]Standard errors of the regression coefficients are shown in parentheses.

Table 34. Regression Coefficients and Standard Errors Associated with the Explanatory Variable Subjective Frame Size Score (1–15), 1986–87 Data[a] — Concentrate Diet

	Cost-Price Conditions				
Dependent Variable	Base Prices and Costs	High Carcass Price	Low Carcass Price	High Feed Cost	Low Feed Cost
Days on feed	4.5648 (0.0001)	2.1781 (0.2682)	6.6596 (0.4460)	6.2918 (0.0001)	1.0877 (0.0001)
Final live weight (lb)	14.9736 (0.0001)	10.2421 (1.4428)	18.6549 (1.7394)	18.0562 (0.0001)	7.6168 (0.0001)
Final fat thickness (mm)	-0.0325 (0.6843)	-0.2102 (0.0642)	0.1306 (0.0874)	0.0952 (0.2822)	-0.2599 (0.0001)
Yield grade	-0.0044 (0.0167)	-0.0288 (0.0088)	0.0179 (0.0120)	0.0129 (0.2864)	-0.0357 (0.0001)
Marbling score	0.0341 (0.0001)	0.0126 (0.0036)	0.0523 (0.0049)	0.0472 (0.0001)	0.0021 (0.4875)
Feed cost ($/hd.)	4.0517 (0.0001)	2.5352 (0.3309)	4.5723 (0.3230)	5.4279 (0.0001)	1.1943 (0.0001)
Cost of gain ($/lb)	-0.0046 (0.0124)	-0.0066 (0.0019)	-0.0032 (0.0017)	-0.0040 (0.0461)	-0.0056 (0.0008)
Net revenue ($/hd.)	-2.3911 (0.0121)	-2.9305 (0.8679)	-1.3226 (1.0309)	-0.3825 (0.7515)	-3.7833 (0.0001)
Derived feeder value ($/cwt.)	0.5920 (0.0001)	0.4925 (0.1401)	0.7883 (0.1699)	0.9554 (0.0001)	0.3383 (0.0024)

[a]Standard errors of the regression coefficients are shown in parentheses.

Table 35. Regression Coefficients and Standard Errors Associated with the Explanatory Variable Subjective Frame Size Score (1–15), 1986–1987 Data[a] — Silage-Concentrate Diet

	Cost-Price Conditions				
Dependent Variable	Base Prices and Costs	High Carcass Price	Low Carcass Price	High Feed Cost	Low Feed Cost
Days on feed	2.4280 (0.2669)	2.3658 (0.2285)	1.8712 (0.3600)	2.4118 (0.3901)	2.9743 (0.2184)
Final live weight (lb)	8.0169 (1.5331)	7.6122 (1.4359)	7.9660 (1.7387)	8.7784 (1.7499)	8.5006 (1.3905)
Final fat thickness (mm)	-0.1027 (0.0766)	-0.1058 (0.0693)	-0.1604 (0.0885)	-0.1241 (0.0899)	-0.0693 (0.0662)
Yield grade	-0.0141 (0.0105)	-0.0144 (0.0095)	-0.0220 (0.0121)	-0.0171 (0.0123)	-0.0094 (0.0090)
Marbling score	0.0067 (0.0090)	0.0060 (0.0080)	-0.0040 (0.0106)	0.0036 (0.0108)	0.0146 (0.0076)
Feed cost ($/hd.)	2.0390 (0.3243)	2.2985 (0.3440)	1.4269 (0.3269)	2.2174 (0.4235)	2.3959 (0.2779)
Cost of gain ($/lb)	-0.0003 (0.0016)	-0.0034 (0.0018)	-0.0032 (0.0015)	-0.0035 (0.0018)	-0.0024 (0.0016)
Net revenue ($/hd.)	-4.8150 (0.8828)	-5.0179 (0.8561)	-4.2677 (0.9694)	-3.6676 (1.1190)	-5.6592 (0.7337)
Derived feeder value ($/cwt.)	0.3281 (0.1372)	0.2886 (0.1310)	0.4232 (0.1558)	0.5307 (0.1862)	0.1735 (0.1035)

[a]Standard errors of the regression coefficients are shown in parentheses.

