6-1-1989

Price Variability at South Dakota Livestock Auction Markets

Larry Janssen
South Dakota State University

Richard Shane
South Dakota State University

PRICE VARIABILITY AT SOUTH DAKOTA LIVESTOCK AUCTION MARKETS

by
Larry Janssen*
and
Richard Shane*

Economics Research Report 89-2

June 1989

ACKNOWLEDGEMENTS

The authors wish to thank the livestock auction managers for permission to access their sales files, to Mrs. Verna Clark for her careful typing of this manuscript and to our reviewers, Professor Gene Murra and Don Taylor for their constructive comments. This research was supported by the SDSU Agricultural Experiment Station.

*Dr. Larry Janssen is Associate Professor and Dr. Richard Shane is Professor of Economics, South Dakota State University, Brookings, South Dakota.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

PRICE VARIABILITY AT SOUTH DAKOTA LIVESTOCK AUCTION MARKETS

by
Larry Janssen
and
Richard Shane

SUMMARY AND CONCLUSIONS

Livestock prices are established through various market channels, such as terminal markets and auction markets. Auction sales account for 74% of all cattle purchases and 64% of all cattle sales by South Dakota producers (Clauson, 1983). Livestock auctions are also an important market channel for feeder pigs, slaughter hogs and slaughter lambs.

The major purpose of this research was to determine which factors, controllable or noncontrollable, have a significant impact on livestock prices established at auction market outlets in South Dakota. Factors to be tested include market location, month of sale, sex, weight, breed and lot size.

Data on sale prices and selected characteristics of animals sold were obtained for each lot of cattle, hogs and lambs sold at seven auction locations in the second week of the months of January, May, August and November, 1981. The auctions were located in the South Dakota cities of Watertown, Huron, Yankton, Kimball, Belle Fourche, St. Onge and Sturgis.

Most types of cattle (steer and heifer calves, feeder and slaughter steers and heifers, cull slaughter cows and cull slaughter bulls) were sold in all seven auctions. Data for heiferettes (first calf heifers culled from the breeding herd) were useful from only four auction locations (Huron, Belle Fourche, St. Onge and Sturgis) due to a very low number of heiferettes sold at the other three auctions.

PRICE ANALYSIS OF CATTLE AUCTION SALES

Two alternative statistical models were developed for each type of cattle examined. In all cases, price per hundredweight (cwt) was the dependent variable and the unit of observation was one lot of cattle. In the first model (dummy variable model) all sets of explanatory variables (month of sale, auction location, weight class or weight class by sex, lot size and breed) are specified as categorical variables. In the second model, weight and lot size are specified as continuous variables, while other independent variables are categorical variables. Multiple regression procedures (SAS programs REG and GLM) were used to estimate the parameters (SAS, 1982). A total of 1672 lots of cattle and calf sales were examined.

Feeder cattle and calves

Results from the two statistical models applied to feeder cattle and calves from 200 - 900 pounds indicate nearly identical findings. First, the price mean was $63.75/cwt, heifer prices were an average of $6.00 - 8.50/cwt lower than steer prices, and prices were reduced by $1.70/cwt for each 100 pounds of weight increases. Second, truck load lot sizes (50 or more head) commanded the highest prices compared to less than trade load lots. Dairy calves and feeders brought a substantially lower price/cwt compared to herefords while exotic breeds obtained a significantly ($p<0.01$) higher price. Finally, month of sale was an important factor with lowest prices received in October, 1981.

Overall, independent variables included in both models explained 73% of the variation in price/cwt. Similar models were estimated for feeder calves (steers 200 to 625 lbs. and heifers 200 to 575 lbs.) and for feeder-slaughter cattle (steers over 625 and heifers over 575 lbs.). The findings were very

similar, but the statistical goodness of fit was inferior to the models discussed above. The principal reason is that the market segments for slaughter animals and feeder animals are substantially different.

Heiferettes

Heiferette pricing data were examined for 109 lots sold at four auction markets. The price mean was $53.79/cwt. Month of sale and auction location were significant explanatory variables, with highest sale prices in January. Heiferette prices were not significantly related to weight or breed. Most heiferettes were sold in small lot sizes and a premium price was paid for heiferettes sold in lots of 5 or more. The independent variables explained about 50% of variation in price/cwt. Additional variables such as fill, condition and frame size should be included in future studies of heiferettes.

Slaughter cull cows and bulls

The marketing of cull cows and cull bulls for slaughter is primarily the consequence of breeding herd decisions. In many cases, the cows and bulls are sold a few days (or weeks) after culling and marketed solely for salvage value. Most cull cows and bulls were sold in small lot sizes of 1 - 9 head.

Separate sets of statistical models were used to analyze price variation among lots of slaughter cows and slaughter bulls. The price mean for cull cows was $43.60/cwt with an R^2 of 38% - 41%, depending on model specification. The price mean for slaughter bulls was $54.17/cwt with an R^2 of 50% - 52%.

Month of sale, auction location and weight were statistically significant ($p<0.05$) variables in the slaughter cow and slaughter bull models. The monthly price pattern was similar for cows and bulls with lowest prices in October. Heavier cow weights were negatively related to sale price/cwt while heavier bull weights were positively related to sale price/cwt. Increased lot size was

an important variable in the slaughter bull model. Additional variables such as age, condition and frame size should be included in future studies of slaughter cows or slaughter bulls.

PRICE ANALYSES OF SLAUGHTER SWINE AND LAMB AUCTION SALES

Price analyses of swine were confined to two auctions located in Huron and Yankton. Price analysis of market lambs was confined to three auctions located in Huron, Watertown and Belle Fourche. The primary reason was lack of swine or lamb sales at other auctions examined.

Separate pricing models were developed for slaughter hogs (barrows and gilts) and for slaughter breeding swine (sows and boars). Month of sale, auction location, weight and lot size were explanatory variables in models for both swine types. The findings from both slaughter swine models were similar in many respects. Month of sale and weight class were statistically significant variables, while coefficients for lot size were not significant. Slaughter hogs weighing 210 - 269 pounds commanded the highest price/cwt. Slaughter sow prices were $2.50 - 3.00/cwt above slaughter boar prices in comparable weight classes. Approximately 83% of price variation was explained in both sets of swine pricing models.

The same explanatory variables were used in the slaughter lamb pricing models. Month of sale, auction location and lot size were statistically significant variables, but lamb weight was not significant. However, most lambs are sold in a narrow weight range (80 - 120 pounds) resulting in a similar price/cwt.

OVERALL FINDINGS

In this auction pricing study examined more animal types were examined than in other livestock auction market pricing studies. Emphasis was placed

on the importance of weight, lot size and location for most classes of cattle, hogs and sheep and sex of calves and feeder cattle as factors explaining variation in prices paid. In general, findings from this study were consistent with those reported in other auction studies. One should be careful in the interpretation of price differences by auction location. Location price differences among auctions may reflect differences in numbers of animals sold, differences in their package of marketing services provided and/or differences in transportation costs.

INTRODUCTION

In the 1980's, five of every eight dollars of South Dakota's $2.5 - 3.0 billion dollars of annual agricultural commodity sales has come from livestock or livestock product marketings (USDA, 1987). Prices for livestock are established through various market channels such as terminal markets and auction barns. Auction sales account for 74% of all cattle purchases and 64% of all cattle sales by South Dakota producers (Clauson, 1983). The auction is the most popular market channel for feeder and breeding livestock. Eighty percent of South Dakotas' stocker and feeder cattle are marketed through auction barns. Livestock auction barns also are important market channels for feeder pigs, slaughter hogs and slaughter lambs.

Through observation and newspaper reports of auction barn livestock prices, it is apparent that prices vary from one location to another and from one time period to the next. Factors other than time or location will also have an impact on the price a farmer pays or receives for livestock. These factors include the sex, weight, breed and number of animals in a lot, or interactions of these factors.

The profitability of livestock production is highly dependent on prices paid for livestock inputs and prices received for the final livestock output. Some factors which affect price for the livestock buyer or seller may be within their control if understood. As the buyer or seller controls more factors affecting price, profits may be enhanced. Also, the auction barn manager may be able to offer enhabced service to customers as factors affecting price are managed properly.

