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Effect of Location Variables on Feeder Calf Basis at Oklahoma Auctions

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Past research has reported differences in feeder cattle prices received due to location of sale barns, but little is reported on the source of those differences. We developed a feeder calf hedonic pricing model that includes location-specific characteristics. Local factors may affect transaction costs for buyers and sellers, impacting the basis. Results show that basis increased $0.64/cwt for every 100,000 acres of wheat within a 100-mile radius. Basis decreased $0.07 per mile from four-lane roads. Basis decreased $1.99 per 1% of value-added volume. The impact of lot size, weight, hide color, frame, gender, and other phenotypic characteristics were also analyzed.

Key words: feeder calf basis, hedonic price, location variables

Introduction

Numerous factors influence prices received for feeder calves at local market auctions. Producers can influence some price determinants such as health, breed, value-added traits, and weight through management (Bulut and Lawrence, 2007; Coatney, Menkhaus, and Schmitz, 1996; Schroeder et al., 1988; Schumacher, Schroeder, and Tonsor, 2011; Williams et al., 2012, 2014) or reputation (Schulz, Dhuyvetter, and Doran, 2015). Other factors, such as location, are outside the sphere of influence for producers (Williams et al., 2012). In the jargon of the trade, "basis," which measures the difference in prices between a local market and a reference market, differs by sale location.

When basis differs between sale barn locations, there must be structural reasons for why these market prices differ. Otherwise, arbitrage would occur to eliminate market inefficiencies. We hypothesize that local factors,[1] in part, determine basis differences. Factors influencing basis include nearby transportation infrastructure, local supply and demand conditions, and lot characteristics of calves for sale. While lot characteristics and sale barn location have been modeled in the literature on feeder cattle value, location-specific supply and demand factors have not been investigated. The goal of this research is to investigate factors that influence individual sale barn feeder cattle basis, including both the impact of cattle characteristics and sale location-specific factors. Specifically, we seek to determine the impact of local conditions on local basis, including wheat acres within a 100-mile radius of each sale barn and access to transportation infrastructure as measured by linear distance to four-lane highways. We also examine the impact of sale volume on local basis, including percentage of value-added calves at a given sale and total number of cattle at a given sale. Our hedonic model, much like the one used in Williams et al. (2012), determines the value of cattle

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[1] For the purposes of this study, local factors are variables specific to a sale location and date rather than each lot at a given sale. For example, sale volume and percentage of value-added cattle at a given sale barn and date are considered location variables.

characteristics in Oklahoma sale barns and identifies differences in basis due to location-specific attributes. Basis, the dependent variable, is measured as difference between the Chicago Mercantile Exchange nearby futures contract price for feeder cattle and the actual price received in dollars per hundred weight price ($/cwt). Independent variables include lot size, phenotypic traits, sale price, management practices, and local market influences.

Location-Specific Influences

Location-specific demand factors in the Oklahoma feeder cattle market that may influence basis include wheat acres near the sale barn and distance to four-lane highways. Similarly, supply of calves (i.e., volume) at a given sale on a particular day may influence basis. In the U.S. Southern Plains, weaned cattle are often fed on winter wheat for 90 to 105 days, typically November to March. Winter wheat grazing occurs statewide in Oklahoma but is more prevalent in the western part of the state, where a majority of Oklahoma's wheat is grown (U.S. Department of Agriculture, National Agricultural Statistic Service, 2007–2013). Approximately 60% of the state's wheat acres are grazed annually from November to March. Wheat grazing gains are typically lower cost than feedlot gains (Peel, 2006). Therefore, demand is likely higher for weaned cattle in the western half of Oklahoma versus other areas of the state. Instead of buying cattle in the eastern half of Oklahoma, where little wheat is grown for forage, buyers would rather purchase cattle near their delivery point to reduce transportation expenses and calf stress. Sale locations in areas with more wheat forage acres in surrounding counties are therefore hypothesized to have a higher sale price (i.e., a larger basis) compared to sale locations with fewer nearby acres of wheat, due to increased local demand for stocker cattle for grazing.

A sale barn's linear distance from a four-lane road was used as a proxy measure of transportation infrastructure. Less accessible sale barns are less desirable as cattle delivery and shipment points. A sale barn far from a major four-lane road could require unwanted extra miles. This variable also encompasses the quality of road leading to the sale barn. Concerns include speed of travel and weight restrictions on two-lane versus four-lane roads. Four-lane roads commonly have higher speed limits, higher weight limits, and may receive more maintenance and attention from state agencies. Transporting cattle at a faster pace with heavier loads lowers transportation cost. More cattle and more cattle buyers are likely to be present at sale locations nearest to four-lane roads due to lower transportation costs. Since both supply and demand of cattle may be influenced by transportation infrastructure, the impact on sale price cannot be predicted *a priori*.