Table 36. Regression Coefficients and Standard Errors Associated with the Explanatory Variable Subjective Muscle Thickness Score (1–15), 1986–1987 Data[a] — Concentrate Diet

	Cost-Price Conditions				
Dependent Variable	Base Prices and Costs	High Carcass Price	Low Carcass Price	High Feed Cost	Low Feed Cost
Days on feed	-1.4981 (0.0401)	-0.5065 (0.4532)	-0.9078 (0.7537)	-0.6623 (0.3504)	-0.1925 (0.5941)
Final live weight (lb)	-6.6793 (0.0187)	-3.8657 (2.4383)	-6.6240 (2.9395)	-6.2163 (0.0331)	-2.8004 (0.2042)
Final fat thickness (mm)	-0.1790 (0.1868)	-0.0876 (0.1085)	-0.1347 (0.1477)	-0.1070 (0.4745)	-0.0487 (0.6223)
Yield grade	-0.0244 (0.1886)	-0.0119 (0.0149)	-0.0184 (0.0202)	-0.0146 (0.4765)	-0.0066 (0.6261)
Marbling score	-0.0173 (0.0426)	-0.0075 (0.0061)	-0.0104 (0.0083)	-0.0077 (0.3154)	-0.0034 (0.5081)
Feed cost ($/hd.)	-1.9434 (0.6000)	-1.2393 (0.5592)	-1.2331 (0.5458)	-1.3506 (0.0374)	-0.7213 (0.0597)
Cost of gain ($/lb)	0.0014 (0.6385)	0.0008 (0.0032)	0.0026 (0.0029)	0.0030 (0.3663)	0.0005 (0.8571)
Net revenue ($/hd.)	-3.0924 (0.0544)	-2.5666 (1.4667)	-4.3865 (1.7422)	-5.3317 (0.0093)	-2.3120 (1.1621)
Derived feeder value ($/cwt.)	-0.3119 (0.2303)	-0.2294 (0.2368)	-0.5360 (0.2871)	-0.7244 (0.0366)	-0.1766 (0.3457)

[a]Standard errors of the regression coefficients are shown in parentheses.

Table 37. Regression Coefficients and Standard Errors Associated with the Explanatory Variable Subjective Muscle Thickness Score (1–15), 1986–1987 Data[a] — Silage-Concentrate Diet

	Cost-Price Conditions				
Dependent Variable	Base Prices and Costs	High Carcass Price	Low Carcass Price	High Feed Cost	Low Feed Cost
Days on feed	-0.3003	-0.2422	-0.3291	-0.5542	-0.3578
	(0.3870)	(0.3313)	(0.5221)	(0.5656)	(0.3167)
Final live weight (lb)	-0.0817	-0.0858	0.2339	-0.3154	-0.2502
	(2.2229)	(2.0820)	(2.5210)	(2.5372)	(2.0162)
Final fat thickness (mm)	-0.1356	-0.1142	-0.1417	-0.1521	-0.1120
	(0.1111)	(0.1005)	(0.1283)	(0.1304)	(0.0960)
Yield grade	-0.0187	-0.0157	-0.0194	-0.0208	-0.0154
	(0.0152)	(0.0138)	(0.0176)	(0.0179)	(0.0131)
Marbling score	-0.0169	-0.0141	-0.0178	-0.0206	-0.0147
	(0.0139)	(0.0116)	(0.0153)	(0.0158)	(0.0111)
Feed cost ($/hd.)	-0.6981	-0.7825	-0.5520	-0.8536	-0.7374
	(0.4703)	(0.4988)	(0.4740)	(0.6141)	(0.4030)
Cost of gain ($/lb)	-0.0010	-0.0013	-0.0010	-0.0012	-0.0009
	(0.0024)	(0.0026)	(0.0022)	(0.0026)	(0.0023)
Net revenue ($/hd.)	-2.3300	-2.3479	-2.0445	-2.0538	-2.5777
	(1.2800)	(1.2413)	(1.4055)	(1.6225)	(1.0639)
Derived feeder value ($/cwt.)	0.0613	0.0601	0.1064	0.1020	0.0226
	(0.1990)	(0.1900)	(0.2260)	(0.2700)	(0.1507)

[a]Standard errors of the regression coefficients are shown in parentheses.

Summary and Conclusions

The primary objective of this study was to examine the contributions of identifiable feeder calf characteristics to inherent or derived calf value under different carcass prices and feed costs. A secondary objective was to examine the effects of differences in feeder calf characteristics on other feedlot performance and carcass characteristics of the animals at slaughter. The feeder calf characteristics examined in the study were initial weight, initial fat thickness, breed, frame size, and muscle thickness. Individual effects of these observable feeder calf characteristics on the length of the feeding process, final live weight and fat thickness, carcass yield grade and marbling score, feed cost, cost of weight gain, net revenue from feeding, and derived value of the feeder animal were analyzed for animals fed to their individual and group optimal slaughter points. Derived value of the feeder animal was defined as the carcass value of the finished animal less all costs incurred during the feedlot finishing process. That is, it is the inherent value of the animal at the beginning of the feedlot finishing process.