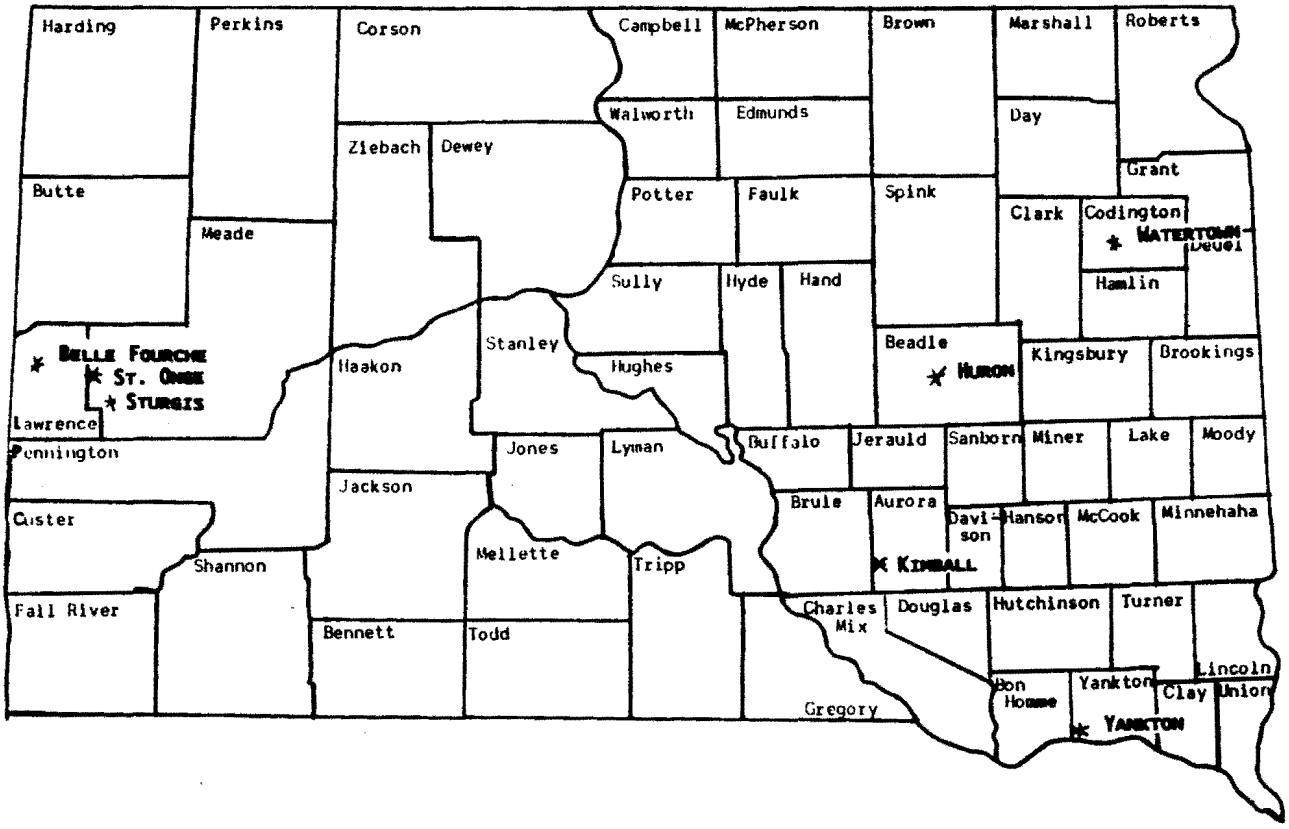
RESEARCH OBJECTIVE AND PROCEDURES

The purpose of this research was to determine what factors, controllable or noncontrollable, have a significant impact on livestock prices established at auction barn markets in South Dakota. Factors to be tested were location, time, sex, weight, breed and lot size.

Through telephone contact with auction market management personnel, it was determined that information for these factors was available for at least one year. Major auction barn managers agreed to make the information available through the personal interview process and by allowing researchers access to their files. Since most auction barn managers were willing participants, the sample of businesses selected was based on auctions having sufficient volume of livestock sales to allow statistical analysis. In addition, an effort was made to select auctions that represented different geographic areas of South Dakota. The location of the seven livestock auctions selected is shown in Figure 1.

Data collected at each location included type of livestock (i.e., calves, cows, lambs, hogs), breed of animal, weight, sex, lot size, price and date of sale. The 1981 sale dates examined were the second week in each of four months: January, May, August and October. The second week of these months were selected to avoid the impacts of holidays on livestock marketing. The months selected were more closely related to cattle and sheep marketing decisions than hog marketing decisions, since hogs marketings are less seasonal than cattle and sheep marketings. January was selected because many producers hold animals and sell livestock early in the year for income tax reasons. May was selected because of pasture demand for cattle of various types. October was selected as a major month of livestock sales as animals

Figure 1. Location of South Dakota Livestock Auctions included in Study.



are weaned and/or culled. August was selected as an "off month" when livestock marketing numbers are lower for many types of animals.

Multiple linear regression (OLS) was the statistical procedure used to test if a factor made a significant contribution to the price established for each type of livestock. The Statistical Analysis System (SAS, 1982) multiple regression packages REG and GLM (General Linear Model) were used to estimate the coefficients and provide the summary statistics. The GLM procedure was used to obtain the type III partial sums of squares and resultant F-test which allows for testing the significance of adding subsets of categorical (dummy) variables within the model.

REVIEW OF SELECTED LITERATURE

SOUTH DAKOTA LIVESTOCK MARKETING STUDIES

Several studies of livestock marketing in South Dakota have been completed. Most researchers have emphasized feeder cattle marketing while relatively few researchers have examined the marketing of slaughter cattle, hogs or sheep.

Ottar Nervik (1951) completed one of the earliest post-World War II studies concerning the marketing of South Dakota feeder cattle. He found that around 40% of the feeder cattle sold were marketed through auctions and nearly 35% were sold through terminal public markets. Part of this study dealt with factors influencing market practices and it was found that 78.5% of the feeder cattle were sold in lot sizes exceeding 10 head. He also found that nearly 30% of the calves were sold by the head rather than by weight. Also, steers were sold mostly based on weight while over 40% of the heifers were sold by the head because heifers were discriminated against when sold by weight. He made no attempt to analyze how these practices affected price.

Researchers who conducted an economic analysis of South Dakota livestock auctions in 1964 emphasized unit marketing costs by size of auction facility. Livestock auctions handled about 48% of the cattle, 23% of the hogs and 34% of the sheep marketed in South Dakota, compared to 34%, 20%, and 19%, respectively, in 1957 (Beck and Bendt, 1969). Pricing efficiency was not considered in this study.

Gaarder (1972) studied South Dakota Marketing Systems and Alternatives emphasizing potential shifts in market structure of South Dakota's beef industry. He found that auction markets had gained in market share of all cattle and calves marketed. From 1957 to 1970 auction markets' share rose

from 34% to 64% of cattle marketings in South Dakota. This gain was at the expense of farm-to-farm direct marketings and public stockyard marketings. The large percentage of cattle handled at auction barns was due to the importance of feeder cattle marketings in the state. Meat packers still purchased twice as many slaughter cattle at terminals as at auction barns.

The South Dakota Crop and Livestock Reporting Service conducted an extensive Livestock Marketing Survey in 1972 (USDA, 1974). This descriptive study provides information on marketing of cattle and calves, sheep and lambs, and hogs and pigs. Information published includes marketing channels used by producers in selling and buying livestock, location of livestock markets and slaughter plants, livestock auction sale days and volume, and imports and exports of South Dakota livestock. It does not contain information on prices received or factors influencing prices paid or received at South Dakota auctions. Updated information related to beef marketing is provided by Clauson (1983), Swain (1984) and Bau (1987).

A 1980 marketing survey of South Dakota swine producers indicated about 15% of slaughter hogs and 28% of feeder pigs sold were marketed through auctions. In earlier studies by USDA, 18% of slaughter hogs sold in 1957 were sold through auction barns and 24% of slaughter hogs sold in 1972 were sold through auction barns. Auction barns were more likely to be used by swine producers in the lower hog density regions of western and central South Dakota. In 1980, direct shipments to the packer were favored by large-scale swine producers while other producers used terminal markets and auction barns more frequently (Janssen and Weischedel, 1983).

In 1980, most slaughter hogs (60%) were marketed between 220-240 lbs. and another 30% were sold at 200-220 lbs. Most (77%) slaughter hogs were sold by

live weight pricing methods and over 95% of hogs sold were not forward priced via forward contracts or futures markets.

Feeder pig production and sales nearly doubled from 1969 to the early 1980's and comprised 24% of the total number of hogs and pigs sold from South Dakota farms in 1982. A majority of feeder pig producers reporting in the 1980 marketing survey sold feeder pigs throughout auction barns, but a majority of feeder pigs were sold by direct marketing to other farms (Janssen and Weischedel, 1983).

LIVESTOCK AUCTION PRICING STUDIES

Several studies have been completed which estimate the degree to which specified variables affect prices at different auction locations in other states.

A 1982 - 1983 Tennessee study of feeder cattle and slaughter cow prices examined the importance of location and total sales volume at each auction on average sale price. Daily average sale prices at each of 16 auction markets in Tennessee were used to estimate the parameters of the model. Auction sale volume and location were statistically significant explanatory variables, but animal characteristics per lot were not examined (McLemore, et. al., 1986).

Slaughter lamb teleauction pricing was studied in Oklahoma from 1979 - 1982. Researchers indicated some important variables affecting the sale price of slaughter lambs were: buyer numbers, seasonality, wholesale lamb prices and wool pelt prices (Ward, 1983). Weekly average prices were used as the dependent variable and characteristics of individual lots were not examined.

Sullivan and Denton (1981) found that pricing and operational efficiency of producer marketing associations exceeded that of livestock auctions in Alabama. Examination of animal characteristics per lot sold indicated lot size

and homogeneity of cattle sorted per lot were positively associated with sale price. Feeder cattle age, finish, sex and weight were other statistically significant explanatory variables.

The four studies most directly related to this research effort include a 1972 North Central Regional study of feeder cattle (McCoy, et. al., 1972) pricing at Kansas and Nebraska auctions, a 1976 - 1977 study concerning the livestock auction pricing mechanism in West Virginia (Kuehn, 1979), a 1984-85 study of Arizona feeder cattle auctions (Faminow and Gunn, 1986) and a 1986 study of Kansas feeder cattle auctions (Schroeder, et. al., 1988).

The North Central region of the United States includes South Dakota and results of the McCoy study (1972) apply to the entire region. Factors hypothesized to impact feeder cattle prices were weight, sex, grade, lot size, breed, fresh vs. trader cattle, fill, fleshiness, auction location, sales transaction number, and horns. Observers were present at six Kansas and Nebraska auctions from late November through mid-December to record all sales transactions.

Multiple linear regression analysis was used to test the significance of each factor in determining feeder cattle price. The variables included in the regression model explained 72% of the variability in the feeder cattle prices. Results indicated that both sex and weight were significant with prices declining as weights increased and heifers demanding lower prices than steers. Price-by-grade indicated that buyers paid significantly higher prices for quality feeders while discounting for low quality. Price increased with lot size but the price differences between lot sizes of 10-29 head and 30-49 head was only $0.29 per cwt. Fifty head or more in a lot demanded $1.22 per cwt more than lots of 30-49 head. Ten to 29 head lots brought $2.03 per cwt

more than singles and lots of two to nine head brought $1.49 more than singles.

Most breeds of cattle (except Hereford - Angus crossbred cattle) brought significantly lower prices than the base breed - Herefords.

Fill and fleshiness were both significant variables in determining price of feeder cattle. Over fill tended to reduce price while under fill tended to increase price. Thin cattle demanded a higher price than "normal" feeders but fleshy feeders were not discounted significantly even though the regression coefficient was negative.

Horns did not affect prices but sales transaction number did. The first ten sales of the day were used as a base. Sales 11-50 received an additional $0.73 per cwt and sales 51 and above were $0.80 per cwt above the base.

Kuehns' study (1979) was based on 18 feeder calf sales at 10 locations in West Virginia. Compared to the McCoy study, Kuehn did not include variables for fresh vs. trader, fill, fleshiness and horns. Added variables in this study were sale size (total number of cattle sold that day), type of buyer (order buyer vs. farmer buyer) and number of order buyers and number of farmer buyers. The model was derived using multiple regression techniques with 82% of the price variation explained by the model variables. The model was quadratic with all possible variables included in a squared term as well as a linear term. All squared terms were significant.

