Factors Affecting Preconditioned Calf Price Differentials: How much do Market and Sale Conditions Matter?

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Feeder calf prices are determined by the interaction of many factors. This study uses transactions data from Iowa preconditioned and regular feeder calf auction sales to investigate the impact of a wide variety of factors, many of which have not been used in previous studies on feeder calf prices. Unlike previous studies, this analysis explicitly incorporates changes in feeder cattle market fundamentals during the data collection period. Notably, market premiums for preconditioned sales versus regular sales, feedlot capacity utilization, and seller reputation are significant factors affecting feeder calf prices.

Key words: feeder calves, hedonic model, preconditioning, price analysis, price differentials, seller reputation

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Introduction

Producers are repeatedly challenged to produce calves that are not only acceptable, but also desirable in the industry. Preconditioning programs, while not new, continue to capture the interest of producers. Preconditioning refers to the practice of preparing calves to enter a stocker or backgrounding program or to go directly into a feedlot for finishing. Preconditioning involves performing a series of health protocols and other management practices to improve the health status and post weaning performance of calves.

Recent developments in the U.S. beef industry will likely increase the interest in preconditioning programs. Value-based marketing, source verification, individual animal identification, and consolidation (at the cow-calf level) are all somewhat compatible with management practices such as preconditioning (Dhuyvetter, Bryant, and Blasi 2005). Furthermore, given the current record high cattle and beef prices in the industry, improved health and performance of preconditioned calves is critically important for both buyers and sellers of feeder calves.

The numerous market and sale conditions cow-calf producers and buyers of feeder calves face motivate this study to determine how evolving changes are impacting, or being valued in, the market place over time. The primary objective of this study is to determine the implicit values of feeder calf attributes and to quantify the effects of both market and sale dynamics. Specific objectives include (i) determine the impact various characteristics have had on feeder calf prices, (ii) determine if a price difference between calves marketed at a preconditioned sale and a regular sale exists and how it has varied over time, (iii) given the decision to market calves at a preconditioned sale, determine the impact sale specific characteristics have on feeder calf prices, and (iv) determine if a seller reputation exists for calves sold at a preconditioned sale.

Background and Previous Literature

Feeder calf sale prices vary across transactions and over time. Several previous studies have examined determinants of feeder calf transaction prices. These studies have generally found sale lot calf characteristics (e.g., weight, lot size, sex, frame, muscling), market characteristics (e.g., futures prices, transportation costs), and seasonality explain much of the variability in transaction prices within a particular market (Faminow and Gum 1986; Schroeder et al. 1988; Lambert et al. 1989; Coatney, Menkhaus, and Schmitz 1996; Sartwelle et al. 1996a, 1996b; Dhuyvetter and Schroeder 2000; Smith et al. 2000; Ward, Ratcliff, and Lalman 2005; and Barham and Troxel 2007). As producers have implemented a myriad of value-added health and other management programs, that are increasingly being presented at sale, research has followed (Lalman and Smith 2001; Ward and Lalman 2003; Avent, Ward, and Lalman 2004; King and Seeger 2004; Dhuyvetter, Bryant, and Blasi 2005; Blank et al. 2006; King et al. 2006; Bulut and Lawrence 2007; Blank, Forero, and Nadar 2009; Williams et al 2012; Zimmerman et al. 2012; and Williams et al. 2014). With the current industry likely to continue preconditioning programs, it is important to understand the value of marketing preconditioned calves, especially under evolving market and sale conditions. In addition, Tomek (1993) pointed out the critical importance of replicating existing studies to insure the reliability of economic and econometric analyses.

In this study attention is devoted to several fundamental components of feeder calf price discovery. Nearly every previous study on feeder calf price determinants discusses price differentials for different calf characteristics (including certifications or marketing channels) and market forces, but in the literature thorough research into seller reputation and potential buyer competition is incomplete.

Feeder calf auctions are a prime example of an agricultural market containing quality-differentiated products. When a heterogeneous set of producers sell calves to a heterogeneous set of buyers, those calves likely represent a wide range in quality. Calf buyers use visual inspections of calves' physical characteristics, market characteristics, knowledge of a sale's reputation, and knowledge of a seller's reputation to make bidding decisions. Building reputation and integrity for both a preconditioned sale and sellers of preconditioned calves takes time and effort. Several studies have found reputation to be an important driver of prices for purebred bulls (Chvosta, Rucker, and Watts 2001; Dhuyvetter et al. 1996; and Jones et al. 2008), but the impact of seller reputation for feeder calves has generally not been examined. Bulut and Lawrence (2007) indicate that the reputation of sellers is of less concern in a feeder cattle auction environment given that the majority of producers sell a small number of cattle and they are only in the market once or twice a year. They examine the potential benefit of third-party certification (TPC) for a preconditioning claim and find a significant premium associated with TPC. Chymis et al. (2007) discuss how asymmetric information in cattle auctions can lead to revaccination problems. As markets develop, seller reputation might preclude the need for TPC and reduce the problem associated with asymmetric information.

The cattle feeding sector has undergone long periods with relatively poor returns (Tonsor and Dhuyvetter 2014). Persistently negative returns are likely a sign of overcapacity in the feedlot industry that is slow to adjust. As the size of the U.S. cowherd has declined with minimal change in total feedlot capacity, cattle feeders likely have to compete more to keep cattle in their feedyards. This is the first study to incorporate feedlot capacity utilization into a model of feeder calf price determinants. Feedlot capacity utilization can account for variation in competition and can change the leverage position of the feedlot versus cow-calf producer. Recently there has been an increased attention on excess capacity in the feedlot sector. Despite claims about the importance of this core fundamental on feeder calf prices, the price impact of feedlot capacity utilization has not been well established.

Pricing Model

An explicit supply-and-demand framework is formulated in which feeder calf transaction characteristics are incorporated. Thus, implications of each characteristic on the reduced form of the price equilibrium, i.e., the hedonic pricing function, can be derived. The model captures basic features of the auction market for feeder calves.

(i) The number of feeder calves sold at any given sale is exogenously given. It is not possible for sellers to react during the sale to favorable or unfavorable price conditions by changing the number of head sold. Thus, there is a fixed supply at any particular sale.

(ii) Demand for feeder calves is a derived demand for an input into a production process whereby feeder calves are transformed into slaughter-weight cattle. Thus, determinants of the demand curve at the cattle feeding sector should enter the derived demand.

(iii) Characteristics of feeder calves are the result of management and marketing decisions. These characteristics are thus predetermined by the decisions of sellers, at each sale, and reflect important information for bidders.

Given these features, the following model can be formulated for the sales of feeder calves of lot *i* at time *t*:

$$(1)\quad Quantity_{it}^{S} = \overline{Quantity}_{it} \qquad \text{(supply function)},$$

$$(2)\quad Quantity_{it}^{D} = f\left(Price_{it}, \sum_{k=1}^{J} X_{ijt}\right) \qquad \text{(demand function)},$$

$$(3)\quad Quantity_{it}^{S} = Quantity_{it}^{D} \qquad \text{(equilibrium function)},$$

where $Quantity_{it}^{S} = Quantity_{it}^{D}$ is the quantity supplied (demanded) of feeder calves of transaction *i* at time *t*, $Price_{it}$ is the price of lot *i* at time *t*, X_{ijt} is the *j*th characteristic of the *i*th transaction at time *t*, and ¯ indicates that a variable is exogenously given.

From equations (1) through (3), the following reduced form of the hedonic pricing model can be derived:

$$(4)\ \ Price_{it} = f\left(\overline{Quantity}_{it}, \sum_{j=1}^{J} X_{ijt}\right).$$

This framework provides the ability to isolate the effects of individual characteristics on transaction prices. In the present context the hedonic method gives us tremendous insight into the value placed on feeder calf attributes and both market and sale dynamics.

Data

The Iowa feeder cattle auction market is an ideal market to study relative to this model. The Northwest Iowa Preconditioned Sale Committee, Iowa Cattlemen's Association, and Iowa Veterinary Medical Association (IVMA) co-sponsor preconditioned sales in December, January, and February. The preconditioned sales offer green-tag and gold-tag preconditioning programs, which are determined by a joint effort of the IVMA and the Iowa Cattlemen's Association.

A green-tag calf has been weaned for 30 days, bunk adjusted, and vaccinated at least once for the major infectious diseases (IBR, PI-3, BVD, BRSV, 7-way Clostridial, Mannheimia haemolytica, and Histophilus somni), treated for internal and external parasites, and castrated and de-horned, if necessary. Green-tags are issued to veterinarians by the Iowa Veterinary Medical Association (IVMA), and each tag carries an identification number. The second step in the traditional green-tag program is the IVMA Pre-Conditioning Certificate. This certificate, official only if signed by the attending veterinarian, is not issued until all calves listed in the certificate by the green-tag number have been weaned at least 30 days. Another requirement is that the calves must be owned at least 60 days by the seller, whose signature appears on the certificate.

The gold-tag program requires the mandatory green-tag procedures of vaccinations, treatment for internal and external parasites, castration, dehorning, and 60-day ownership. However, additional procedures are required. The gold-tag indicates calves have received a second set of vaccinations (except Mannheimia haemolytica which is optional) and have been weaned for 45 days. The gold tag and "gold certificate" certify that re-vaccination was performed at least 14 days before the cattle are sold.[1]

Beginning in December 2008 and continuing through February 2014, data were collected on individual lots of calves sold through a preconditioned sale as well as 11 regular auction sales in the same week and the week following the preconditioned sale.[2] Livestock auctions surveyed were located in Bloomfield, Centerville, Creston, Denison, Dunlap, Humeston, Knoxville, Lamoni, Russell, Sheldon, Sigourney, and Tama, which represented auction markets available to producers across the state of Iowa.[3]

Transaction-level data from both the preconditioned sales and regular sales were obtained from U.S. Department of Agriculture market reporters. Modeling individual transaction prices enables an estimation of factors affecting individual sales transactions that could not be accounted for using aggregate data. For example, modeling procedures were better able to account for lot characteristics that might be changing over time as market conditions were

[1] More information about the preconditioning programs can be found at http://www.iowavma.org/.
[2] Transactions were collected from regular sales in the same week and the week following the preconditioned sale to capture alternative market opportunities with similar market conditions.
[3] Feeder calves sold at regular sales may or may not have been preconditioned; however, the data as provided by U.S. Department of Agriculture's Agricultural Marketing Service did not include any preconditioning program information.

changing. All transactions are illustrated in figure 1, where each point represents a transaction price. The average price was $141.71/cwt (hundredweight); however, considerable variation is present over time and across transactions.