To reach the objectives, a bioeconomic simulation model was developed to represent animals individually during the feedlot finishing process. The mathematical equations constructed for the model described relevant aspects of the purchase, feeding, growth, and selling processes for the 784 animals in the simulation. Each equation was based on data developed from animals actually fed in Tennessee Agricultural Experiment Station facilities or on data from published sources. Regression analysis was used to generate estimates for growth of individual animals in terms of weight, fat thickness, feed consumption, yield and quality grades, and salable carcass weight. Budget information and price data were used to calculate costs associated with the feeding process and price data were used to calculate carcass values at various points during the feeding process.

The simulation model was designed to allow optimization of slaughter dates for individual animals by calculating the number of days on feed at which net revenue to the animal was maximized. Feedlot performance and carcass characteristics were measured at that optimal slaughter date.

The base simulation models used prices and costs that were representative of the 1983–84 period and the 1986–87 period. The simulations based on 1983–84 data determined the optimal slaughter point on an individual animal basis, while the simulations based on the 1986–87 data determined the optimal slaughter points based on the average of pens of animals grouped according to feeder calf characteristics. To examine the effects of different price and cost situations on the results, carcass prices and feed costs were increased and decreased by 20 percent for additional runs of the simulation model. Multiple linear regression methods were used to estimate the effects of the initial feeder calf characteristics on the feedlot performance and carcass characteristics of the 784 finished animals.

The results indicated that the bioeconomic simulation model developed for this study responded predictably to differing cost-price conditions. As expected, increases in carcass prices and decreases in feed costs resulted in increases in the average number of days on feed to reach the optimal slaughter point and increases in average slaughter weight, fat thickness, yield grade, marbling score, net revenue per head, and derived value per hundredweight of the feeder animal. Decreases in carcass prices and increases in feed costs led to decreases in average optimal days on feed and corresponding decreases in the other feedlot and carcass characteristics listed in the preceding sentence.

Regressions of each of the finished animal characteristics on the group of initial feeder animal characteristics resulted in R^2 values ranging from 0.06 to 0.77. Therefore, differences in the feeder calf characteristics do not explain all the variation in feedlot performance and carcass characteristics and, in some cases, explain only a small percentage of that variation. The unexplained variation must be due to causes not examined in this study.

Initial Weight

Heavier feeder animals took fewer days on feed to reach optimal slaughter points and had greater live weights at the optimal points. Initial weight had no significant effects on fat thickness at slaughter or on yield grade except in a few circumstances. Larger initial weights were associated with lower carcass marbling scores due primarily to the reduction in the number of days on feed for heavier feeder animals. Cost per pound of feedlot weight gain was higher for heavier feeder animals. The effects of initial weight on net revenue per head were mixed depending upon whether the feeder animal purchase price weight differentials used in the models reflected true differences in value of the feeder animals per hundredweight. Under most cost-price conditions, the effects of heavier feeder animal weights on derived value per hundredweight of the feeder animal were negative. The negative effects were larger as feed costs decreased. That is, heavier feeder animals should have been discounted by larger amounts as feed costs decreased.

Initial Fat Thickness

Fatter feeder animals required fewer days on feed to reach their optimal slaughter points, and they tended to have smaller live weights when they reached the optimal point. Initial fat thickness was positively related to final carcass fat thickness and yield grade. Marbling score was not significantly affected by fatness of the feeder animal in most cases. Fatter feeder animals required less feed cost per head, reflecting their shorter optimal feeding periods. Cost per pound of feedlot gain was higher for initially fatter animals. Net revenue from feeding was negatively affected by increases in feeder animal fatness, indicating that the purchase prices charged for the feeder animals in the simulations overvalued fatter animals relative to thinner animals. Derived value per hundredweight of the feeder animal declined as initial fatness increased, indicating that fatter feeder animals were worth less per hundredweight. The apparent reasons for the lower derived value for fatter feeders include higher cost per pound of feedlot gain and lower carcass value per pound because of higher yield grades at optimal slaughter points.