The impact on price demonstrated by the variables weight, sex, grade and location were similar to the impacts reported in the McCoy study. Price increased with lot size up to 40 head but declined with larger lots. In this study, prices decreased with order of sale until the 106th lot and then began to increase.

Breeds that demanded significantly higher than average prices were Charolais and black white face. No breed received a significantly lower than average price.

Order buyers paid $0.46 per cwt less than farmer buyers for feeder cattle. The number of order buyers present at the auction was significant with prices per cwt increasing as the numbers of order buyers increased to seven and then begin to decline. Price begins to decline as the number of order buyers exceeded seven. The number of farmer buyers affected price similarly with prices peaking with 17 farmer buyers present at all times.

In both studies the variables which exerted the greatest impacts on price were weight, sex, lot size, number of buyers and location. Breed also had an impact in the West Virginia study. Other variables, although significant, did not have large regression coefficients and therefore did not have a large impact on price. This suggests that a model that includes weight, sex, lot size and location variables will capture most of the price variability at auction markets.

Faminow and Gunn (1986) reported a 1984-85 study of two Arizona livestock auctions. For steers, they indicate that price-lot size and price-weight relationships were not different for the two years of the study. For heifers, this was not true. The normal price-weight relationship is characterized by diminishing price decreases with equal weight increases. With the heifer data, the second year analysis results demonstrated just the opposite price-weight relationship. As weight increased, prices decreased by consecutively larger amounts. Some analysts would agree that this is the normal price-weight relationship for heifers because of the impact of herd rebuilding or downsizing at different points in time. This implies that in times of herd

downsizing, heifers should be sold at lighter weights.

Lot size was determined to be optimized at sixty head in this study. However, this study was conducted in May only and differences in size or weight of animals at different times of the year were not considered. Therefore, a lot-weight relationship was modeled and the result indicated an optimum at 32,000 pounds. This was somewhat surprising since most truck capacities were 40,000 pounds. Very few sales occurred in the greater than optimal (60 head) lot size and other factors may have out weighed this variable in this analysis. In summary, these researchers determined that Arizona feeder cattle prices were related to sex, weight, lot size, breed and auction market.

A recent Kansas study was more comprehensive in analysis of variables impacting auction market prices (Schroeder, et. al., 1988). They found that feeder cattle prices at Kansas auctions were significantly affected by sex, weight, lot size, health, condition, horns, fill, frame size, muscling, breed, time of sale, futures prices and auction location. Data in this study were stratified in four sex-weight groups to yield a more homogeneous group of feeder cattle for analysis.

Some findings of the Kansas study were that the best price was received for a lot size of 40 to 45 head for light weight feeders (300-599 lbs) and for heavier feeders (600-899 lbs) a lot size of 55 to 65 head. Muddy cattle or cattle in poor health received large price discounts. Presence of horns reduced price/cwt. more for heavier animals than for light weight animals. Animals of near average weight and fill, received higher prices than thin cattle or very heavy cattle. Buyers paid premium for large frame well muscled cattle and discounted small framed or thin muscled cattle. Breed premiums

were paid for exotic crosses and white faced crosses with others discounted relative to herefords. Finally, cattle sold in the second and third quarter of the sale received $1 to $2 per hundredweight premiums to cattle sold in the first quarter.

The South Dakota livestock auction pricing study presented in this report contains all of the major variables found in other studies except the number of order buyers or farmer buyers. This study includes price analysis of calves, feeder-slaughter cattle, heiferettes, cull cows, slaughter bulls, slaughter barrows and gilts, cull sows and boars, and market lambs. This study is somewhat unique in that sale prices of several different types of livestock are examined.

ANALYSIS OF CATTLE AUCTION SALES

Cattle sales transactions data were obtained from seven auction barn locations in South Dakota. Calves and feeder slaughter cattle were 64% to 94% of sale value recorded during the weeks examined at each of the seven auction barns. Feeder - slaughter cattle were a majority of the sale value (during the weeks examined) of cattle sold in auction barns located in eastern and south central South Dakota (Huron, Yankton and Kimball). Calves were a majority of sale value recorded in western South Dakota livestock auctions at St. Onge and Sturgis (Table 1). In most auctions, heifer and steer calves were sold in separate lots. However, many lots of calves sold in October at Sturgis and St. Onge were not sorted by sex. Heifers and steers were sorted and sold in separate lots in the other months examined at these two auctions.

Bred cows and cow/calf pairs were sold in all seven auctions and represented 9.4% - 11.5% of sale value recorded at the auction barns in Watertown, St. Onge and Belle Fourche. The sale of slaughter cull cows was a

substantial source of sales revenue (22.6%) at the auction in Watertown and an important source of sales volume (7.0% - 8.7%) at auctions located in Yankton, Belle Fourche and Sturgis. Slaughter bulls were sold at all auctions and represented 0.8% - 5.0% of sale value at each location. Heiferettes (first calf heifers culled from the breeding herd) were an important source of sales revenue at Huron-Magness and were also sold at four other auction barn locations (Table 1).

Examination of monthly marketing patterns by type of cattle (for the months examined) confirmed that most calves (63.3%) and nearly half (46.5%) of the heiferettes were sold in October. Sales of feeder - slaughter cattle, cull cows and bulls were concentrated in May and August, respectively (Table 2).

PRICE ANALYIS OF CATTLE AUCTION TRANSACTIONS - DATA LIMITATIONS AND MODEL SPECIFICATIONS

Statistical models were developed to explain price variability for the following types of cattle:

(1) Feeder calves and cattle - steers and heifers, 200-900 lbs. - purchased for further finishing,

(2) Steer calves (200-625 lbs.) and heifer calves (200-575 lbs.),

(3) Feeder - slaughter cattle - steers above 625 lbs. and heifers above 575 lbs. - purchased for finishing or slaughter,

(4) Heiferettes, 625-1200 lbs.,

(5) Cull cows sold for slaughter, 800 lbs. and above,

(6) Bulls sold for slaughter, 900-2200 lbs.

These cattle represented 80% - 98% of the value of cattle sold at each auction during the months examined.

Table 1. Percent of Sale Value by Type of Cattle by South Dakota Auction Location[a]

Type of Cattle	Huron Magness	Watertown	Yankton	Kimball	St. Onge	Belle Fourche	Sturgis
	percent of sale value						
Calves[b]	25.6	23.2	16.8	31.6	54.5	33.5	56.5
Feeder/Slaughter Cattle[c]	55.1	41.1	72.2	62.6	27.0	40.6	22.6
Cull Cows	3.8	22.6	8.4	1.9	4.6	8.7	7.0
Bulls	0.8	3.4	0.9	1.2	1.9	4.4	5.0
Heiferettes	10.7	--	--	0.9	0.6	1.3	2.5
Bred Cows/Pairs	4.0	9.4	1.8	1.8	11.3	11.5	6.4
Total Percent	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Total Number of Cattle Sold	2293	1086	1623	1137	7828	5765	3562

[a]Percent of sale value and number of cattle sold are the sum of sales in the second week of January, May, August and November, 1981 by South Dakota auction location.

[b]Calves includes steer calves up to 625 lbs. and heifer calves up to 575 lbs.

[c]Feeder/Slaughter cattle are steers above 625 lbs. and heifers above 575 lbs.

Source: South Dakota Livestock Auction Survey

Table 2. Monthly Marketing Pattern by Type of Cattle

Type of Cattle	January	May	August	October
	--percent of cattle marketed by month--			
Calves	19.7	13.4	3.5	63.3
Feeder/Slaughter Cattle	12.7	32.7	33.5	21.1
Cull Cows	17.5	43.8	26.2	12.5
Bulls	8.8	34.4	47.0	9.8
Heiferettes	10.9	26.1	16.5	46.5
Bred Cows/Pair	50.6	39.2	1.6	8.6

[a]Percent of cattle by type marketed through seven South Dakota auctions during the second week of January, May, August and October, 1981.

Source: South Dakota Livestock Auction Survey

Cattle excluded from the price analysis include sale of: (1) bull calves, (2) calves not sorted by sex, (3) bred cows and (4) cow/calf pairs. Bull calves were excluded because of few (if any) sales at most locations. The autumn rush of calf sales in western South Dakota leads to several unsorted lots of calves (steers and heifers are not separated) at two auction locations. These lots were excluded from further analysis because this practice occurred in only one time period at two locations.

Bred cows and cow/calf pairs were priced per head. Lack of recorded information on size and condition of cows and calves and the breeding history of bred cows led to excluding these lots of animals from further analysis.

Two alternative statistical models were developed for each type of cattle examined. These models incorporate explanatory factors suggested in the literature review, subject to data limitations. In all cases, price/cwt was the dependent variable and the unit of observation was one lot of cattle. In the dummy variable model all sets of explanatory variables are specified as categorical variables. Explanatory variable sets include month of sale, auction location, weight class or weight class by sex, lot size and breed. In the second model (continuous/dummy variable model) weight and lot size are specified as continuous variables, while other sets of explanatory variables remain specified as categorical variables. In the second model, lot size is the reciprocal of number of head sold which implies that impact of lot size on price is largest for smaller size lots.

The general form of the two statistical models for all types of cattle examined is shown in Figure 2. In model I, the weight-sex interaction variables are binary variables of weight class by sex (steers and heifers) and is used to test for differential price response by sex as the weight class

Figure 2. Statistical Model Specifications - Cattle Auction Price Models

Model I - Dummy variable model for steers and heifers

$$Y = Bo + \sum_{m=1}^{M=1} B1_m D1_m + \sum_{a=1}^{A=1} B2_a D2_a + \sum_{sw=1}^{SW=1} B34_{sw} D34_{sw}$$

$$+ \sum_{l=1}^{L=1} B5_l X5_l + \sum_{b=1}^{B=1} B6_b D6_b + \in$$

where: Y = auction sale price per hundred weight per lot

Bo = average price/cwt. for the base Hereford steer, lowest weight class, sold in October at Huron Magness, lot size = 1 head

D = categorical (dummy) variable set

$D1_m$ = month of sale - October, January, May or August (October = base)

$D2_a$ = auction location (Huron = base)

$D34_{sw}$ = weight=by-sex class (lowest weight class of steers = base)

$D5_l$ = lot size class (1-head = base)

$D6_b$ = breed of cattle (Hereford = base)

$B1_m$, $B2_a$, $B34_{sw}$, $B5_l$, $B6_b$ are regression coefficients

$\in$ = error term

changes. In model II, weight (cwt) is a continuous variable, and sex is a binary variable. The weight-sex interaction variable is a continuous-dummy variable of animal weight by sex and is used to test for differential linear price response by sex as weight increases. The models (III and IV) for heiferettes, cows, and bulls are similar to model specifications for steers and heifers (I and II) except that sex and weight-sex interaction variables are not necessary. Weight class is specified as a set of categorical (dummy) variables in model III and animal weight is a continuous variable in model IV.