Data collected included price, lot size, calf gender (steer or heifer), frame size, and muscle scores. Frame size and muscle scores were determined based on the U.S. Standards for Grades of Feeder Cattle (U.S. Department of Agriculture 2000). Additional data were collected for the preconditioned calf sales by a trained Iowa State University Extension Beef Specialist who worked with the U.S. Department of Agriculture market reporter present at the sales. These data included the certified preconditioning program (green-tag or gold-tag), hair coat color (black, black and white, silver, continental cross (cream, gold, gray, and white), red, red and white, and other), health status (unhealthy or healthy), sale order, and seller name. Supplementary data collected for this study included Chicago Mercantile Exchange feeder cattle futures prices, U.S. Energy Information Administration diesel fuel prices, and Iowa feedlot capacity information.

Feedlot capacity utilization for feedlots with 1,000+ head capacity and 1-999 head capacity was estimated with U.S. Department of Agriculture National Agricultural Statistics Service monthly cattle on feed estimates. Iowa is the only state in the U.S. that reports monthly cattle on feed estimates for both 1,000+ head capacity and 1-999 head capacity feedlots. Because actual capacity is not available, a proxy variable was used where feedlot capacity utilization was defined as the cattle on feed in a given month divided by the maximum value recorded in any month since January 1999 (by feedlot size category, i.e., 1-999 head and 1000+ head). While this calculated value is not exactly equal to capacity utilization, it should be a reasonable approximation that will capture relative changes over the time period of analysis. In addition, since the monthly cattle on feed estimates are as of the first of each month, a linear relationship between two successive months was used to account for the number of cattle on feed changing within a particular month. For consistency, a similar process was used to convert diesel prices from weekly to daily.

Empirical Models

The hedonic pricing models estimated in this study were based on previous research and the novel transaction characteristics from the data described. Two hedonic models are estimated. Equation (5) estimates the coefficients related to preconditioned sales versus regular auction market feeder calf sales. Equation (6) estimates the coefficients related to marketing calves at a preconditioned sale. Table 1 provides definitions and tables 2 and 3 provide summary statistics of variables included in the models.

Preconditioned Sale versus Regular Sale Regressions

In order to estimate the expected premiums, historical transaction prices of feeder calves sold through preconditioned sales and regular sales were used. The empirical model can be generalized as:

$$\begin{aligned} Price_{it} = f(&Quantity_{it}, Weight_{it}, Lotsize_{it}, Gender_{it}, Frame_{it}, Muscle_{it}, \\ &FeederFutures_{t}, Diesel_{t}, LargeUtilization_{t}, SmallUtilization_{t} \\ &Month_{t}, MarketYear_{t}, Location_{i}) \end{aligned} \quad (5)$$

where *i* refers to an individual transaction at time *t*.

The dependent variable *Price* is the average price per hundredweight (cwt) for each individual transaction (lot). *Quantity* is the total number of head sold at each sale for the data used in the analysis. As previously mentioned, the quantity for any given sale is fixed, but it will vary across location and across time. Characteristics unique to each lot of calves, such as lot size, gender, and average weight, are expected to affect the transaction price, *ceteris paribus*. Therefore, to account for specific attributes of calves in a transaction, individual lot characteristics are included as explanatory variables in the model. A lot size variable (*Lotsize*) is included. The average weight of marketed cattle (*Weight*) is included because cattle buyers prefer cattle within a specific weight range. Both linear and quadratic terms for *Lotsize* and *Weight* are included because these variables are expected to be nonlinearly related to price. A binary variable for cattle sex *Gender* accounts for quality differences among calves associated with gender (steers versus heifers). Binary variables for *Frame* size and *Muscle* score are included.

Additional price determinants included in the model are nearby feeder cattle futures prices (*FeederFutures*) to account for current market conditions, diesel fuel prices (*Diesel*) to account for changing transportation costs over time, measures of feedlot capacity utilization (*SmallUtilization* and *LargeUtilization*), to account for variation in local competition or changing cattle feeding versus cow-calf producer market leverage over time. Squared values of these feedlot capacity utilization variables are also included to allow for a potential nonlinear effect.

Binary variables for each market year (*MarketYear*) are included to allow for year-over-year patterns in buying activity. Seasonality (*Month*) is expected to have varied effects on price depending on seasonal supply and demand conditions. Seasonal interactions between weight and weight-squared are included to detect seasonal preferences for different weights of calves (Schroeder et al. 1988).

Due to confidentiality restrictions, specific locations are not identified. Thus, locations are identified as *Preconditioned Sale* and *Regular Sale 1* through *Regular Sale 11*. The empirical model specifies two different effects of location on price. The term *Location* is the direct effect of the location on price. Each location is associated with calves marketed and buyers present, compared to that of a benchmark location. The location of each auction market is included as a binary variable in the model, and the resulting coefficient may be positive or negative depending on whether the location of lot *it* is superior or inferior to that of the benchmark location. Apart from the direct effect of location, interaction terms cover a second effect of location. That is, the impact of location on price likely is a function of lot characteristics and market factors. To allow for this, the binary variable for the preconditioned sale location was interacted with quantity, weight, lot size, gender, month, market year, and feeder cattle futures price.

Selecting a reference transaction was necessary to obtain a regressor matrix of full rank so that the relative discounts and premiums in the model could be calculated. An arbitrarily chosen transaction of steers, medium framed, muscle score 1, sold in December during the first market year (2008-09), and sold at the preconditioned sale was used as a reference lot. The results are invariant to the reference choice.

Preconditioned Sale Regression

Given the decision to market calves at the preconditioned sale location, the following empirical model can be generalized as:

$$
\begin{aligned}
&Price_{it} = f(Quantity_{it}, SaleQtr_{it}, Weight_{it}, Lotsize_{it}, Gender_{it}, Frame_{it}, Muscle_{it}, \\
(6)\quad &\qquad Color_{it}, HealthStatus_{it}, PCTag_{it}, FeederFutures_{t}, Diesel_{t}, \\
&\qquad LargeUtilization_{t}, SmallUtilization_{t}, Month_{t}, Seller_{t}),
\end{aligned}
$$

where *i* refers to an individual transaction at time *t*.

Variables are defined as in equation (5). There are several variables unique to this equation. Buyer activity has been shown to exhibit a within-sale pattern, suggesting a corresponding within-sale price pattern (Schroeder et al. 1988). Binary variables for each quarter of the sale (*SaleQtr*) were included to allow for quarter-of-sale patterns in buying activity. Binary variables for hair coat color (*Color*) were included as a proxy for breed or genetics.[4] Black hair coat typically signals Angus breed genetics. Whether black calves bring significant price premiums over non-black calves is investigated here. Unhealthy calves increase the possibility of death loss and poor feeding performance, thus, *HealthStatus* is an important piece of information, obtained by visual inspection, for bidders. A binary variable was included for *PCTag* to account for the difference in the green-tag and gold-tag programs.

Due to confidentiality restrictions, specific seller names are not identified. Thus, individual sellers are identified as *Seller 1* through *Seller 190*. Seller variables are included as a proxy for reputation to investigate if certain sellers receive significant price premiums or discounts, *ceteris paribus*. Even though producers may only sell a small number of calves once or twice a year, the reputation of sellers may be important if this is a distinguishing factor of heterogeneous cattle presented at sale.

An arbitrarily chosen transaction of green-tag, healthy, black hair coat, steers, medium framed, muscle score 1, sold in December in the first quarter of the sale by seller 1 was used as the reference lot.

Results

The data used in this analysis represent a panel consisting of many transactions across time. The panel of transactions is unbalanced in that there are different numbers of sale lots for each

[4] At auction, rarely do buyers know breed. But, they do observe hair coat color based on visual inspection.

location in equation (5) and seller in equation (6) across time. The use of a fixed effects estimator allows us to control for the time invariant unobservable factors that may impact the transaction price.[5] We generate a binary variable for each location in equation (5) and for each seller in equation (6). The regression is a fixed effects model with constant slopes but intercepts that differ according to the cross-sectional unit.

Following Greene (2003), an *F*-test, resembling the structure of the *F*-test for R^2 change, is used to test the hypothesis that the location and seller constants are all equal; thereby, testing the significance of the fixed effects. Rejecting the null hypothesis in both cases, suggests a pooled model omits important time-invariant location and seller effects, and hence we use fixed effects models.

The data utilized in this study have repeated observations per cross-section and over time. As a result, the errors are potentially serially correlated (i.e., correlation over t for a given i) and heteroskedastic. To detect the presence of serial correlation the Durbin-Watson test was used (Durbin and Watson 1971). Residuals in each model were tested for heteroskedasticity using White's test (White 1980). The results of these tests show the coexistence of serial correlation and heteroskedasticity. Standard errors are obtained by exploiting the Newey and West covariance estimator (Newey and West 1987).

[5] The Durbin-Wu-Hausman test was used to determine if the time invariant unobservable factors should be treated as a fixed effect or random effect (Wu 1973). The test was performed by obtaining the group means of the time invariant variables and adding them to the estimated random effects model. Then the joint hypothesis that the coefficients on the group means are all zero was tested. The hypothesis that the individual effects are uncorrelated with the other regressors was rejected. This suggests that these effects are correlated with other variables in the model, thus the fixed effects model is appropriate.

The hedonic models were specified linearly.[6] Cropper, Deck, and McConnell (1988) found that the linear specification hedonic model performed as well as alternative functional forms when attributes were omitted or proxies used.

Empirical results from the hedonic pricing models are presented in Tables 4 and 5. The coefficient estimates refer to changes in feeder calf prices in dollars per hundredweight from one-unit changes in the independent variables, *ceteris paribus*. A positive coefficient represents a premium for the particular characteristic while a negative coefficient indicates a discount.