Breed

The effects of breed were measured as differences between the specific breed and the average of all breeds in the simulation. Angus cattle showed lower final live weights, lower feed costs per head, lower net revenue per head from feeding, higher cost per pound of gain, and lower derived value per hundredweight of the feeder animal. Hereford cattle showed few significant differences from the average over all breeds. Charolais-cross cattle were associated with lower carcass fat thickness, lower yield grade, and, in some cases, lower marbling score. Charolais-crosses also showed more days on feed and heavier final live weights than the average in some situations. Angus-Hereford cross cattle tended to show heavier final live weight, greater carcass fat thickness and yield grade, and higher marbling score. Cost per pound of gain in the feedlot was lower under most circumstances for Angus-Hereford crosses. They also had higher net revenues per head, indicating that they were underpriced in the simulation model. Derived value per hundredweight of the feeder animal was higher for Angus-Hereford cross cattle than for the average of the breeds.

Frame Size

Feeder animals with larger frame scores tended to require more days on feed to reach optimal slaughter points and to be heavier when they reached the optimal point. Because they were fed longer and were heavier, they also required more feed cost per head. However, larger frame animals showed lower cost per pound of feedlot weight gain in most cases. Net revenue per head was negatively affected by increases in frame score, indicating that the prices used in the simulation model to value larger frame feeder animals were too high relative to smaller frame cattle. Derived value per hundredweight of the feeder animal was higher for larger frame cattle. This tends to confirm the common observation that frame size is a positive factor affecting feeder cattle value per hundredweight.

Muscle Thickness

Muscling score of the feeder animal had no significant effects on the feedlot performance and carcass characteristics of the finished animal except in a few cases. Increased muscling score had negative effects on feed cost per head in a few price-cost situations and negative effects on net revenue per head from feeding in some situations. Initial muscling score of the feeder animal had no significant effects on derived value per hundredweight of the feeder animal. These results offer no evidence that muscle thickness is related to the inherent value of feeder cattle. In interpreting this conclusion, the reader should remember that only beef breeds were included in this study. If thinner-muscled, dairy-type cattle had been included, effects of muscle score on derived value might have been detected.

Implications

The effects of feeder animal weight on value per hundredweight of the animal are well understood, and the results of this study are consistent with existing knowledge. Initial fat thickness of the feeder animal has normally been considered to have an effect on value, with fatter animals receiving a discount. The results of this study confirm that fatter animals are worth less per hundredweight and that this effect is significant. Of the breeds included in this study, Angus-Hereford cross feeder animals tended to be worth more per hundredweight than the average across breeds. The frame size of the feeder animal was also found to be a significant determinant of value, with larger framed cattle receiving a premium. This is also consistent with market data. However, within the beef breeds included in this study, initial muscle thickness of the feeder animal does not appear to affect inherent value of the feeder animal. This is contrary to conventional wisdom and to the concepts underlying the current USDA feeder cattle grading system (USDA 1979).

The results of this study indicate that feeder cattle fatness is a more important determinant of animal value than is muscle thickness. This conclusion implies that the current feeder cattle grading system may need to be reevaluated to consider inclusion of fatness and, perhaps, exclusion of muscle thickness as grade factors. This change would make the grade factors in the system more closely related to the readily observable determinants of actual animal value. Related concerns about the grading system have been raised by Anderson (1980) and by Trapp (1982).

Literature Cited

Abraham, H. C., C. E. Murphey, H. R. Cross, G. C. Smith, and W. J. Franks, Jr. 1980. Factors affecting beef carcass cutability: an evaluation of USDA yield grades for beef. *Journal of Animal Science* 50(May): 841–51.

Anderson, K. B. 1980. An evaluation of feeder cattle grading standards. *Southern Journal of Agricultural Economics* 12(December): 43–49.

Brown, J. E., H. A. Fitzhugh, Jr., and T. C. Cartwright. 1976. A comparison of nonlinear models for describing weight-age relationships in cattle. *Journal of Animal Science* 42(April): 810–18.

Butts, W. T., W. R. Backus, E. R. Lidvall, J. A. Corrick, and R. F. Montgomery. 1980a. Relationships among definable characteristics of feeder calves, subsequent performance and carcass traits: I. objective measurements. *Journal of Animal Science* 51(December): 1297–305.

Butts, W. T., E. R. Lidvall, W. R. Backus, and J. A. Corrick. 1980b. Relationships among definable characteristics of feeder calves, subsequent performance and carcass traits: II. subjective scores. *Journal of Animal Science* 51(December): 1306–13.

Butts, W. T., D. O. Onks, J. B. Neel, J. A. Corrick, and J. W. Holloway. 1984. Relationships between traits of cow-calf pairs and a measure of partial efficiency. *Journal of Animal Science* 59(November): 1176–84.

Crouse, J. D., and M. E. Dikeman. 1976. Determinates of retail product of carcass beef. *Journal of Animal Science* 42(March): 584–91.