Mean values of the dependent variable (price/cwt) and selected independent variables (month, auction, lot size, breed, sex and weight) are reported by type of cattle sold in Table 3. The mean values of specific sets of dummy variables (month, auction, lot size, breed, sex) can be interpreted as the proportion of lots sold that are in a specific category. For example, 27.9% for feeder calves and cattle lots are sold in October, 14.9% of lots sold are located in Huron, 8.7% of lots are single animals, 30.6% of lots are Hereford cattle and 64.2% of lots sold are steers (Table 3). A similar interpretation can be made for other types of cattle.

Model II = Continuous dummy variable model for steers and heifers

$$Y = Bo + \sum_{m=1}^{M=1} B1_m D1_m + \sum_{a=1}^{A=1} B2_a D2_a + \sum_{s=1}^{S=1} B3_s D3_s + B4X4$$
$$+ B34\ D3X4 + B5X5 + \sum_{b=1}^{B=1} B6_b D6_b + \epsilon$$

where: Y = auction sale price per hundredweight per lot

D = categorical (dummy) variable set and X = continuous variable

Bo = average price/cwt. for the base Hereford steer sold in October at Huron auction, unadjusted for impact of annual weight and lot size

D1m = month of sale - October, January, May or August (October = base)

D2a = auction location, (Huron = base)

D3 = sex, heifer or steer (steer = base)

X4 = hundred weight (cwt.)

D3X4 = sex*cwt

X5 = reciprocal of lot size = 1/number of head sold per lot

$D6_b$ = breed of cattle (Hereford = base)

$B1_m$, $B2_a$, $B3_s$, B4, B34, B5, $B6_b$ are regression coefficients

ϵ = error term

Model III = Dummy variable model for heiferettes, cows and bulls

$$Y = Bo + \sum_{m=1}^{M=1} B1_m D1_m + \sum_{a=1}^{A=1} B2_a D2_a + \sum_{w=1}^{W=1} B4_w D4_w$$

$$+ \sum_{l=1}^{L=1} B5_l X5_l + \sum_{b=1}^{B=1} B6_b D6_b + \in$$

where: Y = auction sale price per hundred weight per lot

Bo = average price for the base Hereford animal (heiferette, cow, bull), lowest weight class, sold in October at Huron Magness, lot size = 1 head

$D4_w$ = weight class (lowest weight class = base)

$B4_w$ = regression coefficient for weight class dummy variables

All other variables are previously defined in Model I.

Model IV = Continuous-dummy model for heiferettes, cows and bulls

$$Y = Bo + \sum_{m=1}^{M=1} B1_m D1_m + \sum_{a=1}^{A=1} B2_a D2_a + B4X4$$

$$+ B5X5 + \sum_{b=1}^{B=1} B6_b D6_b + \in$$

where: Y = auction sale price per hundred weight per lot

Bo = average price for the base Hereford animal (heiferette, cow or bull) sold in October at Huron auction, unadjusted for impact of animal weight and lot size

All other variables are previously defined in Model II

Table 3. Mean Values of Selected Variables in South Dakota Cattle Auction Price Models

Variable[a]	Model Type[b]	Feeder Calves and Cattle	Calves	Feeder/ Slaughter Cattle	Heiferettes	Cull Cows	Bulls
		Type of Cattle[c]					
Tables Referenced:		4-5	A1-A2	A3-A4	6-7	8-9	10-11
Dependent							
Price/cwt	Both	$63.75	$66.52	$60.06	$53.79	$43.60	$54.17
Independent							
Month: January	Both	0.274	0.400	0.155	0.238	0.212	0.104
May	Both	0.233	0.212	0.251	0.394	0.402	0.297
August	Both	0.214	0.076	0.371	0.229	0.295	0.523
October	Both	0.279*[f]	0.312*	0.223*	0.139*	0.091*	0.076*
Auction: Huron	Both	0.149*	0.179*	0.202*	0.184*	0.056*	0.036*
Watertown	Both	0.062	0.046	0.086	---[g]	0.125	0.066
Yankton	Both	0.109	0.062	0.062	---	0.051	0.038
Kimball	Both	0.090	0.082	0.093	---	0.028	0.208
St. Onge	Both	0.218	0.201	0.203	0.165	0.219	0.273
Belle Fourche	Both	0.213	0.256	0.134	0.330	0.321	0.311
Sturgis	Both	0.159	0.174	0.120	0.321	0.200	0.245
Lot Size 1	D	0.087*	0.056*	0.155*	0.633*	0.711*	0.878*
2-4	D	0.163	0.166	0.163	0.229	0.189	0.099
5-9	D	0.196	0.182	0.227	0.138[h]	0.060	0.023[h]
10-19	D	0.224	0.248	0.181	---	0.040[h]	
20-29	D	0.108	0.136	0.071	---	---	---
30-49	D	0.113	0.125	0.091	---	---	---
50+	D	0.109	0.086	0.112	---	---	---
Lot Size: Nbrd	CD	0.203	0.176	0.270	0.743	0.800	0.921
Breed:[e] Hereford	Both	0.306*	0.336*	0.260*	0.486*	0.453*	0.435*
Dairy	Both	0.060	0.038	0.086	---	0.176	0.061
Angus	Both	0.117	0.130	0.105	0.211	0.147	0.250
Shorthorn	Both	---	---	---	---	---	0.038
Bwf	Both	0.102	0.123	0.083	0.110	0.049	0.080
Exotic	Both	0.043	0.035	0.069	0.055	0.051	0.070
Xbrd	Both	0.372	0.338	0.400	0.138	0.124	0.066
Sex: Steer	CD	0.642*	0.681*	0.618*	---	---	---
Heifer	CD	0.358	0.319	0.382	---	---	---
Weight: Cwt	CD	6.02	4.90	8.16	8.64	11.64	16.07

Table 3 - continued

[a]Variable listing includes all independent variables except weight class and weight-sex class binary variables used in the dummy variable model. Weight class or weight-sex class variables differ for each type of cattle.

[b]CD = continuous-dummy variable mode; D = dummy variable model; Both = CD and D models

[c]Type of Cattle:

1. Feeder calves and cattle are steers and heifers, 200 to 899 lb. Does not include steers and heifers sold for slaughter.
2. Feeder/slaughter cattle are steers and heifers sold for finishing or for slaughter. Steers are 625 lb. or more and heifers are 575 lb. or more.
3. Calves are steer and heifer calves sold for backgrounding or finishing. Steer calves weigh 200 lb. to 625 lb. while heifer calves weight 200 lb. to 575 lb. Does not include sale of bull calves or calves not sorted by sex.
4. Heiferettes are first calf heifers culled from the breeding herd, 625-1199 lb.
5. Cull cows are sold for slaughter, 800 lb. and above.
6. Bulls sold primarily for slaughter, 900-2200 lb.

[d]Nbr = 1/Number of head sold per lot

[e]Bwf = black-white face, Angus-Hereford crossbred cattle
Xbrd = Crossbred cattle and mixed breed cattle

[f]Variables marked by an * are included in the intercept term of both models by type of cattle.

[g]Auction and breed variables marked by --- are not included in the models because there were no lots sold of this specific type of cattle.

[h]The large lot size variables for heiferettes, bulls and cull cows are sales of 5 or more heiferettes, 5 or more bulls and 10 or more cull cows, respectively.

EMPIRICAL RESULTS - PRICE ANALYSIS OF CATTLE

Feeder Cattle and Calves

Data from seven auction barn locations in South Dakota were used in estimating the impact of specified variables on the price paid per hundredweight (cwt) for feeder cattle and calves weighing 200 - 899 pounds. The explanatory variables were included in two different forms in a dummy variable model and in a continuous/dummy variable model.

Results from the two models were nearly identical with an adjusted R^2 of 0.78. The price mean was $63.75/cwt and the root mean square error (RMSE) was equal to $3.61 - $3.62 per cwt (Tables 4 and 5). This means that 78% of the variability of feeder cattle prices in this dataset was explained by the variables included in the regression models. The RMSE of $3.61 - 3.62 indicates how close price estimates would be to actual prices if this model were used for predictive purposes. The F-value indicates that the models are each significant at the 0.01 probability level. The remaining values in the tables indicate how price/cwt changes as different factors are considered.

The intercept value of $64.13 in Table 4 can be interpreted as the average price per cwt for the base animal - a single hereford steer, 200 - 399 lb., sold in October at Huron-Magness auction barn. All numbers below the $64.13 in the parameter estimate column indicate how much must be added or subtracted from the base animal price if the animals

Table 4. Feeder Cattle Price Variation for Selected Marketing Factors at Selected South Dakota Auctions, 1981, Dummy Variable Model.[1]

	Variables	Parameter Estimate	Standard Error
	Intercept[2]	64.13	0.98***[3]
Month	January	9.94	0.44***
	May	3.31	0.44***
	August	5.70	0.46***
Auction	Watertown	-0.95	0.72
	Yankton	-0.20	0.60
	Kimball	1.02	0.63
	St. Onge	1.69	0.51***
	Belle Fourche	0.47	0.54
	Sturgis	0.78	0.55
Sex/Weight	Heifer 200-399	-8.01	1.40***
	Steer 400-499	-2.69	0.86***
	Heifer 400-499	-10.13	0.90***
	Steer 500-599	-4.89	0.86***
	Heifer 500-599	-10.78	0.94***
	Steer 600-699	-6.99	0.91***
	Heifer 600-699	-13.37	0.96***
	Steer 700-799	-8.41	0.93***
	Heifer 700-799	-12.91	1.00***
	Steer 800-899	-8.53	0.95***
	Heifer 800-899	-15.99	1.13***
Lot Size	2-4	1.39	0.60**
	5-9	2.32	0.60***
	10-19	2.72	0.61***
	20-29	2.94	0.69***
	30-49	2.73	0.68***
	≥50	4.03	0.68***
Breed	Dairy	-7.56	0.68***
	Angus	0.06	0.50
	Bwf	0.45	0.55
	Exotic	1.83	0.75***
	Xbrd	0.23	0.36

R^2 = 0.741 Price Mean = $63.75 N = 677

$\bar{R}^2$ = 0.729 RMSE = 3.62 F-value = 59.56***

[1]Includes sale of steer and heifer calves and feeder cattle, 200-899 lb.