Preconditioned Sale versus Regular Sale

As expected given the large sample size, almost all estimated coefficients are statistically significant (Table 4). However, because of the many sale location interaction variables in equation 5, direct interpretation of a number of the coefficients is somewhat difficult.

Medium to large framed calves brought a significant premium ($5.06/cwt) relative to medium framed calves. Lots with a muscle score of 1-2 brought a significant discount ($7.00/cwt) relative to muscle score 1 lots. Based on visual examination of Figure 1, as expected, calves sold in earlier market years brought significantly lower prices than calves sold in the later market years. As expected, cash prices are positively related to feeder cattle futures. For every $1/cwt increase in futures price, cash prices increase $0.60/cwt; however the increase is only $0.44/cwt for calves sold in the preconditioned (PC) sale.

The impact of diesel price was also positive, where a $0.10/gallon increase is associated with an increase in calf price of $0.51/cwt. The positive relationship likely is because higher transportation costs make local calves more attractive than buying calves from further distances.

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[6] We also considered a log-linear model. Box-Cox regressions suggest that a log-linear functional form is more appropriate. However, the difference in “fit” is slight. In this case, the linear functional form is preferred because the price-per-hundredweight interpretation is more straightforward and tractable for model predictions. General conclusions from each model specification are qualitatively the same.

Iowa is a net importer of feeder calves, and thus, buyers of calves at regular auctions are likely considering calves from multiple locations (including out of state). Higher fuel prices may lead to higher prices for "local" feeder calves as this still results in a lower procurement cost than buying calves from further distances.

High volume sales received higher prices, but the value was relatively low ($0.88/cwt for every 1,000 head increase). This likely reflects higher volume sales attracting more buyers and thus the increased quantity is also associated with stronger demand. The impact of lot size is for increasing prices at a decreasing rate; where, the optimal lot size for calves sold in regular auctions is 129 head compared to only 23 head in the PC sale (average and range for PC sale was considerably lower than regular auctions).

To illustrate the impact of factors with interactions that are more complex, results are shown in figures with model-estimated prices. Figure 2 shows the model-estimated price for steers versus selling weight at the PC sale and the average of the top and bottom two auction sales (all other variables at their mean values for the 2013-14 market year). Consistent with previous research, prices decline at a nonlinear rate as weight increases. The advantage of the preconditioned calves also declines at heavier weights, as would be expected. Heifer prices follow a similar declining rate pattern, but the premium on PC calves is higher (data not shown).

Figure 3 displays the 6-year average model-estimated price premium for calves sold in the PC sale versus the 11 regular sales.[7] The premiums are quite consistent across location with the exception of two locations, *Regular Sale 4* and *Regular Sale 5*, which have considerably lower premiums than the other locations. Also, the premiums for preconditioned heifers have

[7] Prices were calculated for each location for each year based on means of other variables (e.g., futures price, diesel, weight, feedlot utilization) and then premiums were calculated as the difference between the PC sale price and auction price. The average of the premiums over the six market years was calculated and reported in Figure 3.

been significantly higher than for steers. This is likely due to preconditioned heifers in some cases being purchased for replacement animals rather than feeders to enter into the feedlot.

As shown in Figure 2, the value of preconditioning calves depends upon the selling weight, but it also varies seasonally. Figure 4 shows the model-estimated prices for steer calves sold in the PC sale versus regular sales at three weights (mean – std, mean, mean + std) by month of sale. As would be expected, the premiums (difference between PC and regular sales) are greater for lighter weight calves sold earlier in the year. Prices for heavier calves sold in February are essentially equal, i.e., there is no premium for the PC sale.

With the exception of the 2012-13 market year, average premiums for PC calves have been increasing over time. Figure 5 reports the average premium (versus the 11 regular sales) as well as the premium versus the average of the two top and bottom auction prices. Compared to the top two auctions, there are two years where there was no premium to selling calves in the PC sale and another two years where the premium was less than $1/cwt for steers. The premium compared to the average of all auctions ranged from approximately $2 to $6/cwt for steers and about $6 to slightly over $10/cwt for heifers over the six-year period.

Figure 6 displays the model-estimated steer prices versus feedlot capacity utilization (other variables at their means for 2013-14). The three levels of large feedlot utilization included (i.e., 90%, 95%, and 100%) are approximately the mean +/- one standard deviation. Likewise, the scale on the x-axis for small feedlot capacity utilization reflects the same range (mean +/- std). It can be seen that as the large feedlot capacity utilization varies there is minimal impact on price, but that is not true for small feedlots. As the capacity utilization increases from the mean (87%) to the mean plus one standard deviation (96%), prices increase over $8/cwt. Because small feedlots are likely more reflective of farmer-feeder and “seasonal” operations, this result is what we would expect (i.e., the demand for large feedlots is more inelastic relative to small feedlots).

Preconditioned Sale

The results for estimating equation (6) for the preconditioned sales are reported in Table 5. Figure 7 shows the estimated coefficients for the individual sellers. The range in coefficients, relative to base seller, is approximately $22/cwt indicating producers receive considerably different prices for their preconditioned calves after accounting for characteristic variables included in the model. Of the 189 seller coefficients, only 38 (20.1%) are statistically different from zero at the 10% level (this result will vary based on which seller is the reference transaction). This result suggests a reputation effect (positive or negative) likely exists for some sellers although the majority of sellers receive comparable prices.

Medium to large framed calves brought a significant premium ($4.91/cwt) relative to medium framed calves. Lots with a muscle score of 1-2 brought a significant discount ($3.78) relative to muscle score 1 lots. As expected, cash prices are positively related to feeder cattle futures prices. For every $1/cwt increase in futures price, cash prices increase $1.46/cwt.[8] The impact of diesel price was negative, where a $0.10/gallon increase is associated with a decrease in calf price of $1.92/cwt. This contrasts to the result found in the precondition sale versus regular sale model. A possible explanation is that buyers at a preconditioned sale may not be considering calves from other locations (including other states) and thus for a single location diesel price would be expected to be negatively correlated with price as it increases feeder calf procurement costs through higher transportation costs.

[8] It is not appropriate to directly compare the estimated coefficient on feeder cattle futures in equation (6) with that of equation (5) because the individual market year binary variables are not included in this model (equation 6) due to the inclusion of the individual seller binary variables.

As the volume of the PC sale increased, prices declined. For every additional 500 head offered for sale the price decreased $3.16/cwt. This likely indicates that there are a limited amount of buyers willing to pay a premium for preconditioned calves. The impact of lot size is for increasing prices at a decreasing rate, the optimal lot size is 27 head (the mean lot size in PC sales was approximately 7 head and ranged from 1 to 48). Calves sold certified with a gold-tag received a $2.51/cwt discount relative to calves certified with a green-tag. Thus, the added expense of the second round of vaccinations does not appear to be valued by the buyers. This result could be because calves may appear fleshier when they are preconditioned (on-feed) for at least an additional 15 days. Unfortunately, we do not have the data to test this hypothesis. Also, the green-tag program has existed since the 1970's while the gold-tag program has only existed since the 2004-05 market year. Perhaps newly launched preconditioning programs take time to build recognition and reputation. If, and when, this preconditioning program will be successful in garnering a premium over the green-tag program is unknown.

All hair coat colors received discounts relative to solid black cattle; however, not all were statistically significant. Those that were statistically significant at the 10% level were continental cross (white, cream, gold, orange, etc.) — $2.26/cwt discount; red and white — $4.45/cwt discount; and red — $1.10/cwt discount. Lots that were classified by the Iowa State University recorder as being unhealthy (~1% of lots) received discounts of $12.01/cwt.

Weight and seasonality results of the PC sale only model are generally similar to what was presented in the previous section. That is, prices decrease with increasing weight and are higher in December and January than they are in February. The price-weight relationship is slightly different in that prices decline at an increasing weight. This is likely because the value of a preconditioned calf will be higher at lighter weights and thus buyers decrease the price for heavier cattle at a slightly faster rate than general auction cattle.

The impact of feedlot capacity utilization changed considerably from the previous section (equation 5). In this case, the sensitivity to small feedlot utilization was relatively flat, but the impact of large feedlot capacity utilization had a much larger impact on prices (Figure 8). As large feedlots increase their capacity utilization, prices increase at a decreasing rate. The increase from 90% (approximately mean – std) to the mean of 95% results in a price increase of over $8/cwt. This compares to a price increase of slightly over $2/cwt when capacity increases from 95% to 100% (approximately mean + std). An interesting impact is highlighted here. Prices are highest when small feedlot capacity utilization is at its lowest. Put another way, small feedlot capacity utilization is lowest when prices are high. Small feedlots, i.e., farmer-feeder operations, tend to respond to current market conditions. Thus, a possible explanation for this result is that at high feeder calf prices small feedlots market feeder calves instead of placing them on feed, resulting in lower feedlot capacity utilization.

Application of Results

The main goals of this paper are two-fold. First, is to add understanding to the literature on feeder calf price determinants by estimating hedonic models of transaction prices. Second, is to provide the cattle industry, especially producers, with information that allows them to make informed production and marketing decisions. However, because of the various interaction terms and nonlinear variables in the estimated models, users of this information cannot simply look at the estimated coefficients for guidance as to what they should do. Rather, the estimated coefficients need to be used in a predictive way such that they have more value in making management and marketing decisions.

To demonstrate how the estimated hedonic models might be used to help producers make management and marketing decisions, consider the following example: medium to large framed, muscle score 1, steer calves weaned in early November to be sold in December. After roughly 30 days of backgrounding, steer calves are expected to weigh 600 pounds. A producer is interested in knowing if it is worth the expense of preconditioning the calves versus selling them at a regular auction (roughly same distance to PC sale and regular sale location 3). Further, the producer wants to know, if he/she chooses to precondition the calves, should he/she feed them to January or February rather than sell them in December assuming they will gain 1.5 pounds per day. To evaluate these decisions, model coefficients reported in Table 4 are used to generate model-predicted prices (all other independent variables are held constant at means from 2013-14 market year).