In order to account for immediate total supply of a sale location, percentage value-added sale volume and overall sale volume were included in this research. Percentage value-added sale volume is defined as the percentage of cattle at a single sale date that are polled/dehorned, vaccinated, castrated (if male), and weaned at least thirty days. Percentage value-added sale volume is ambiguous in expected sign. Buyers may be willing to pay more for calves at a value-added sale, but the number of buyers at these sales may potentially be lower. Unfortunately, the number of registered buyers and the demand that they represent were not available, leaving the expected sign ambiguous.

While economic theory indicates that higher sale volume (i.e., more cattle available on a given day at a given location) should equate to a lower sale price due to the supply effect, Bulut and Lawrence (2007) and Schulz, Dhuyvetter, and Doran (2015) argued that larger sales attract more and larger buyers. Thus, potentially larger demand at larger sales may offset the impact that larger volume has on price. Bulut and Lawrence (2007) argued that the marginal impact of sale volume cannot be signed *a priori* because of these factors.

Past Feeder Cattle Price Research

When producers choose where to sell their cattle, they take into account a list of variables that could influence the price they receive. This long list of variables has been researched recently. Schroeder et al. (1988) modeled calf sale price as a function of weight, lot size, health, muscling, and other observable "time of sale" characteristics. Similarly, Coatney, Menkhaus, and Schmitz (1996) used a hedonic pricing model to estimate similar characteristics that influence price received. Leupp et al. (2009) also reported only on features that can be determined at the time of sale. More recent articles, like Bulut and Lawrence (2007), covered value-added characteristics that must be verified by a third party in order for the buyer to have confidence. Zimmerman et al. (2012) used Superior Livestock Auction data from 2001–2010 to find price differentials for value-added characteristics and found that steer calves sold in certified health programs had premiums ranging from $7 to $10/cwt. Williams et al. (2012) utilized data from Oklahoma sale barns to focus on a value-added certification program called the Oklahoma Quality Beef Network (OQBN). They reported both the premiums received on OQBN cattle and the price differentials of over twenty other characteristics.

A few studies have employed other methods to estimate the value of calf traits and past management. Schumacher, Schroeder, and Tonsor (2011) surveyed feedlot managers, asking perceptions about value-added practices, and found a premium of $7 to $12/cwt for vaccinated and weaned cattle. Williams et al. (2014) employed a matched-sampling method to reduce potential negative self-selection bias of value-added cattle caused by a hedonic model. The hedonic pricing model in Williams et al. (2012) showed a premium for value-added cattle in a range of $0.52 to $4.32/cwt, as opposed to a $5.38/cwt premium when the matched-sampling method (Williams et al., 2014) was used for the same data.

Past research has also investigated how sale volumes, or quantities, influence sale prices. Bulut and Lawrence (2007) reported that price received increases at a decreasing rate as sale size increases. For sale sizes of one, two, three, and four thousand head, sellers realized premiums of $1.06, $2.75, $3.88, and $4.55/cwt, respectively, versus a sale with only 500 head present. A supply effect begins at 4,500 head as premiums begin to decrease at an increasing rate compared to 500-head sale dates. Schulz, Dhuyvetter, and Doran (2015) also found a positive relationship between sales volume and price, albeit much smaller, at $0.0011 per head of volume.

Regional and intrastate differences in feeder cattle prices have also been considered (Bailey, Peterson, and Brorsen, 1991; Blank, Forero, and Nader, 2009; Zimmerman et al., 2012). For example, Blank, Forero, and Nader (2009) collected data on cattle across the western United States to determine the price discount that western region cattle producers receive due to location relative to the Midwest. Their additional objectives were to discover price differentials for value-added management practices such as weaned, bunk broke, and absence of implants. Schroeder et al. (1993) employed a distance variable to determine cost per mile ($0.0013/cwt per mile) to ship cattle from the feedyard to the packer. Williams et al. (2012) used a sale barn dummy variable to account for location premiums and discounts between various Oklahoma sale barns. They identified the sale barn by number with no information provided based on location characteristics and significant differences among sale barns were found.

While the effect of wheat acres on sale prices has not previously been modeled, it does parallel the approach taken by Schulz, Dhuyvetter, and Doran (2015), who considered feedlot capacity utilization and its impact on prices. Wheat acres are a similar measure of demand to feedlot capacity utilization.