[2]Intercept includes October, Huron Magness Auction, Hereford, steer calves of 200-399.

[3]Profitability level of significance for coefficient,
Ho: Xi = 0
*** = 0.01, ** = 0.05, * = 0.10

Table 5. Feeder Cattle Price Variation for Selected Marketing Factors at Selected South Dakota Auctions, 1981, Continuous/Dummy Variable Model.[1]

	Variables	Parameter Estimate	Standard Error
	Intercept[2]	72.31	0.94***[4]
Month	January	9.71	0.43***
	May	3.98	0.42***
	August	5.56	0.44***
Auction	Watertown	-1.30	0.70*
	Yankton	-0.26	0.60
	Kimball	0.64	0.62
	St. Onge	1.58	0.51***
	Belle Fourche	0.42	0.54
	Sturgis	0.41	0.55
Sex	Heifer	-8.43	1.30***
Weight	Cwt	-1.70	0.13***
Interaction	Cwt*heifer	0.33	0.21
Lot Size	Nbr[3]	-3.57	0.56***
Breed	Dairy	-8.03	0.66***
	Angus	0.01	0.50
	Bwf	0.39	0.54
	Exotic	1.78	0.73***
	Xbrd	0.19	0.36

R^2 = 0.738 Price Mean = $63.75 N = 677

$\bar{R}^2$ = 0.730 RMSE = 3.61 F-value = 102.76***

[1]Includes sale of steer and heifer calves and feeder cattle, 200-899 lb.

[2]Intercept includes October, Huron Magness Auction, Steer, and Hereford.

[3]Nbr = 1/Number of head sold per lot

[4]Profitability level of significance for coefficient,
Ho: Xi = 0
*** = 0.01, ** = 0.05, * = 0.10

description is changed. For example, if you sold a 450 lb. dairy heifer at St. Onge in May, the price would be reduced $10.13 for heifer and weight, reduced $7.56 for dairy, increased $1.69 for St. Onge location and increased $3.31 for sale in May; the estimated price of the 450 lb. dairy heifer is $51.44 = $64.13 - 10.13 - 7.56 + 1.69 + 3.31.

The coefficients of all sets of explanatory variables (month of sale, auction location, weight class - by - sex, lot size and breed) are each collectively significant at the 0.01 probability level. Average sale prices for January, May, and August all are significantly higher than sale prices in October, 1981. St. Onge is the only auction location where sale prices are significantly different than those at Huron-Magness (base auction for this data set). The weight class - by - sex categorical variables indicate that as weight increases, price/cwt decreases and heifer prices are $4.50 - $8.01 lower than steer prices within each weight class.

Lot size is also a categorical (dummy) variable with all lot size coefficients significant at the 0.01 probability level. The price of feeder cattle in a lot size of 2 - 4 head receives $1.39/cwt more than the price for a single animal. The coefficients for various lot sizes between 5 - 49 head are very similar to each other indicating that as long as buyers are putting together a load of 30 - 50 head, the price paid per lot is not effected very much as long as 5 or more head are in each lot. However, a lot size of 50 or

more head commands a substantial price increase over smaller lot sizes.

Compared to Herefords, dairy calves and feeders bring a substantially lower price/cwt (-$7.56) while exotic breeds command a significantly higher price (+$1.83).

Results from the continuous/dummy variable model specification are very similar to the previous model results for the month, auction and breed categorical variables. Lot size and weight are continuous variables, sex is a category variable and the interaction of sex and weight is a continuous/dummy slope variable (Table 5). Heifer prices in this model are an average of $8.43/cwt lower than steer prices and prices are further discounted $1.70/cwt as weight increases. The coefficients for sex (heifer) and weight are significant ($p<0.01$) while the coefficient for the interaction of weight - by - sex is nonsignificant ($p>0.10$). This finding indicates that price discounts for heifers and for weight are separable; increased weight does not significantly increase the price differential between heifers and steers.

The lot size variable is estimated as the reciprocal of lot size (1/number of head sold) and assumes a positive value between zero and one. Since the sign of the lot size coefficient is negative, a larger lot size means a higher price. The reciprocal lot size variable provides similar findings to the dummy variable lot size specification, but

does not convey the information as readily about the price premium paid for truck size lots.

In the dummy variable model, the intercept coefficient of $64.13 was a direct estimate of the sale price/cwt for the base animal - a single hereford steer calf, 200 - 399 lb., sold in October at Huron-Magness). The procedure used to estimate the price/cwt of the base animal has to be modified when using the continuous/dummy variable model. The intercept coefficient of $72.31 has to be adjusted for the reciprocal lot size coefficient (-$3.57) and weight (-$1.70/cwt). The estimated price range for a 200 - 399 lb. base steer calf is $62.94 - 66.34 per cwt and is an estimated $64.64/cwt for a 300 lb. steer calf.

Compared to the North Central study (1972), the only major difference in results from this study is the significant price increase for exotic feeder cattle breeds over the traditional English breeds. A price premium for exotic breeds also was shown in the 1986 Kansas livestock auction study (Schroeder, 1988). The price difference supports the changing preference of cattle feeders and consumers for leaner types of beef.

Conclusions that can be drawn from this analysis are that a producer, on average, will receive the best price for feeder cattle sold in truck load lot sizes. If a truck size lot is not possible, a producer should at least strive for lots of 5 head or more. It would appear that switching to

exotic breeds will result in higher prices for feeder cattle. However, a word of caution is in order for producers considering possibilities for making any changes in their businesses. A decision to increase herd size so that lot size may be increased results in more costs. Changing from one breed of cattle to another also may result in more costs. Each producer must determine if the increases in prices will offset the increases in costs in their own business situation before deciding to make the change. Other options may be to crossbreed, using exotic bulls on the existing cow herd. An option to replace expansion is to market jointly with another producer in order to increase lot size. This may be accomplished through the producers' efforts or may be a service provided by the auction barn. Auction barns and producers must be careful to mingle feeders of comparable quality or risk damaging their reputation of providing quality animals.

Similar models were estimated for feeder calves (steer calves weighing 200 - 625 lb. and heifer calves weighing 200 - 575 lb.) and for feeder - slaughter cattle (steers weighing 625 -1299 lb. and heifers weighing 575 lb - 1199 lb.). The findings were very similar, but the statistical fits were inferior to the models presented above, especially for the feeder - slaughter cattle models. The principal explanation is that the market segments for slaughter animals and feeder animals are substantially different. The results for the

feeder calf models and feeder - slaughter cattle models are presented in Appendix Tables A1 - A4.

Heiferettes

Heiferettes were defined as first calf heifers that are culled from the breeding herd. Heiferettes typically are sold in small lots and command a substantial price premium compared to older cull cows.

Data from selected South Dakota auction barns were used in estimating the impact of specified variables on the price of heiferettes. Data for heiferettes were useful from only four of the seven auction locations (St. Onge, Belle Fourche, Sturgis and Huron-Magness) due to a very low number or no heiferettes sold at the other three auctions.

Two models were estimated using various transformations of the data (Tables 6 and 7). The dummy variable model results include an R^2 of 0.493 and RMSE of $3.38. The R^2 indicates that only 49.3% of the variability in heiferette prices was explained by the variables included in the model. The base animal in this model was a Hereford weighing 625-799 pounds and sold in October at Huron Magness auction barn. This base animal commands a price of $51.28/cwt (Table 6). The continuous/dummy variable model had nearly identical R^2 and RMSE values (Table 7). The price mean of the 109 lots of heiferettes was $53.79 per cwt.

Through inspection of results of both models' in Tables 6 and 7, one can see that sale prices in January were

Table 6. Heiferette Price Variation for Selected Marketing Factors at Selected South Dakota Auctions, 1981, Dummy Variable Model.[1]

	Variable	Parameter Estimate	Standard Error
	Intercept[2]	51.82	1.54***[3]
Month	January	4.00	1.53***
	May	-1.81	1.31
	August	2.54	1.42*
Auction	St. Onge	3.73	1.29***
	Belle Fourche	0.85	1.14
	Sturgis	0.13	1.11
Weight	800-899	-0.65	0.81
	900-999	-1.98	1.09*
	≥ 1000	-1.84	1.33
Lot Size	2-4	1.01	0.83
	≥ 5	2.37	1.13
Breed	Angus	0.93	0.92
	Bwf	1.45	1.22
	Exotic	0.53	1.56
	Xbrd	0.72	1.21

R^2 = 0.493 Price Mean = $53.79 N = 109

$\bar{R}^2$ = 0.411 RMSE = $3.38 F-value = 6.03***

[1]Includes sale of heiferettes from 625-1199 lb.

[2]Intercept includes October, Huron Magness Auction, weight 625-799, lot size of one and Hereford.

[3]Probability level of significance for coefficient,
Ho: Xi = 0
*** = 0.01, ** = 0.05, * = 0.10

Table 7. Heiferette Price Variation for Selected Marketing Factors at Selected South Dakota Auctions, 1981, Continuous/Dummy Variable Model.[1]

	Variable	Parameter Estimate	Standard Error
	Intercept[2]	57.70	3.90***[4]
Month	January	3.76	1.46***
	May	-2.02	1.26
	August	2.19	1.37
Auction	St. Onge	3.60	1.29***
	Belle Fourche	0.84	1.15
	Sturgis	0.10	1.14
Weight	Cwt	-0.47	0.37
Lot Size	Nbr[3]	-2.38	1.06**
Breed	Angus	1.06	0.90
	Bwf	1.27	1.19
	Exotic	-0.08	1.49
	Xbrd	0.65	1.20

R^2 = 0.481 Price Mean = $53.79 N = 109

$\bar{R}^2$ = 0.416 RMSE = $3.36 F-value = 7.42***

[1]Includes sale of heiferettes from 625-1199 lb.