Table 6 reports model-predicted prices and respective marginal values for the scenario outlined above. The first column represents selling calves through a regular auction sale and the next three columns reflect selling preconditioned calves in December (same as regular auction calves), January, and February, respectively. Preconditioned calves sold in February receive the lowest price/cwt, but generate the highest revenue per head due to the increased selling weight. Similarly, preconditioned calves sold in January weighing 645 pounds would be expected to receive a slightly lower price/cwt than 600 pound preconditioned calves sold in December. However, they still bring an expected premium of $5.52/cwt over non-preconditioned calves sold in December at the regular auction. If a producer can precondition calves (i.e., provide them shots and other required practices) for less than $37.46/head, they will be better off preconditioning calves than selling them through the regular auction. Furthermore, if they can feed them for an extra 30 days for less than $81.99/head ($182.19/cwt), they should market them in January rather than December. Even though the expected revenue per head is highest for calves sold in February, the marginal gain is quite low indicating the producer would likely be better off selling the preconditioned calves in January as opposed to feeding them an additional 30 days (i.e., cost of gain would likely exceed $24.75/cwt).

The results presented in Table 6 were based on the model coefficients reported in Table 4 (those estimated from preconditioned and regular sales). However, conditional upon a producer deciding to precondition calves, results reported in Table 5 (model estimated with preconditioned sales only) might be more appropriate to use for making management and marketing decisions. Table 7 reports similar results as Table 6 only focusing on the preconditioned scenarios. While the numbers vary, the general conclusions would be the same except in the case of very high feeding costs. That is, the producer should consider marketing preconditioning calves in January (as opposed to December), but feeding them until February will lead to lower expected returns.

The preceding example shows how information from this research can be used to help make management and marketing decisions, and more importantly demonstrates that simply looking at reported coefficients is not sufficient for drawing conclusions given the inter-related and nonlinear relationships that exist between feeder calf prices and their characteristics.

Conclusions

This study adds empirical evidence to the literature on feeder calf price differentials. In some cases the results validate previous results and in other cases they provide new information that has not been previously reported. Some of the results from this study consistent with previous findings are that feeder cattle prices are positively related with larger lot sizes, prices decline at a declining rate as cattle weight increases (i.e., weight-price slide exists), heifers bring lower prices than steers, prices for black hided calves are either similar or higher relative to those of other colors, seasonality exists, premiums for preconditioning exist and they have been increasing somewhat over time.

Results from this study that are new are the interactions between preconditioning premiums with weight and seasonality. Previous research typically identifies a premium associated with preconditioning, but here we show that the premium declines as cattle weight increases and also as calves are marketed later in the year (i.e., further from weaning time). This result is not unexpected, but it is important to quantify it, such that producers can make optimal management and marketing decisions. Unlike previous research, results here suggest a significantly higher premium for preconditioned heifers relative to steers. This finding is likely related to the time period where producers may have been looking at preconditioned calves as replacement females for rebuilding herds. This reinforces why it is important for research to both validate previous results, but also be updated as conditions and markets change.

Another new contribution of this research is our attempt to quantify the impact feedlot capacity utilization has on feeder cattle prices. For regular auctions, prices are much more sensitive to changes in small feedlot capacity utilization than they are for changes in large feedlot utilization. This is consistent with the belief that large feedlots with a higher fixed cost structure will be in the market more consistently than small feedlots. Additionally, to the extent that small feedlots tend to be more farmer-feeders, they will likely be "in and out" of the market more often which will impact prices more than large feedlots that are consistently in the market. However, this result was reversed in the case of the preconditioned sale (i.e., prices were more sensitive to changes in large feedlot capacity utilization). The reason for this is unclear but it points to the need for a better understanding of who the buyers of preconditioned calves are, i.e., do preconditioned calves go to smaller feedlots or to larger feedlots?

Reputation of seller has been documented previously for purebred bulls, but it generally has not considered for feeder cattle due to data availability. This research was able to examine seller reputation in a preconditioned calf sale. After accounting for cattle, lot, and market characteristics, roughly 80% of the lots sold brought statistically similar prices, however 20% received prices that were statistically different (15% higher and 5% lower) indicating a seller reputation likely exists for some producers. The implication of this is that while most research has concluded that premiums exist for preconditioning calves, that will not be true for all producers (i.e., some producers will incur more costs and likely not receive any premiums). Related to seller reputation, it might be that "sale" or "program" reputation matters, as gold-tag certified calves receiving two rounds of vaccinations and weaned for 45 days did not bring a premium over the more commonly known green-tag program. This is another example of research that likely will need continued evaluation and replication to see how robust this result is.

As previously stated, the goals of this research were to 1) add understanding to the literature on feeder calf price determinants and 2) provide information to people in the cattle industry that allows them to make informed management and marketing decisions. Estimating hedonic models based upon transaction-level data from Iowa regular auctions and a preconditioned sale enabled objective one to be met. Using estimated coefficients from these models for predicting prices as a function of cattle characteristics, management practices, and market conditions enabled objective two to be met.

References

Avent, R.K., C.E. Ward, and D.L. Lalman. 2004. "Market Valuation of Preconditioning Feeder Calves." *Journal of Agricultural and Applied Economics*. 36:173-83.

Barham, B.L., and T.R. Troxel. 2007. "Factors Affecting the Selling Price of Feeder Cattle Sold at Arkansas Livestock Auctions in 2005." *Journal of Animal Science.* 85:3434-41.

Blank, S. C., H. Boriss, L. Forero, and G. Nader. 2006. "Western Cattle Prices Vary Across Video Markets and Value-Adding Programs." *California Agriculture.* 60:160–165.

Blank, S. C., L. C. Forero, and G. A. Nader. 2009. "Video Market Data for Calves and Yearlings Confirms Price Discounts for Western Cattle." *California Agriculture* 63:225–231.

Bulut, H. and J.D. Lawrence. 2007. "The Value of Third-Party Certification of Preconditioning Claims at Iowa Feeder Cattle Auctions." *Journal of Agricultural and Applied Economics*. 39(3):625-640.

Chvosta, J., R.R. Rucker, and M.J. Watts. 2001. "Transaction Costs and Cattle Marketing: The Information Content of Seller-Provided Pre-sale Data at Bull Auctions." *American Journal of Agricultural Economics.* 83(2):286-301.

Chymis, A.,G., H.S. James, S. Konduru, and V.L. Peirce. 2007. "Asymmetric Information in Cattle Auction: The Problem of Revaccinations. *Agricultural Economics.* 36:79-88.

Coatney, K. T., D. J. Menkhaus, and J. D. Schmitz. 1996. "Feeder Cattle Price Determinants: An Hedonic System of Equations Approach." *Review of Agricultural Economics.* 18:193-211.

Cropper, M.L., L.B. Deck, and K.E. McConnell. 1988. "On the Choice of Functional Form for Hedonic Price Functions." *The Review of Economics and Statistics*. 70:668-675.

Dhuyvetter, K. C., A. M. Bryant, and D. A. Blasi. 2005. "Case Study: Preconditioning Beef Calves: Are Expected Premiums Sufficient to Justify the Practice?" *The Professional Animal Scientist.* 21:502-514.

Dhuyvetter, K.C. and T.C. Schroeder. 2000. "Price-Weight Relationships for Feeder Cattle." *Canadian Journal of Agricultural Economics*. 48(3):299-310.

Dhuyvetter, K.C., T.C. Schroeder, D.D. Simms, R.P. Bolze, and J. Geske. 1996. "Determinants of Purebred Beef Bull Price Differentials." *Journal of Agricultural and Resource Economics*. 21(2):396-410.

Durbin, J., and G. Watson. 1971. "Testing for Serial Correlation in Least Squares Regression–III." *Biometrika.* 58:1-42.

Faminow, M.D. and R.L. Gum. 1986. "Feeder Cattle Price Differentials in Arizona Auction Markets." *Western Journal of Agricultural Economics*. 11:156-163.

Greene, W. Econometric Analysis. Upper Saddle River, NJ: Prentice Hall, 2003, 5th ed.

Jones, R., T. Turner, K.C. Dhuyvetter, and T.L. Marsh. 2008. "Estimating the Economic Value of Specific Characteristics Associated with Angus Bulls Sold at Auction." *Journal of Agricultural and Applied Economics.* 40(1):315-333.

King, M.E., and J.T. Seeger. 2004. "Ten-year Trends at Superior Livestock Auction: Calves in value-added health programs consistently receive higher prices." Pfizer Animal Health Tech. Bull. SVC05002.

King, M. E., M. D. Salman, T. E. Wittum, K. G. Odde, J. T. Seeger, D. M. Grotelueschen, G. M. Rogers, and G. A. Quakenbush. 2006. "Effect of Certified Health Programs on the Sale Price of Beef Calves Marketed Through a Livestock Videotape Auction Service from 1995 through 2005." *Journal of the American Veterinary Medical Association.* 229:1389-1400.

Lalman, D. and R. Smith. "Effects of Preconditioning on Health, Performance and Prices ofWeaned Calves." 2001. Fact Sheet ANSI-3529, Oklahoma Cooperative Extension Service, Oklahoma State University.

Lambert, C.D., M.S. McNulty, O.C. Grunewald, and L.R. Corah. 1989. "An Analysis of Feeder Cattle Price Differentials." *Agribusiness*. 5:9-23.

Newey, W.K. and K.D. West. 1987. "A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix." *Econometrica*. 55:703-708.

Sartwelle, J.D., III, F.K. Brazle, J.R. Mintert, T.C. Schroeder, and M.R. Langemeier. 1996a. "Buying and Selling Feeder Cattle – The Impact of Selected Characteristics on Feeder Cattle Prices." Kansas State Univ. Coop. Ext. Serv. Bull. MF-2162.

Sartwelle, J.D., III, J.R. Mintert, F.K. Brazle, T.C. Schroeder, R.P. Bolze, Jr. and M.R. Langemeier. 1996b. "Improving the Value of Your Calf Crop – The Impact of Selected Characteristics on Calf Prices." Kansas State Univ. Coop. Ext. Serv. Bull. MF-2142.

Schroeder, T., J. Mintert, F. Brazle, and O. Grunewald. 1988. "Factors Affecting Feeder Cattle Price Differentials." *Western Journal of Agricultural Economics*. 13:71-81.