Model

Two behaviors are relevant to this model. First, cow-calf producers want to maximize the profitability associated with raising a calf for sale by choosing management actions, such as breed/hide color, castration, dehorning/polled, certification enrollment, weaning, and vaccinating. Second, buyers are maximizing the profitability of buying calves, feeding them for a period of time, and reselling them by choosing among lots of calves for sale with varying traits and then managing them optimally. The interactions of these buyers and sellers determine, in part, price at a given sale location and date. As stated previously, other factors may affect basis, including nearby planted wheat acres, total sale volume, percentage value-added sale volume, distance from a four-lane road, and characteristics of each lot of calves to be sold.

Our model estimates basis rather than sale price, similar to Williams et al. (2012). Estimating basis reduces influence from weekly, season, annual, and market fluctuations and allows the marginal impacts of cattle and sale barn traits to be estimated. Similar to Coatney, Menkhaus, and Schmitz (1996), Blank, Forero, and Nader (2009), Williams et al. (2012), and Zimmerman et al. (2012), we estimate a hedonic model. Hedonic models estimate the marginal value of characteristics that contribute to differences in price or, as in our model, basis. Here we model basis as the difference between nearby futures contract for feeder cattle and price received by a lot of calves in \$/cwt. The hedonic model is specified as

$$
\begin{aligned}
Basis_{ik} \quad = \quad & \beta_0 + \beta_1 \ln(Head_{ik}) + \beta_2 AvgWt_{ik} + \beta_3 AvgW_{ik}^2 + \beta_4 Vac_{ik} + \beta_5 Wean_{ik} \\
& + \beta_6 Cert_{ik} + \beta_7 OtherCert_{ik} + \sum_{j=0}^{7} \beta_{8+j} HideColor_{ijk} + \beta_{16} Brahman_{ik} \\
& + \beta_{17} Uniform_{ik} + \beta_{18} Horns_{ik} + \beta_{19} Unhealthy_{ik} + \beta_{20} AgeSource_{ik} \\
(1) \qquad & + \beta_{21} Reputation_{ik} + \sum_{j=0}^{1} \beta_{22+j} Condition_{ijk} + \sum_{j=0}^{3} \beta_{24+j} Muscling_{ijk} \\
& + \sum_{j=0}^{1} \beta_{28+j} Frame_{ijk} + \sum_{j=0}^{1} \beta_{30+j} Gender_{ijk} + \sum_{j=0}^{1} \beta_{32+j} Fill_{ijk} \\
& + \beta_{34} PerValueAdded_k + \beta_{35} \ln(SaleVolume_k) + \beta_{36} WheatAcres_k \\
& + \beta_{37} Distance_k + \beta_{38} DaysToMarch + \varepsilon_{ik} + v_{ik},
\end{aligned}
$$

where k denotes a sales' location on a given date, i denotes each unique lot of cattle at location-date k, ε_{ik} are error terms by lot and location-date, and v_{ik} are random effects for year. Additionally, *Head* denotes the number of calves in lot i for location date k, *AvgWt* is the average weight of the lot, *PerValueAdded* is the percentage of sale volume consisting of value-added cattle, ln*(SaleVolume)* is the natural log of the total number of cattle (in 1,000 head) at an individual location date, *Distance* variable is the linear distance (in miles) from the sale barn to a four-lane road, and *WheatAcres* is the number of planted wheat acres (in 100,000 acres) within a 100-mile radius of the sale location by sale date. Also, *HideColor* ε Red, Hereford, White/Grey, Diary/Longhorn, Other, Black Mixed, Red Mixed, and Mixed represents hide color with black as the base color, *Vac* = 1 if the lot was announced as vaccinated, *Wean* =1 for lots announced as weaned, *Cert* = 1 indicates that third-party verification of vaccination and weaning was announced, similarly for *OtherCert* ε {0, 1} for other certification programs, *Brahman* = 1 if the lot appeared to have Brahman influence, *Uniform* = 1 if the animals appeared to be uniform in frame and weight, *Horns* = 1 indicate whether horns were present, *Health* = 1 if the lot appeared to have a health concern, *AgeSource* = 1 if the lot was announced as age and source verified, *Reputation* = 1 if the lot seller was announced, *Flesh* ε Thin, Average, Fleshy indicates the level of cover observed in the lot, and *Muscling* ε Thick all #1, Mixed #1 & #2, Medium all #2, Mixed #2 & #3, Light all #3 is used to represent the amount of muscling observed in the lot. *Frame* ε {Large, Medium/Large, Medium} describes frame score observed in the lot; *Gender* ε Steers, Heifers, Bulls or Mixed identifies whether the lot was steers, heifers, or bull/mixed; and *Fill* ε {Gaunt, Average, Full} describes the level of fullness observed in the lot. The variable *DaysToMarch* is the number of days between the sale date and March 1 of the following year (the approximate end of the winter grazing season). This variable picks up the seasonality of calf sale prices, which typically bottom out in October and early November and are generally increasing in December.