[2]Intercept includes October, Huron Magness Auction and Hereford

[3]Nbr = 1/Number of head sold per lot

[4]Probability level of significance for coefficient,
Ho: Xi = 0
*** = 0.01, ** = 0.05, * = 0.10

significantly higher ($p<0.01$) than prices in the base month of October. Heiferetts sold at St. Onge were sold at significantly higher prices than heiferettes sold at the Huron auction.

Heiferette prices were not significantly related to weight or breed.

When lot size was used as a continuous variable, the coefficient was statistically significant. The indication from results in Table 7 is that price for a single heiferette is reduced $2.38/cwt from a base price of $57.70. The dummy variable model (Table 6) does not completely support this conclusion. Lot sizes of 5 or more head bring a significantly higher price/cwt than a single heiferette, while lots of 2 - 4 heiferettes do not bring a significantly higher price than a single heiferette.

Several conclusions can be drawn from this analysis. First, variables specified in these models do not perform very well in explaining variability of heiferette prices at selected South Dakota auctions. Variables which do a good job in explaining variability of feeder cattle prices are not very useful in heiferette price determination models. This suggests that additional variables need to be considered in a heiferette model. Variables such as fill, condition and frame size should be included in future studies of heiferettes.

Heiferette prices demonstrate a positive responsiveness

to lot size, but only after at least 5 head are in a lot. This reflects the specialized nature of heiferette markets. Many feeders prefer heifers and steers because of proven performance and because of the volume available for feeding. Heiferette sale volume is not very large and larger lots are simply not available.

Slaughter Cull Cows

The marketing of cull cows is primarily the consequence of breeding herd decisions. Once the producer has decided to cull the animal, the principal decisions are the length of feeding period and type of ration necessary to market the animal at the appropriate weight and condition. In many cases, the cows are sold a few days (or weeks) after culling and marketed solely for "salvage value". In most cases, cull cows are sold in small lot sizes of 1 - 9 head.

Data from seven auction barns in South Dakota were used to estimate the impacts of selected explanatory variables (month of sale, auction location, weight, lot size, and breed) on sale prices of cull cows. The two model specifications were statistically significant at the 0.01 probability level, but variables included explained only 40.9% and 38.4%, respectively, of the sale price variation of the 566 lots of slaughter cows (Tables 8 and 9). A likely reason for the relatively low performance of these models was the lack of information on age and condition of cows sold.

The price mean was $43.60 per cwt and the RMSE was $2.86

- $2.90 in the two cull cow models. Compared to the heiferette model results, the mean price is nearly $10 per cwt lower, but the predictive ability is greater as the RMSE is $0.50 per cwt lower.

Month of sale, auction location and weight were the only statistically significant sets of explanatory variables. Average sale prices in January, May and August were $5.46 - $7.12 per cwt higher than in the base month of October. In both models, coefficients for average sale prices at St. Onge and Kimball were significantly different than sale prices at Huron-Magness.

Heavier weights were related to lower sale prices per cwt, but the relationship was not as distinct as occurs for calves and feeder cattle. Cull cows weighing 1000 - 1399 lb. brought an average of $1.40 - $1.52 lower price per cwt than cull cows weighing 800 - 999 lb. (Table 8). Heavier cows, above 1400 lb., were discounted (-$0.94) a lesser amount.

Most cull cows were sold in small lots of 1 - 9 cows. Increased lot size was negatively related to sale price, which is contrary to price relationships for feeder cattle and heiferettes. However, the lot size coefficients were not statistically significant.

Exotic breeds were the only breed of cull cows with a significantly higher sale price per cwt than Herefords. No breed, including cull dairy cows, brought a significantly lower average sale price. The relatively low price

Table 8. Slaughter Cull Cow Price Variation for Selected Marketing Factors at Selected South Dakota Auctions, 1981, Dummy Variable Model.[1]

	Variable	Parameter Estimate	Standard Error
	Intercept[2]	38.38	0.70***[3]
Month	January	5.85	0.50***
	May	5.48	0.47***
	August	7.12	0.48***
Auction	Watertown	-0.07	0.67
	Yankton	-1.05	0.75
	Kimball	-1.85	0.89**
	St. Onge	2.01	0.60***
	Belle Fourche	0.45	0.58
	Sturgis	1.20	0.60**
Weight	1000-1099	-1.52	0.34***
	1100-1199	-1.40	0.37***
	1200-1399	-1.41	0.39***
	≥ 1400	-0.94	0.55*
Lot Size	2-4	-0.53	0.34
	5-9	-0.50	0.54
	≥ 10	-0.79	0.63
Breed	Dairy	0.14	0.45
	Angus	-0.12	0.37
	Bwf	0.55	0.60
	Exotic	1.25	0.58**
	Xbrd	0.57	0.40

R^2 = 0.409 Price Mean = $43.60 N = 566

$\bar{R}^2$ = 0.386 RMSE = $2.86 F-value = 17.95***

[1]Includes sale of cull cows, 800 lb. and above

[2]Intercept includes October, Huron Magness Auction, cows weighing 800-999 lb., and Hereford

[3]Probability level of significance of coefficient,
Ho: Xi = 0
*** = 0.01, ** = 0.05, * = 0.10

Table 9. Slaughter Cull Cow Price Variation for Selected Marketing Factors at Selected South Dakota Auctions, 1981, Continuous-Dummy Variable Model.[1]

	Variable	Parameter Estimate	Standard Error
	Intercept[2]	38.29	1.09***[4]
Month	January	5.90	0.50***
	May	5.46	0.47***
	August	7.11	0.48***
Auction	Watertown	-0.35	0.67
	Yankton	-1.06	0.76
	Kimball	-1.95	0.90**
	St. Onge	1.73	0.61***
	Belle Fourche	0.27	0.58
	Sturgis	0.94	0.60
Weight	Cwt	-0.13	0.07*
Lot Size	Nbr[3]	0.60	0.42
Breed	Dairy	0.21	0.46
	Angus	-0.03	0.38
	Bwf	0.66	0.60
	Exotic	1.13	0.59*
	Xbrd	0.56	0.41

R^2 = 0.384 Price Mean = $43.60 N = 566

$\bar{R}^2$ = 0.366 RMSE = $2.90 F-value = 19.85***

[1]Includes sale of cull cows, 800 lb. and above

[2]Intercept includes October, Huron Magness Auction and Hereford

[3]Nbr = 1/Number of head sold per lot

[4]Probability level of significance of coefficient, Ho: Xi = 0
*** = 0.01, ** = 0.05, * = 0.10

differential among breeds reflects the nature of derived demand for utility or canner-cutter cattle.

Slaughter Cull Bulls

The marketing of slaughter bulls were primarily the consequence of breeding herd culling decisions. Bulls are usually sold in small lots of 1 - 9 head.

Data from seven auction barn locations in South Dakota were used in estimating the impacts of selected explanatory variables on sale prices of slaughter bulls. The two model specifications were statistically significant at the 0.01 probability level and explained 51.9% and 50.4%, respectively, of the sale price variation of 212 lots of slaughter bulls. The price mean was $54.17/cwt and the RMSE was $2.94/cwt (Tables 10 and 11).

Month of sale, auction location, lot size and weight were the statistically significant sets of explanatory variables. The seasonal pattern of bull prices was similar to cull cow prices. Sale prices in January, May, and August were $4.84, $6.25 and $8.36 per cwt, respectively, higher than average sale prices in the base month of October. In both models, coefficients for average sales prices at livestock auctions in Watertown and Sturgis were significantly lower ($p<0.05$) than sale prices at Huron-Magness.

Heavier weights were positively related to higher sale prices per cwt. Bulls weighing 1700 lb. or more received an

Table 10. Slaughter Bull Price Variation for Selected Marketing Factors at Selected South Dakota Auctions, 1981, Dummy Variable Model.[1]

	Variable	Parameter Estimate	Standard Error
	Intercept[2]	46.50	1.44***[3]
Month	January	4.84	1.08***
	May	6.25	0.90***
	August	8.36	0.88***
Auction	Watertown	-4.33	1.36***
	Yankton	-0.82	1.51
	Kimball	0.12	1.64
	St. Onge	-1.30	1.14
	Belle Fourche	0.07	1.14
	Sturgis	-2.06	1.14*
Weight	1300-1499	0.96	0.80
	1500-1699	0.62	0.78
	1700-1899	2.20	0.80**
	1900-2299	3.08	0.94***
Lot Size	2-4	1.84	0.79**
	5-9	1.15	1.39
Breed	Dairy	-0.05	0.98
	Angus	1.55	0.52**
	Bwf	1.36	1.22
	Shorthorn	1.10	0.80
	Exotic	0.31	0.88
	Xbrd	0.27	0.89

R^2 = 0.519 Price Mean = $54.17 N = 212

$\bar{R}^2$ = 0.466 RMSE = $2.94 F-value = 9.75***

[1]Includes sale of bulls, 900 lb. and above

[2]Intercept includes October, Huron Magness auction bulls from 900 - 1299 lb., and Hereford

[3]Probability level of significance of coefficient,
Ho: Xi = 0
*** = 0.01, ** = 0.05, * = 0.10

Table 11. Slaughter Bull Price Variation for Selected Marketing Factors at Selected South Dakota Auctions, 1981, Continuous/ Dummy Variable Model.[1]

	Variable	Parameter Estimate	Standard Error
	Intercept[2]	44.04	1.95***[4]
Month	January	5.56	1.06***
	May	6.68	0.88***
	August	8.79	0.86***
Auction	Watertown	-3.95	1.37***
	Yankton	-0.70	1.51
	Kimball	0.73	1.64
	St. Onge	-1.40	1.14
	Belle Fourche	0.03	1.13
	Sturgis	-2.04	1.14*
Weight	Cwt	0.33	0.09***
Lot Size	Nbr[3]	-2.06	1.04**
Breed	Dairy	-0.06	0.99
	Angus	1.56	0.53***
	Bwf	0.96	1.21
	Shorthorn	1.14	0.80
	Exotic	0.72	0.86
	Xbrd	0.59	0.88

R^2 = 0.504 Price Mean = $54.17 N = 212

$\bar{R}^2$ = 0.460 RMSE = $2.95 F-value = 11.59***

[1]Includes sale of bulls, 900 lb. and above

[2]Intercept includes October, Huron-Magness auction and Herford

[3]Nbr = 1/Number of head sold per lot

[4]Probability level of significance of coefficient, Ho: Xi = 0
*** = 0.01, ** = 0.05, * = 0.10

average of $2.20 - $3.08 higher sale price per cwt than slaughter bulls weighing 900 -1299 lb.