Smith, S. C., D. R. Gill, C. Bess III, B. Carter, B. Gardner, Z. Prawl, T. Stovall, and J.Wagner. "Effect of Selected Characteristics on the Sale Price of Feeder Cattle in Eastern Oklahoma." 2000. Ircular E-955, Oklahoma Cooperative Extension Service, Division of Agricultural Sciences and Natural Resources, Oklahoma State University.

Tomek, W. G., 1993. Confirmation and Replication in Empirical Econometrics: A Step toward Improved Scholarship, *American Journal of Agricultural Economics.* 75:6-14.

Tonsor, G.T. and K.C. Dhuyvetter, May 2014. "Historical and Projected Kansas Feedlot Net Returns," Kansas State University Factsheet AM-GTTT-KCD-KFR-5.2014. *www.AgManager.info* (accessed May 13, 2014).

U.S. Department of Agriculture. 2000. "U.S. Standards for Grades of Feeder Cattle." Agricultural Marketing Service. October. 2000. 542 AMS-586. Washington DC.

Ward, C.E. and D.L. Lalman. 2003. "Price Premiums from a Certified Feeder Calf Preconditioning Program." Selected paper presented at the 2003 annual meetings of the NCR-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management, St. Louis, Missouri.

Ward, C.E., C.D. Ratcliff, and D.L. Lalman. 2005. "Buyer Preferences for Feeder Calf Traits." Oklahoma State Univ. Coop Ext. Serv. Bull. AGEC-602.

White, H. 1980. "A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity." *Econometrics* 48: 817-838.

Williams, G.S., K.C. Raper, E.A. DeVuyst, D. Peel, and D. McKinney. 2012. ''Determinants of Price Differentials in Oklahoma Value-Added Feeder Cattle Auctions." *Journal of Agricultural and Resource Economics*. 37:114-27.

Williams, B.R., E.A. DeVuyst, D.S. Peel, and C.C. Raper. 2014. "The Likelihood of Positive Returns from Value-Added Calf Management Practices." *Journal of Agricultural and Applied Economics*. 46(1):125-138.

Wu, D. 1973. "Alternative Tests of Independence between Stochastic Regressors and Disturbances." *Econometrica*. 41:733-750.

Zimmerman, L.C., T.C. Schroeder, K.C. Dhuyvetter, K.C. Olson, G.L. Stokka, J.T. Seeger, and D.M. Grotelueschen. 2012. "The Effect of Value-Added Management on Calf Prices at Superior Livestock Auction Video Markets." *Journal of Agricultural and Resource Economics.* 37(1):128-143.

Table 1. Definitions of Variables

Dependent Variable	
Price	Location specific feeder calf transaction price ($/hundredweight (cwt))
Independent Variables	
Sale Characteristics	
Quantity	Number of head sold at a sale (head).[a]
Time of sale	Consists of four binary (0,1) variables assigned 1 if sold, (i) quarter 1, (ii) quarter 2, (iii) quarter 3, or (iv) quarter 4, and each variable was assigned 0 otherwise.
Calf Characteristics	
Weight	Average per-head weight of animals in a lot (pounds).
Lot size	Number of head in a lot (head).
Gender	Gender of animals, gender = 0 if steers and = 1 if heifers.
Frame size	Frame size, frame size = 0 if Medium and = 1 if Medium and Large.
Muscle score	Muscle score, muscle score = 0 if muscle score 1and = 1 if muscle score 1-2.
Color	Consists of seven binary (0,1) variables assigned 1 if hair coat color, (i) black, (ii) black and white, (iii) silver, (iv) continental cross (white, cream, orange, gold, etc.), (v) red, (vi) red and white, or (vii) other, and each variable was assigned 0 otherwise.
Health status	Assessment of health status, health = 0 if healthy and = 1 if unhealthy.
Preconditioned tag	Preconditioning program, preconditioning = 0 if green-tag and = 1 if gold-tag.
Market Characteristics	
Feeder cattle futures price	Feeder cattle futures settlement price of nearby feeder cattle contract for the trading day of the sale date ($/cwt).
Diesel price	Daily retail price of taxable diesel fuel (cents/gallon).
Small feedlot capacity utilization	Daily capacity utilization of Iowa feedlots 1-999 head capacity (percent).
Large feedlot capacity utilization	Daily capacity utilization of Iowa feedlots 1000+ head capacity (percent).
Seasonal Characteristics	
Month	Consists of three binary (0,1) variables assigned 1 if month, (i) December, (ii) January, or (iii) February, and each variable was assigned 0 otherwise.
Market year	Consists of six binary (0,1) variables assigned 1 if market year, (i) 2008-09, (ii) 2010, (iii) 2011, (iv) 2011-12, (v) 2012-13, (vi) 2013-14, and each variable was assigned 0 otherwise.
Location Characteristics	
Sale	Consists of twelve binary (0,1) variables assigned 1 if sale, (i) 1, …, or (xii) 12, and each variable was assigned 0 otherwise.
Seller Characteristics	
Seller	Consists of 190 binary (0,1) variables assigned 1 if seller, (i) 1, …, or (cxc) 190, and each variable was assigned 0 otherwise.

[a] Consists of the quantity sold at each auction for the data used in the analysis.

Table 2. Summary Statistics of Preconditioned Sale and Regular Sale Transactions

Variable	Mean	Standard Deviation	Variable	Mean	Standard Deviation
Price	141.711	34.491			
Sale Characteristics			Location Characteristics		
Quantity	1958.230	851.968	Preconditioned Sale	0.064	0.244
			Regular sale 1	0.034	0.181
Calf Characteristics			Regular sale 2	0.023	0.151
Weight	592.644	121.670	Regular sale 3	0.095	0.294
Lot size	12.804	13.443	Regular sale 4	0.178	0.383
Heifer	0.464	0.499	Regular sale 5	0.146	0.353
Steer	0.536	0.499	Regular sale 6	0.052	0.222
Medium	0.007	0.082	Regular sale 7	0.069	0.253
Medium and Large	0.993	0.082	Regular sale 8	0.076	0.265
Muscle 1	0.840	0.366	Regular sale 9	0.117	0.321
Muscle 1-2	0.160	0.366	Regular sale 10	0.048	0.215
			Regular sale 11	0.098	0.297
Market Characteristics					
Feeder cattle futures price	133.517	27.765	Observations	34,414	
Diesel price	343.825	62.407			
Large feedlot capacity utilization	95.165	4.855			
Small feedlot capacity utilization	86.832	9.143			
Seasonal Characteristics					
January	0.579	0.494			
February	0.222	0.416			
December	0.199	0.399			
Market year $_{(2008-09)}$	0.193	0.395			
Market year $_{(2010)}$	0.086	0.280			
Market year $_{(2011)}$	0.152	0.359			
Market year $_{(2011-12)}$	0.196	0.397			
Market year $_{(2012-13)}$	0.193	0.395			
Market year $_{(2013-14)}$	0.180	0.384			

Table 3. Summary Statistics of Preconditioned Sale Transactions

Variable	Mean	Standard Deviation	Variable	Mean	Standard Deviation
Price	150.023	34.139			
<u>Sale Characteristics</u>			<u>Market Characteristics</u>		
Quantity	1236.580	527.894	Feeder cattle futures price	138.213	26.713
Qtr1	0.248	0.432	Diesel price	354.086	57.355
Qtr2	0.244	0.429	Large feedlot capacity utilization	95.222	4.634
Qtr3	0.249	0.433	Small feedlot capacity utilization	85.088	8.961
Qtr4	0.258	0.438			
			<u>Seasonal Characteristics</u>		
<u>Calf Characteristics</u>			January	0.573	0.495
Weight	570.503	126.125	February	0.205	0.404
Lot size	6.963	6.447	December	0.221	0.415
Heifer	0.462	0.499			
Steer	0.538	0.499	<u>Seller Characteristics</u>		
Medium	0.069	0.253	Seller	NA	NA
Medium and Large	0.931	0.253			
Muscle 1	0.627	0.484	Observations	2,186	
Muscle 1-2	0.373	0.484			
Black	0.784	0.412			
Black and white	0.032	0.176			
Silver	0.024	0.154			
Continental X	0.014	0.118			
Red and White	0.112	0.315			
Red	0.011	0.106			
Other	0.022	0.148			
Unhealthy	0.010	0.100			
Green-tag	0.761	0.427			
Gold-tag	0.239	0.427			

Table 4. Coefficient Estimates of Preconditioned Sale and Regular Sale Transactions Model

Variable	Coefficient Estimate	Standard Error	Variable	Coefficient Estimate	Standard Error
Intercept	463.778***	78.773	Location Characteristics		
			Regular sale 1	-20.447***	7.789
Sale Characteristics			Regular sale 2	-20.592***	7.789
Quantity	0.00088***	0.0001	Regular sale 3	-20.839***	7.786
			Regular sale 4	-17.406**	7.787
Calf Characteristics			Regular sale 5	-18.340**	7.787
Weight	-0.202***	0.006	Regular sale 6	-21.749***	7.788
Weight-squared	0.00009***	0.000005	Regular sale 7	-20.987***	7.785
Lot size	0.234***	0.018	Regular sale 8	-21.317***	7.786
Lot size-squared	-0.0004***	0.0001	Regular sale 9	-20.845***	7.787
Lot size × Weight	-0.0002***	0.00003	Regular sale 10	-22.068***	7.789
Heifer	-47.435***	1.380	Regular sale 11	-22.062***	7.787
Heifer × Weight	0.075***	0.005			
Heifer × Weight-squared	-0.00003***	0.000004	Interactions		
Medium and Large	5.055***	0.448	PC sale × Quantity	-0.001	0.001
Muscle 1-2	-7.004***	0.100	PC sale × Weight	-0.015	0.009
			PC sale × Weight-squared	0.00001	0.00001
Market Characteristics			PC sale × Lot size	0.718***	0.135
Feeder cattle futures	0.598***	0.024	PC sale × Lot size-squared	-0.012***	0.002
Diesel price	0.051***	0.013	PC sale × Lot size × Weight	-0.0004*	0.0002
Large capacity utilization	-7.112***	1.239	PC sale × Heifer	4.351***	0.291
Large capacity utilization-squared	0.038***	0.006	PC sale × January	-0.038	0.863
Small capacity utilization	-1.039	1.011	PC sale × February	-4.652***	0.705
Small capacity utilization-squared	0.011*	0.006	PC sale × Market year $_{(2010)}$	2.219***	0.815
			PC sale × Market year $_{(2011)}$	6.960***	2.408
Seasonal Characteristics			PC sale × Market year $_{(2011-12)}$	12.902***	4.587
January	15.351***	1.762	PC sale × Market year $_{(2012-13)}$	11.452**	4.810
January × Weight	-0.024***	0.006	PC sale × Market year $_{(2013-14)}$	17.329***	6.191
January × Weight-squared	0.00001*	0.00001	PC sale × Feeder cattle futures	-0.161*	0.084
February	28.098***	2.116			
February × Weight	-0.049***	0.007			
February × Weight-squared	0.00002***	0.00001			
Market year $_{2009-10}$	-2.385**	1.089			
Market year $_{2010-11}$	15.343***	1.925			
Market year $_{2011-12}$	33.104***	2.830	R^2	0.965	
Market year $_{2012-13}$	34.065***	3.104	RMSE	6.425	
Market year $_{2013-14}$	54.635***	3.979	Observations	34,414	

Notes: Single, double, and triple asterisks (*, **, ***) indicate significance at the 10%, 5%, and 1% level, respectively.