Faris, J. E. 1960. Analytical techniques used in determining the optimum replacement pattern. *Journal of Farm Economics* 42(November): 755–66.

Ferguson, K. W. 1986. An economic analysis of the effects of feeder calf characteristics on important feedlot and carcass characteristics. M.S. Thesis, The University of Tennessee Department of Agricultural Economics, Knoxville.

Fitzhugh, H. A., Jr. 1976. Analysis of growth curves and strategies for altering their shape. *Journal of Animal Science* 42(April): 1036–51.

Jeremiah, L. E., G. C. Smith, and J. K. Hillers. 1970. Utilization of breed and traits determined from the live beef steer for prediction of marbling score. *Journal of Animal Science* 31(December): 1089–95.

Jeske, K. E. 1982. Prediction of post-weaning subcutaneous fat deposition in feedlot steers. M.S. Thesis, The University of Tennessee Department of Animal Science, Knoxville.

Kauffman, R. G., G. G. Suess, R. W. Bray, and R. D. Scarch. 1968. Incidence of marbling in the bovine and porcine longissimus. *Journal of Animal Science* 27(July): 969–71.

Lofgreen, G. P., and W. N. Garrett. 1968. A system for expressing new energy requirements and feed values for growing and finishing beef cattle. *Journal of Animal Science* 27(May): 793–806.

Nair, K. R. 1954. The fitting of growth curves. *Statistics and Mathematics in Biology*. Oscar Kempthorne, ed. Iowa State College Press, Ames. pp. 119–32.

National Research Council. 1982. *United States—Canadian Tables of Feed Composition.* 3rd ed. Subcommittee on Feed Composition. National Academy Press, Washington D.C.

Nelson, K. E., and W. D. Purcell. 1972. A quantitative approach to the feedlot replacement decision. *Southern Journal of Agricultural Economics* 4(July): 143–49.

Pindyck, R. S., and D. L. Rubinfeld. 1991. *Econometric Models and Economic Forecasts*. 3rd ed. McGraw-Hill Book Co., New York. pp. 121–23.

Purcell, J. C., and M. R. Holmes. 1978. *Spatial Alignment in Cattle and Calf Prices Between Southern and Central Markets 1968-76, With Implications*. Research Report 292. University of Georgia Agricultural Experiment Stations. Athens.

Raikes, R., G. M. Sieck, H. L. Self, and M. P. Hoffman. 1979. *Weight Loss of Fed Steers and Marketing-Decision Implications*. Special Report 82. Iowa State University, Agriculture and Home Economics Experiment Station. Ames.

Ray, R. M., and H. N. Walch. 1985. *Farm Planning Manual*. EC 622. The University of Tennessee Agricultural Extension Service, Knoxville.

Taylor, R. E. 1984. *Beef Production and the Beef Industry: A Beef Producer's Perspective*. Burgess Publishing Company, Minneapolis, Minnesota.

Tennessee Crop Reporting Service. 1985. *Tennessee Agricultural Statistics*. Annual Bulletins T-22. Tennessee Department of Agriculture, Nashville, and United States Department of Agriculture, Washington, D.C.

Tennessee Crop Reporting Service. 1987. *Tennessee Agricultural Statistics*. Annual Bulletins T-24. Tennessee Department of Agriculture, Nashville, and United States Department of Agriculture, Washington, D.C.

Trapp, J. N. 1982. Economic homogeneity of grade classifications under the new and old feeder cattle grading systems. *Southern Journal of Agricultural Economics* 14(July): 105–8.

USDA (United States Department of Agriculture). 1979. *Livestock: Grades and Standards for Feeder Cattle*. Agricultural Marketing Service, Washington, D.C. *Federal Register* 1(August): 45,319–22.

———. 1985–1986. *Livestock and Poultry Situation and Outlook Report*. LPS 18-20. Economic Research Service, Washington, D.C.

———. 1983–1987. *Livestock Meat Wool Market News Weekly Summary and Statistics*. Agricultural Marketing Service, Washington D.C. vols. 51–53.

The University of Tennessee. 1986. *Livestock and Forage Budgets for 1987*. AE&RD Info. 37. The University of Tennessee Agricultural Extension Service, Knoxville.

Young, J. 1981. The relationship among initial linear body measurements, characteristics of feedlot cattle and subsequent performance. M.S. Thesis, The University of Tennessee Department of Animal Science, Knoxville.

Zinn, D. W., R. M. Durham, and H. B. Hedrick. 1970. Feedlot and carcass grade characteristics of steers and heifers as influenced by days on feed. *Journal of Animal Science* 31(August): 302–6.

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