Increased lot size was positively related to higher sale prices. Angus bulls were the only breed of bulls receiving a significantly higher sale price/cwt than Herefords.

ANALYSIS OF LIVESTOCK AUCTION SALES TRANSACTIONS FOR HOGS AND SHEEP

PRICE ANALYSIS OF SLAUGHTER HOGS

Data from two auction locations, Huron-Bales and Yankton, were used to examine auction pricing of swine. Few (or none) hogs and pigs were sold at any of the other auction markets examined.

During the second week of each month of the four months examined, market hogs (barrows and gilts) were 61% of swine sales dollar volume and 42% of animals sold while slaughter sows and boars were nearly 10% of sales dollar volume and 4% of animals sold. Feeder pigs were 29% of sales dollar volume and 54% of animal numbers sold. Slaughter hogs, sows and boars were sold on a per cwt basis while feeder pigs were usually sold on a per head basis.

Average lot size was 35 - 40 head per lot of feeder pigs, 12 - 15 head per lot of barrows and gilts, and 2 - 5 head per lot of slaughter sows and boars. Most feeder pigs (67%) and sows (73%) in this dataset were sold in May and

October, while 67% of market hogs were sold in August and October. The lowest proportions of feeder pigs, market hogs and slaughter sows were sold in January.

Feeder pigs were not included in the price analysis, because they were sold on a per head basis and adequate information on animal characteristics was not available.

Dummy variable models for market hogs (barrows and gilts) and slaughter sows and boars were developed for analysis of sale prices/cwt. Month of sale, auction location, lot size and weight class were included as explanatory variables for barrow and gilt prices. Month of sale, auction location, lot size and weight class - by - sex were included as explanatory variables for the sale price of slaughter sows and boars.

Slaughter Barrows and Gilts

Month and weight class were significant sets of explanatory variables for sale prices of barrows and gilts, while auction location and lot size were nonsignificant ($p>0.10$) sets of explanatory variables (Table 12). The predicted sale price was highest in August (+$6.46/cwt above the base period in October) and lowest in January (-$3.40/cwt).

The highest prices per cwt were obtained from the sale of 210 - 239 lb. hogs, although price discounts for 180 - 209 lb. hogs and 240 - 269 lb. hogs were less than $0.40/cwt. The price discount was $2.11/cwt for heavier market hogs of

Table 12. Market Hog (Barrows and Gilts) Price Variation for Selected Marketing Factors at Selected South Dakota Auctions, 1981, Dummy Variable Model.[1]

	Variable	Parameter Estimate	Standard Error
	Intercept[2]	42.58	0.46***[3]
Month	January	-3.40	0.46***
	May	1.36	0.42***
	August	6.46	0.39***
Auction	Yankton	0.50	0.34
Lot Size	5-9	0.05	0.44
	10-19	0.49	0.44
	20-29	0.50	0.50
	≥ 30	0.49	0.56
Weight	180-209	-0.34	0.51
	240-269	-0.26	0.35
	270-330	-2.11	0.50

R^2 = 0.836 Price Mean = $44.37 N = 120

$\bar{R}^2$ = 0.819 RMSE = $1.60 F-value = 50.0***

[1]Includes sale of market hogs (barrows and gilts) from 180-330 lb.

[2]Intercept includes October, Huron-Magness Auction, lot size of 1-4 market hogs, and market hogs weighing 210-239 lb.

[3]Probability level of significance of coefficient, Ho: Xi = 0
*** = 0.01, ** = 0.05, * = 0.10

270 - 330 lb. Most lots sold were hogs weighing between 210 - 269 lb., so most producers were marketing at the appropriate weights and receiving the highest prices/cwt.

Overall, about 83.6% of the price variation of 120 lots of barrows and gilts was explained by the variables included in this simple model. The mean price was $44.37 and the root mean square error (RMSE) was $1.60.

Slaughter Sows and Boars

Auction barns are important outlets for the sale of cull sows and boars. Few cull sows and boars are sold relative to barrows and gilts. Lot sizes are much smaller, average sale price/cwt is lower and average weight per animal is substantially higher than for barrows and gilts. The sale of cull sows and boars were the consequence of breeding herd decisions.

The explanatory variables in the dummy variable model explain about 83% of the price variation in this small data set of 42 lots. The price mean was $39.09/cwt and the RMSE was $1.69 per cwt. Month of sale, auction location, and weight class - by - sex are significant sets ($p<0.05$) of explanatory variables. Lowest average prices occurred in January and the highest average prices were in August, as in the market hog model. Boars were sold for about $2.50 - $3.00 per cwt less than sows in comparable weight classes.

The findings from both slaughter swine models (Tables 12 and 13) were similar. Month of sale, weight class or weight

Table 13. Slaughter Cull Sow and Boar Price Variation for Selected Marketing Factors at Selected South Dakota Auctions, 1981, Dummy Variable Model.[1]

	Variable	Parameter Estimate	Standard Error
	Intercept[2]	39.23	0.88***[3]
Month	January	-3.44	0.90***
	May	-0.92	0.81
	August	4.74	0.82***
Auction	Yankton	-1.47	0.58**
Lot Size	2-4	0.50	0.71
	≥ 5	1.07	0.69
Sex/Weight	Sows, 400-499	0.23	0.73
	Boars, 300-499	-2.72	1.17**
	Sows, ≥ 500	0.61	0.78
	Boars, ≥ 500	-3.73	1.18***

R^2 = 0.829 Price Mean = $39.09 N = 42

$\bar{R}^2$ = 0.774 RMSE = $1.69 F-value = 15.08***

[1]Includes sale of cull sows and cull boars for slaughter, 300 lb. and above

[2]Intercept includes October, Huron auction, lot size of 1 and sows weighing 300-399 lb.

[3]Probability level of significance of coefficient,
Ho: Xi = 0
*** = 0.01, ** = 0.05, * = 0.10

class - by - sex were statistically significant sets of explanatory variables. It was surprising that coefficients for lot size were nonsignificant in both models. However, slightly higher prices/cwt were obtained from the sale of swine in larger size lots. The timing of swine slaughter marketings is largely determined by previous breeding decisions and the extent of culling practiced. Slight flexibility can be obtained from marketing at lower or higher weights.

PRICE ANALYSIS OF SLAUGHTER LAMBS

Data available to study the factors affecting auction prices for lambs came from three auction locations: Huron-Bales, Watertown and Belle-Fourche. Sales of lambs at other auction barns examined were not of sufficient volume in the study period to allow statistical testing. Most of the sheep sales volume (>90%) at these three auctions were slaughter lamb sales, while the remaining sales were cull breeding stock (ewes and rams) for slaughter.

Two models were developed to examine the impact of selected factors (month of sale, auction location, lot size and weight) on the sale price of slaughter lambs at South Dakota auction barns. Only slaughter lambs weighing 80 pounds or more were included in this analysis. In the continuous/dummy variable model, lot size and weight were specified as continuous variables while month of sale and

auction location were specified as categorical (dummy) variables. All sets of explanatory variables were specified as categorical variables in the dummy variable model.

In both models, all variables were significant in determining lamb prices, except weight, at the 0.05 probability level (Tables 14 and 15). Approximately 82 - 83% of the variability in slaughter lamb prices was explained by the included variables. The price mean was $51.78 and the RMSE was $3.19 - $3.22 in the two models. These results indicate that time, location of sale, and lot size impact lamb prices more than lamb weight. However, there was very little difference in average weights among lots of lambs sold. Most lambs were sold between 80-120 lb.

In this dataset, May was the best month to sell lambs as average prices were $19.45 - $19.70 per cwt above sale prices in the base month of October. Prices obtained in January and August were also significantly higher ($p<0.05$) than sale prices in October. These findings suggest that timing of lamb sales is an important variable in profitable marketing.

Location of sale also had a significant impact on lamb prices. One must be careful in the interpretation of these results as the price differences may be a reflection of differences in volume from one sale barn to the next, differences in marketing services and/or differences in transportation costs from one sale barn to another.

The number of lambs per lot ranged from singles to more

Table 14. Lamb Price Variation for Selected Marketing Factors at Selected South Dakota Auctions, 1981, Dummy Variable Model.

	Variable	Parameter Estimate	Standard Error
	Intercept[1]	47.26	0.98***[2]
Month	January	6.03	1.02***
	May	19.45	1.02***
	August	1.65	0.74**
Auction	Belle Fourche	-3.20	0.95***
	Watertown	-4.28	1.21***
Lot Size	10-39	2.49	0.76***
	40-99	3.21	0.97***
	100 -	3.10	1.10***
Weight	80-99	-1.43	0.75*
	100-119	-0.38	0.86
	≥ 120	-2.30	1.23

R^2 = 0.842 Price Mean = $51.78 N = 131

$\bar{R}^2$ = 0.828 RMSE = $3.19 F-value = 70.84***

[1]Intercept includes Huron Bales Auction, October, lot size of 1-9 head and weights of less than 80 pounds.

[2]Probability level of significance for coefficient,
Ho: Xi = 0
*** = 0.01, ** = 0.05, * = 0.10

Table 15. Lamb Price Variation for Selected Marketing Factors at Selected South Dakota Auctions, 1981, Continuous/ Dummy Variable Model.

	Variable	Parameter Estimate	Standard Error
	Intercept[1]	50.11	1.88***[3]
Month	January	5.60	0.98***
	May	19.71	1.02***
	August	2.46	0.73**
Auction	Belle Fourche	-2.63	0.77***
	Watertown	-4.89	1.22***
Lot Size	Nbr[2]	-4.16	1.10***
Weight	Lbs.	-0.0099	0.02

R^2 = 0.834 Price Mean = $51.78 N = 131

$\bar{R}^2$ = 0.825 RMSE = $3.22 F-value = 88.27***

[1]Intercept includes Huron Bales Auction and October

[2]Nbr = 1/Number of head sold per lot

[3]Probability level of significance for coefficient,
Ho: Xi = 0
*** = 0.01, ** = 0.05, * = 0.10

than 100 head. The -$4.16 parameter estimate for lot size in Table 15 suggests that as lot size increases, lamb price/cwt also increases. Results from the dummy variable model suggests that lot sizes of 40 head or more receive the highest average prices (Table 14).