Table 5. Coefficient Estimates of Preconditioned Sale Transactions Model

Variable	Coefficient Estimate	Standard Error	Variable	Coefficient Estimate	Standard Error
Intercept	-1152.670***	231.400	Market Characteristics		
			Feeder cattle futures	1.459***	0.044
Sale Characteristics			Diesel price	-0.192***	0.034
Quantity	-0.006***	0.001	Large capacity utilization	24.452***	4.411
SaleQtr2	-0.165	0.568	Large capacity utilization-squared	-0.123***	0.023
SaleQtr3	-0.175	0.577	Small capacity utilization	-0.002	1.829
SaleQtr4	0.215	0.643	Small capacity utilization-squared	-0.001	0.011
Calf Characteristics			Seasonal Characteristics		
Weight	0.009	0.025	January	64.734***	7.413
Weight-squared	-0.0001***	0.00002	January × Weight	-0.216***	0.027
Lot size	0.828***	0.166	January × Weight-squared	0.0002***	0.00002
Lot size-squared	-0.010***	0.002	February	67.270***	8.773
Lot size × Weight	-0.001*	0.0003	February × Weight	-0.269***	0.032
Heifer	0.770	5.508	February × Weight-squared	0.0002***	0.00003
Heifer × Weight	-0.055***	0.020			
Heifer × Weight-squared	0.0001***	0.00002	Seller Characteristics		
Medium and Large	4.906***	0.709	Seller	(Figure 2)	
Muscle 1-2	-3.775***	0.388			
Black and white	-1.139	0.940			
Silver	-1.189	1.100			
Continental X	-2.260**	0.971			
Red and White	-4.454***	1.687			
Red	-1.102*	0.581			
Other	-2.661	2.442	R^2	0.958	
Unhealthy	-12.006***	1.970	RMSE	7.038	
Gold-tag	-2.512***	0.868	Observations	2,188	

Notes: Single, double, and triple asterisks (*, **, ***) indicate significance at the 10%, 5%, and 1% level, respectively.

Table 6. Application of Preconditioned and Regular Sale Transactions Model Results*

Sale type-location	Regular-3	PC sale	PC sale	PC sale
Selling month	December	December	January	February
Sex	Steer	Steer	Steer	Steer
Frame size	Medium to Large	Medium to Large	Medium to Large	Medium to Large
Muscle score	1	1	1	1
Weight	600	600	645	690
Price, $/cwt	$186.26	$192.51	$191.79	$180.89
Price, $/head	$1,118	$1,155	$1,237	$1,248
Premium, $/cwt	base	$6.24	$5.52	-$5.37
Marginal premium, $/cwt			-$0.72	-$10.89
Premium, $/head	base	$37.46	$119.45	$130.59
Marginal premium, $/head			$81.99	$11.14
Value of gain, $/cwt	base	n/a	$265.44	$145.10
Marginal value of gain, $/cwt			$182.19	$24.75

* All other independent values evaluated at means of period 6 (2013-14).

Table 7. Application of Preconditioned Sale Model Results*

Sale type-location	PC sale	PC sale	PC sale
Selling month	December	January	February
Sex	Steer	Steer	Steer
Frame size	Medium to Large	Medium to Large	Medium to Large
Muscle score	1	1	1
Weight	600	645	690
Price, $/cwt	$194.88	$190.14	$174.82
Price, $/head	$1,169	$1,226	$1,206
Premium, $/cwt	base	-$4.74	-$20.06
Marginal premium, $/cwt			-$15.32
Premium, $/head	base	$57.12	$36.99
Marginal premium, $/head			-$20.13
Value of gain, $/cwt	base	$126.94	$41.10
Marginal value of gain, $/cwt			-$44.73

* All other independent values evaluated at means of period 6 (2013-14).