LIST OF REFERENCES

Bau, David. 1987. South Dakota's Beef Industry, Master's Thesis, Economics Dept., South Dakota State University, Brookings, SD.

Beck, Robert L. and Donald K. Bendt. 1969. Livestock Auctions in South Dakota - An Economic Analysis, South Dakota Ag. Expt. Station Bulletin 560, South Dakota State University, Brookings, SD, September.

Clauson, Annette. 1983. Market Structure and Conduct of the South Dakota Beef Industry. Master's Thesis, South Dakota State University, Brookings, SD.

Faminow, M.D. and R.L. Gunn. 1986. Feeder Cattle Price Differentials. Western Journal of Agricultural Economics, Vol. 11, No. 2, December.

Gaarder, Raymond O. 1972. Marketing Systems and Alternatives - South Dakota's Beef Industry, South Dakota Ag. Expt. Station Bulletin 604, South Dakota State University, Brookings, SD, October.

Janssen, Larry and Kevin Weischedel. 1983. Swine Marketing in South Dakota: Results of a Producer Survey. Economics Research Report 83-5, South Dakota State University, Brookings, SD, October.

Kuehn, John P. 1979. An Analysis of the West Virginia Livestock Pricing Mechanism, West Virginia R.M. 177, West Virginia University, September.

McCoy, John et.al. 1975. Feeder Cattle Pricing at Kansas and Nebraska Auctions. North Central Regional Publication 219 and Kansas Ag. Expt. Station Bulletin 582, Kansas State University, Manhattan, Kansas.

McLemore, Dan, Emily McLain and Glen Whipple. 1986. Relationship between Cattle Prices and Sales Volumes on Tennessee Auction Markets. Tennessee Ag. Expt. Station Research Report 86-7, University of Tennessee, Knoxville, TN, April.

Nervik, Otto. 1951. Marketing South Dakota Feeder Cattle, South Dakota Ag. Expt. Station Bulletin 409, South Dakota State College, Brookings, SD, May.

SAS Institute. 1982. SAS User's Guide: Statistics, Cary, NC.

Schroeder, T., J. Mintert, F. Gragle, and O. Grunewald. 1988. Feeder Cattle Price Differentials. Western Journal of Agricultural Economics, Vol 13, No. 1, July.

Sullivan, Gregory and Daniel Linton. 1981. Economic Evaluation of an Alternative Marketing System for Feeder Cattle in Alabama. Alabama Ag. Expt. Station Circular 251, Auburn University, June.

Swain, Larry. 1984. South Dakota Beef Producer Marketing Alternatives. Master's Thesis, South Dakota State University, Brookings, SD.

USDA. 1974. South Dakota - Livestock Marketing - 1972. South Dakota Crop and Livestock Reporting Service, June.

USDA. 1988. Economic Indicators of the Farm Sector: State Financial Summary, 1976. ECIFS 6-4, Economic Research Service, Washington, D.C., February. (Also earlier editions of this annual report).

Ward, Clement E. 1983. An Empirical Study of Price Discovery and Competition for Slaughter Lambs. Oklahoma Ag. Expt. Station, pp. 1438 and Selected Paper. Western Ag Econ Association, Laramie, WY, July.

Table A.1. Feeder Calf Price Variation for Selected Marketing Factors at Selected South Dakota Auctions, 1981, Dummy Variable Model.[1]

	Variable	Parameter Estimate	Standard Error
	Intercept[2]	63.77	1.29***[3]
Month	January	11.67	0.74***
	May	5.52	0.70***
	August	6.15	0.95***
Auction	Watertown	-2.56	1.13**
	Yankton	1.12	1.04
	Kimball	1.98	0.94**
	St. Onge	1.40	0.76*
	Belle Fourche	1.10	0.76
	Sturgis	0.97	0.77
Sex/Weight	Heifer, 200-399	-6.72	1.49***
	Steer, 400-499	-2.84	0.94***
	Heifer, 400-499	-10.67	1.00***
	Steer, 500-625	-5.45	0.95***
	Heifer, 500-575	-11.50	1.09***
Lot Size	2-4	0.29	1.05
	5-9	1.25	1.06
	10-19	1.87	1.07*
	20-29	1.86	1.14*
	30-49	1.57	1.16
	$\geq$ 50	3.14	1.23**
Breed	Dairy	-9.18	1.17***
	Angus	1.91	0.71***
	Bwf	0.61	0.56
	Exotic	1.28	1.20
	Xbrd	0.61	0.56

R^2 = 0.718 Price Mean = $66.52 N = 367

$\bar{R}^2$ = 0.698 RMSE = $3.90 F-value = 34.76***

[1]Includes sale of steer calves from 200-625 lb. and heifer calves from 200-575 lb. Does not include sale of calves not sorted by sex.

[2]Intercept includes October, Huron Magness Auction, steer calves 200-399 lb. and Hereford.

[3]Probability level of significance for coefficient,

Ho: Xi = 0
*** = 0.01, ** = 0.05, * = 0.10

Table A.2. Feeder Calf Price Variation for Selected Marketing Factors at Selected South Dakota Auctions, 1981, Cointinuous/Dummy Variable Model.[1]

	Variable	Parameter Estimate	Standard Error
	Intercept[2]	74.10	1.73***[4]
Month	January	11.96	0.61***
	May	5.92	0.68***
	August	6.78	0.91***
Auction	Watertown	-3.04	1.08***
	Yankton	1.05	1.00
	Kimball	1.48	0.90*
	St. Onge	1.49	0.73**
	Belle Fourche	1.20	0.73*
	Sturgis	0.79	0.74
Sex	Heifer	-5.05	2.94*
Weight	Cwt	-2.51	0.34***
Interaction	Cwt*heifer	-0.47	0.61
Lot Size	Nbr[3]	-3.56	1.00***
Breed	Dairy	-8.47	1.14***
	Angus	1.64	0.68
	Bwf	0.77	0.72
	Exotic	1.74	1.15
	Xbrd	0.75	0.55

R^2 = 0.732 Price Mean = $66.52 N = 367

$\bar{R}^2$ = 0.718 RMSE = $3.77 F-value = 52.74***

[1]Includes sale of steer calves from 200-625 lb. and heifer calves from 200-575 lb. Does not include sale of calves not sorted by sex.

[2]Intercept includes October, Huron Magness Auction, steer and Hereford

[3]Nbr = 1/Number of head sold per lot

[4]Probability level of significance for coefficient, Ho: Xi = 0

Table A.3. Feeder/Slaughter Cattle Price Variation for Selected Marketing Factors at Selected South Dakota Auctions, 1981, Dummy Variable Model.[1]

	Variable	Parameter Estimate	Standard Error
	Intercept	61.10	0.94***
Month	January	3.47	0.60***
	May	1.39	0.53***
	August	4.40	0.48***
Auction	Watertown	-1.75	0.78**
	Yankton	-1.36	0.61**
	Kimball	-0.32	0.70
	St. Onge	-1.17	0.61*
	Belle Fourche	-1.99	0.71**
	Sturgis	-1.10	0.69
Sex/Weight	Heifer, 575-699	-6.27	0.62***
	Steer, 700-799	-2.34	0.62**
	Heifer, 700-799	-6.67	0.74****
	Steer, 800-899	-2.52	0.65***
	Heifer, 800-899	-9.40	0.90***
	Steer, 900-999	-4.33	0.78***
	Heifer, 900-999	-9.57	1.01***
	Steer, ≥ 1000	-4.77	0.74***
	Heifer, ≥ 1000	-8.14	1.00***
Lot Size	2-4	1.09	0.60*
	5-9	2.26	0.58***
	10-19	3.20	0.60***
	20-29	2.95	9,77***
	30-49	3.28	0.71***
	≥ 50	4.67	0.69***
Breed	Dairy	-6.88	0.72**
	Angus	-0.07	0.63
	Bwf	-0.24	0.34
	Exotic	1.78	0.73**
	Xbrd	0.09	0.44

R^2 = 0.614 Price Mean = $60.06 N = 418

$\bar{R}^2$ = 0.585 RMSE = $3.31 F-value = 21.27***

[1]Include sale of steers above 625 lb. and heifer above 575 lb.

[2]Intercept includes October, Huron-Magness Auction steers from 625-699 lb. and Hereford

[3]Probability level of significance of coefficient,
Ho: Xi = 0
*** = 0.01, ** = 0.05, * = 0.10

Table A.4. Feeder/Slaughter Cattle Price Variation for Selected Marketing Factors at Selected South Dakota Auctions, 1981, Continuous/Dummy Variable Model.[1]

	Variable	Parameter Estimate	Standard Error
	Intercept[2]	67.69	1.38***[4]
Month	January	3.65	0.61***
	May	1.80	0.53***
	August	4.19	0.48***
Auction	Watertown	-1.74	0.79**
	Yankton	-1.66	0.60***
	Kimball	-0.18	0.70
	St. Onge	-0.78	0.62
	Belle Fourches	-1.38	0.71**
	Sturgis	-1.05	0.71
Weight	Cwt	-0.70	0.13***
Sex	Heifer	-6.05	1.77**
Interact	Cwt*heifer	0.09	0.22
Lot Size	Nbr[3]	-3.60	0.55**
Breed	Dairy	-7.24	0.73***
	Angus	-0.10	0.63
	Bwf	-0.74	0.72
	Exotic	1.78	0.75**
	Xbrd	0.04	0.45

R^2 = 0.570 Price Mean = $60.06 N = 418

$\bar{R}^2$ = 0.551 RMSE = $3.45 F-value = 24.95***

[1]Include sale of steers above 625 lbs. and heifer above 575 lb.

[2]Intercept includes October, Huron-Magness Auction steers, and Hereford

[3]Nbr = 1/Number of head sold per lot

[4]Probability level of significance of coefficient, Ho: Xi = 0
*** = 0.01, ** = 0.05, * = 0.10