Figure 1. Iowa Feeder Calf Transaction Prices by Market Year

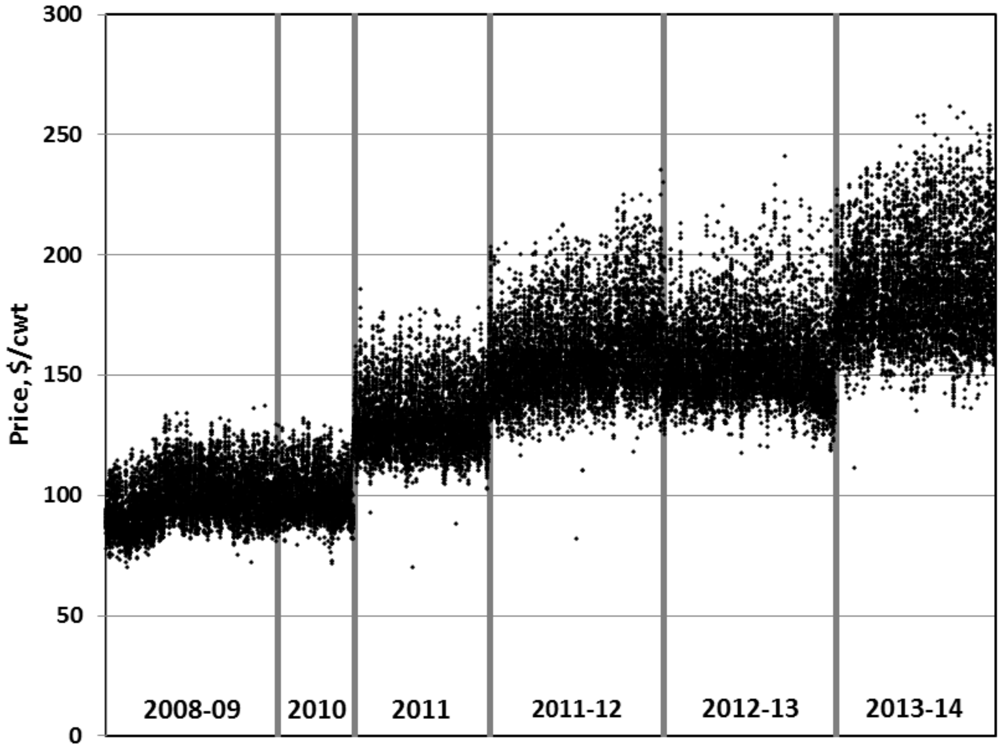


Figure 2. Estimated Price versus Selling Weight, Steers, 2013-2014

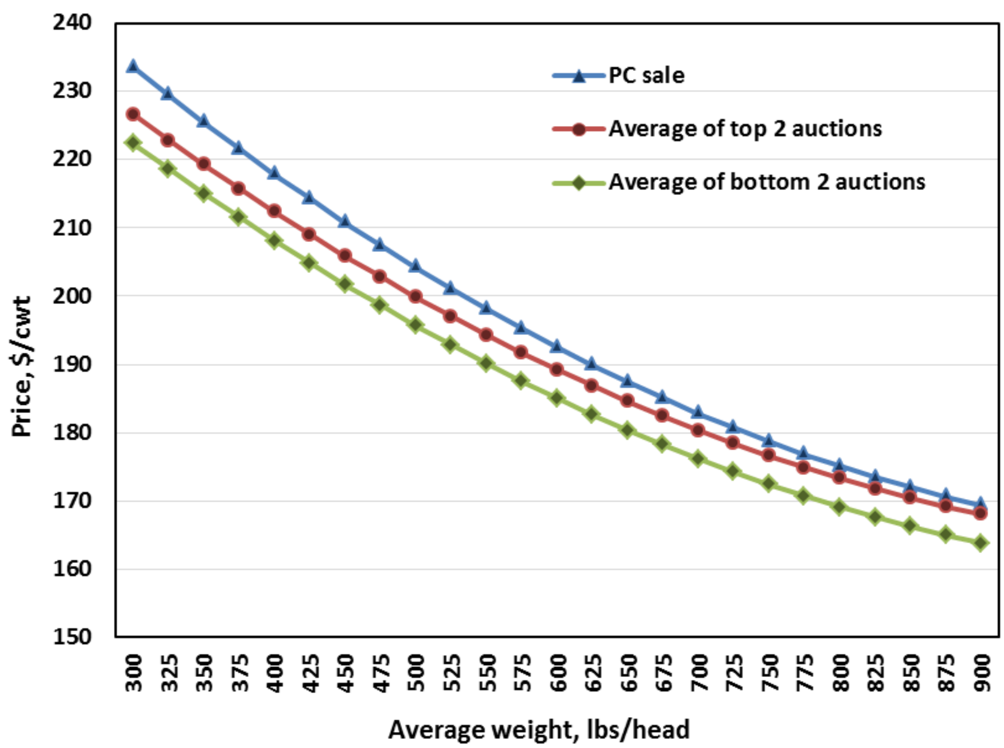


Figure 3. Estimated Premium versus Location, 6-Year Average

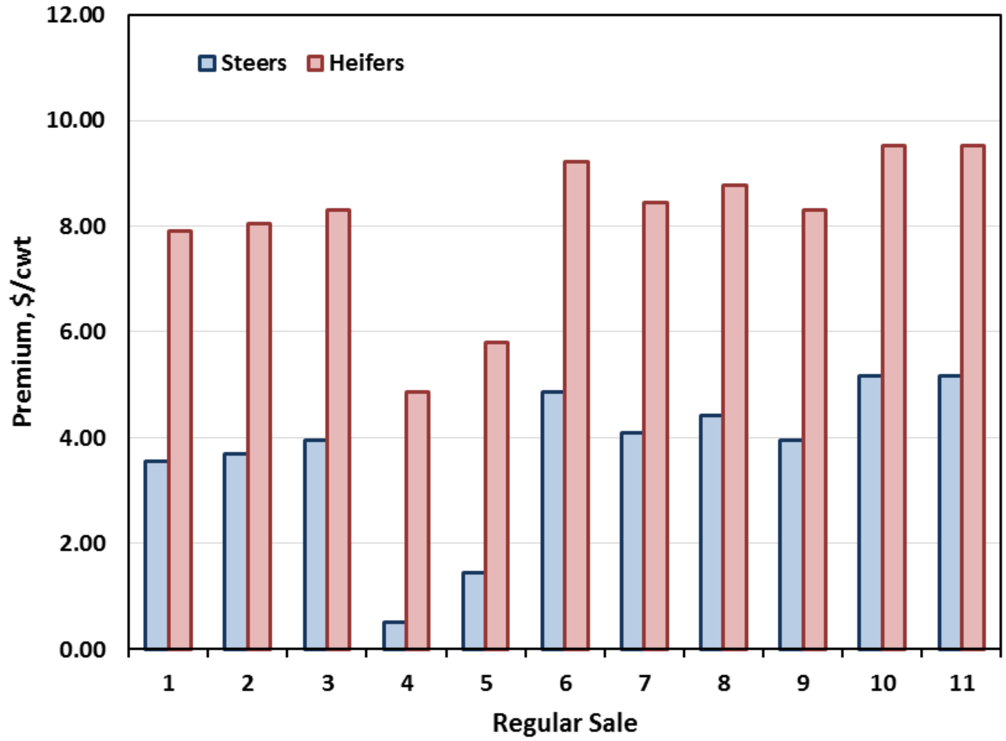


Figure 4. Estimated Steer Price versus Month, Weight, and Sale, 2013-14

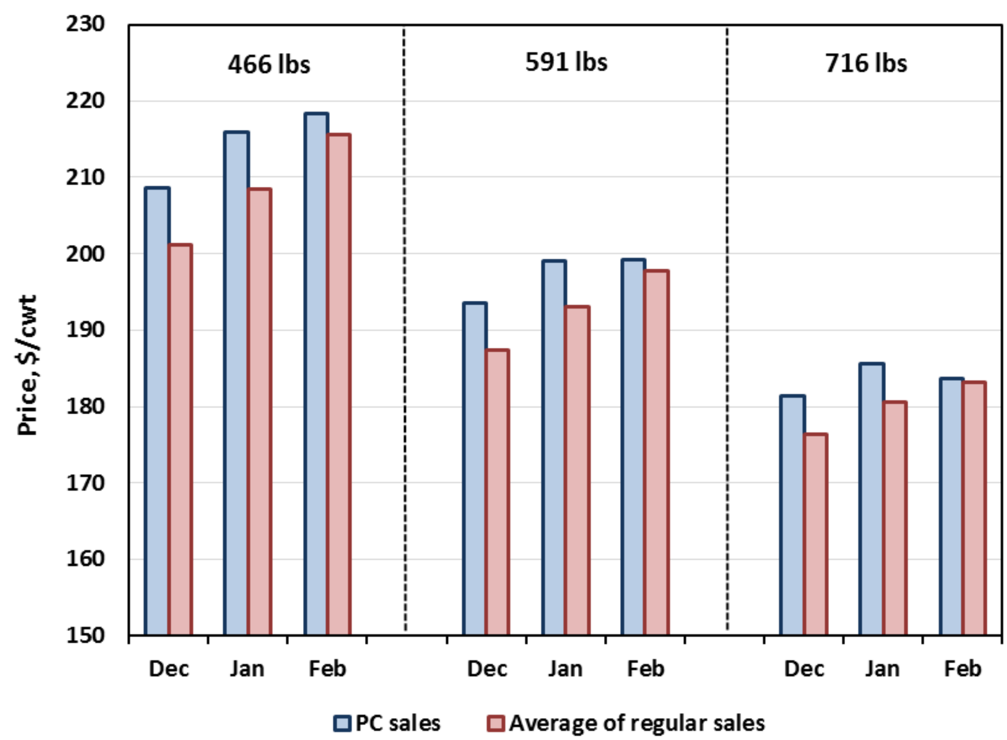


Figure 5. Estimated Premium versus Market Year

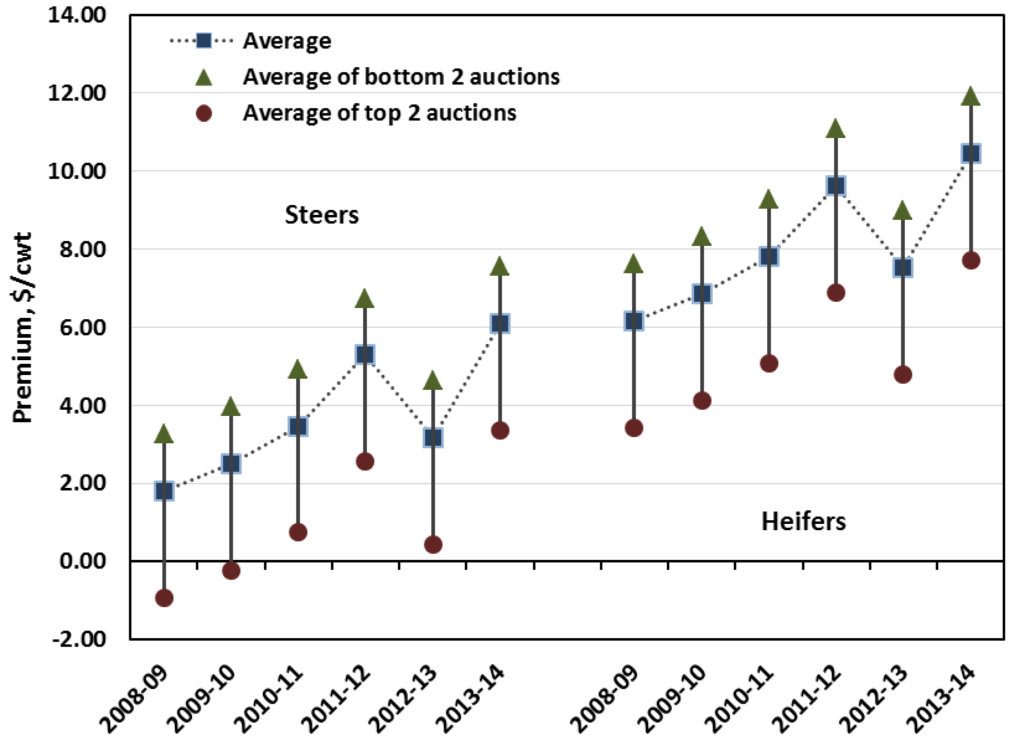


Figure 6. Estimated Steer Price versus Feedlot Utilization, 2013-14

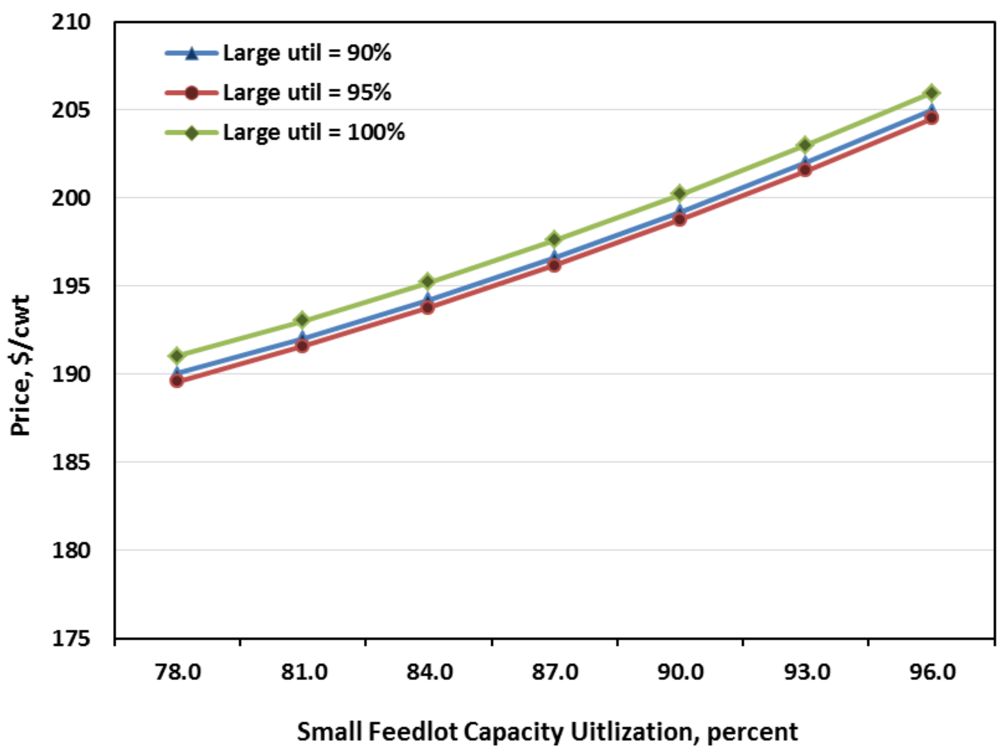
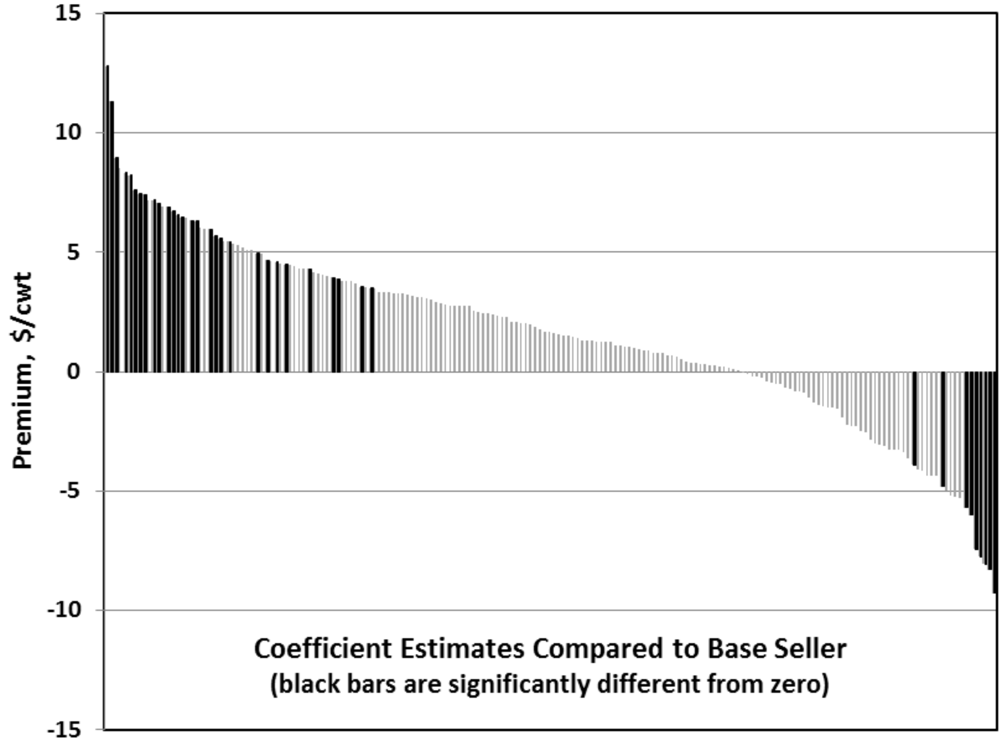
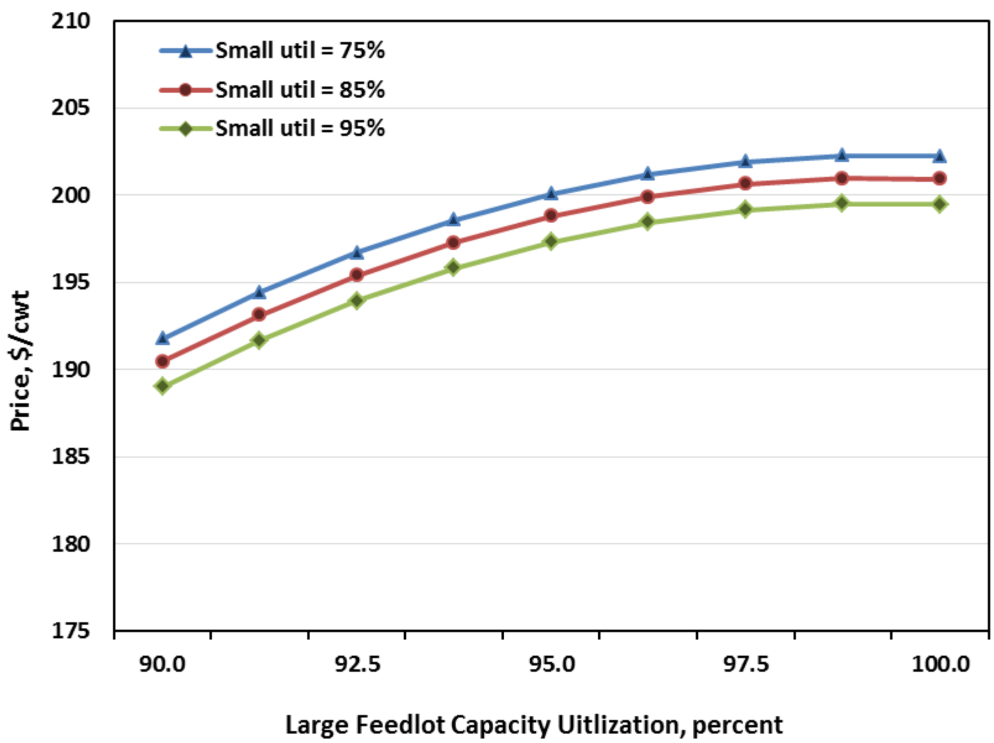


Figure 7. Estimated Seller Premiums and Discounts



Note: Appendix A contains coefficient estimates and standard errors.

Figure 8. Estimated Steer Price versus Feedlot Utilization, 2013-14



Appendix A

Table A.1. Estimated Seller Premiums and Discounts

Seller	Coefficient Estimate	Standard Error	Seller	Coefficient Estimate	Standard Error	Seller	Coefficient Estimate	Standard Error	Seller	Coefficient Estimate	Standard Error
1	12.785***	3.546	49	3.933**	1.977	97	1.566	3.039	145	-0.663	4.425
2	11.319***	3.564	50	3.882*	2.176	98	1.503	2.808	146	-0.742	2.287
3	8.952**	3.924	51	3.808	7.241	99	1.496	3.890	147	-0.818	2.669
4	8.498	5.400	52	3.800	2.466	100	1.429	1.949	148	-0.846	5.330
5	8.308***	2.972	53	3.781	2.754	101	1.382	1.932	149	-0.888	2.454
6	8.221**	3.293	54	3.705	2.506	102	1.319	4.957	150	-1.072	2.920
7	7.603***	2.823	55	3.532*	1.999	103	1.318	1.957	151	-1.319	1.859
8	7.450***	2.010	56	3.518	2.425	104	1.316	1.912	152	-1.387	2.451
9	7.412**	3.648	57	3.492**	1.651	105	1.245	2.304	153	-1.430	3.564
10	7.169	5.437	58	3.477	2.117	106	1.243	2.024	154	-1.501	3.300
11	7.169***	2.768	59	3.342	3.325	107	1.236	2.475	155	-1.504	3.274
12	7.045**	3.386	60	3.338	2.478	108	1.231	3.250	156	-1.550	7.254
13	6.897	4.386	61	3.332	4.099	109	1.093	3.029	157	-1.897	2.898
14	6.888**	3.300	62	3.282	2.568	110	1.069	2.380	158	-2.214	3.357
15	6.707*	3.618	63	3.273	5.288	111	1.053	2.917	159	-2.289	1.927
16	6.549***	2.190	64	3.263	2.853	112	1.021	2.767	160	-2.296	3.266
17	6.450***	2.470	65	3.228	2.900	113	1.007	4.055	161	-2.518	3.578
18	6.431	4.386	66	3.154	2.862	114	0.911	2.779	162	-2.538	2.377
19	6.334**	2.787	67	3.121	3.871	115	0.901	3.326	163	-2.867	2.138
20	6.297**	3.208	68	3.106	2.678	116	0.886	3.593	164	-3.029	2.277
21	6.023	4.492	69	3.084	2.661	117	0.795	2.415	165	-3.063	3.709
22	5.985	3.944	70	3.030	2.078	118	0.793	2.814	166	-3.135	3.259
23	5.948***	1.904	71	2.896	2.048	119	0.773	2.018	167	-3.259	3.283
24	5.671***	2.007	72	2.832	2.170	120	0.700	2.742	168	-3.294	3.885
25	5.561*	3.260	73	2.790	3.058	121	0.677	3.460	169	-3.294	3.685
26	5.470	7.231	74	2.774	2.892	122	0.642	1.806	170	-3.355	3.923
27	5.427*	2.813	75	2.760	5.260	123	0.527	7.259	171	-3.649	3.551
28	5.372	4.410	76	2.744	2.057	124	0.435	2.176	172	-3.904*	2.270
29	5.271	3.577	77	2.727	2.236	125	0.349	3.279	173	-4.115	4.387
30	5.210	3.451	78	2.726	3.209	126	0.347	2.310	174	-4.173	3.497
31	5.087	4.403	79	2.567	2.961	127	0.312	2.651	175	-4.373	3.238
32	5.067	4.323	80	2.470	3.585	128	0.292	2.827	176	-4.377	3.282
33	4.955*	2.571	81	2.462	2.237	129	0.277	1.937	177	-4.387	4.436
34	4.943	3.351	82	2.415	2.254	130	0.273	3.367	178	-4.808*	2.727
35	4.654***	1.672	83	2.403	2.736	131	0.221	2.087	179	-4.975	5.309
36	4.614	5.179	84	2.338	4.525	132	0.186	2.182	180	-5.175	3.907
37	4.588**	1.853	85	2.310	2.678	133	0.145	3.569	181	-5.231	7.327
38	4.510	4.325	86	2.309	2.401	134	0.116	2.092	182	-5.307	3.424
39	4.471*	2.590	87	2.094	3.558	135	0.031	3.308	183	-5.696*	3.326
40	4.469	4.425	88	2.065	2.458	136	-0.074	1.958	184	-6.023*	3.599
41	4.437	4.479	89	2.025	2.838	137	-0.091	3.564	185	-7.444*	4.494
42	4.317	5.247	90	2.014	1.973	138	-0.194	5.321	186	-7.749***	2.504
43	4.308	5.280	91	1.951	3.370	139	-0.215	3.322	187	-8.051*	4.670
44	4.292*	2.399	92	1.893	4.465	140	-0.247	3.983	188	-8.287**	3.254
45	4.156	4.337	93	1.783	5.388	141	-0.407	3.129	189	-9.293**	3.859
46	4.080	3.883	94	1.655	1.799	142	-0.455	3.268			
47	4.053	4.514	95	1.641	2.613	143	-0.501	4.393			
48	4.015	4.019	96	1.632	2.424	144	-0.519	4.522			

Notes: Single, double, and triple asterisks (*, **, ***) indicate significance at the 10%, 5%, and 1% level, respectively.