The location characteristic variables in this research were nested within the years. A repeated statement was used to correct for the nesting. There were a total of 6,027 unique lots of cattle after deleted observations with incomplete data. Each lot of cattle coincided with a location sale barn, sale date, and year, though there were only eight unique locations, thirty-one unique sale dates, and four unique years (2010–2013). Because of this, using a Mixed model to estimate the location characteristic variables overstated degrees of freedom for these variables. In order to correct for the nested variables, degrees of freedom were adjusted to twenty-nine for *PerValADD*, ln*(SaleVolumeK)*, *DaystoMarch*, *TotalCert*, and *OtherCert*; eighteen for *WheatAcres100k*; and six for *Distance*.

Data

Table 1 reports a summary of statistics of the data. Collection dates included in this research span from October 27, 2010, to December 14, 2013, and include 53,731 head of cattle making up 6,027 unique lots (after deleting observations with missing information or misreported information). The following characteristics were recorded on each lot: lot size, phenotypic traits, sale price, management practices, and market influences. Phenotypic traits comprised average weight per head, hide color (breed characteristics), Brahman influence, gender, condition (fleshiness), frame score, uniformity, health, horned status, muscle score, and fill. Management practices comprised vaccinations, weaning, preconditioning certification, age-and-source verification, and seller announced. Data collections from live auctions were conducted by Oklahoma State University faculty and staff. Prices received for calves were adjusted to 2013 dollars using a Producer Price Index (U.S. Bureau of Labor Statistics, n.d.). Market influences comprised planted wheat acres in a 100-mile radius around the sale barn, linear distance from a major four-lane road, percentage value-added sale volume, and total sale volume.

Wheat acres were taken from the CropScape tool (U.S. Department of Agriculture, National Agricultural Statistics Service, 2016). Each sale barn's location was located via longitude and latitude coordinates. Then, circular areas with radii of 25, 50, 100, 150, and 200 miles were used to find winter wheat acres for each sale barn and year. These wheat acres are highly correlated (0.92+), so only one acreage measure could be included in the model. The model was estimated for each radius. Log likelihood ratios were used to compare the alternatives. No single measurement was superior to the others, so we arbitrarily chose the wheat acres associated with a 100-mile radius around each location. Figure 1 shows the location of each of the eight sale barns and the associated 100-mile radial wheat acreage averages.

Linear distance from a four-lane road was calculated using Free Map Tools. The linear distance from a four-lane road for each sale barn was measured as the closest distance from the road entrance of a sale barn to the nearest lane of a four-lane road. Nearby futures contract prices for each sale date were taken from Livestock Marketing Information Center (2015).

Basis was computed as the difference between the nearby feeder calf futures price and price received. Table 2 reports average prices received and basis for the four years of this study.

Results

The model was estimated using the MIXED procedure in SAS Enterprise Guide 5.1 (SAS Institute, Inc., 2012). Multicollinearity in the model was tested using Variance Inflation Factor (VIF). A value of ten was used as a benchmark for whether or not multicollinearity existed in a variable (Kutner, Nachtsheim, and Neter, 2004). All variables showed a VIF value of less than four except for the *AvgWt* and $AvgWt^2$ variables, which is expected since both variables draw from the same values.

Table 1. Summary Statistics

Location Characteristic	Mean	SD	Minimum	Maximum	Freq.
Planted Wheat (100k acres)	6.4	6.1	0	1.5	20
Linear Distance (miles)	7.1	18.4	0.016	55.9	8
Overall Sale Volume (head)	4,024.3	2,559.5	896	9,621	31
VA Sale Volume (head)	627.4	759.2	0	2,852	31
Days to March 1	99.2	15.2	76	141	31

Location Characteristic	Mean	SD	Minimum	Maximum
Lot Size (head)	8.9	16.4	1	315
Weight (lbs)	542.6	129.4	173	1,114
Price (2013 $/cwt)	134.71	29.34	16.00	250.00

Lot Characteristic	Freq.	Percentage	Lot Characteristic	Freq.	Percentage
Vaccinations			Muscling		
Vaccinated	2,941	48.80	Thick, all #1	1,013	16.81
Not vaccinated	3,086	51.20	Mixed, #1 & #2	2,048	33.98
Weaning			Medium, all #2	2,833	47.01
Weaned	3,579	59.38	Mixed, #2 & #3	64	1.06
Not weaned	2,448	40.62	Light, all #3	69	1.14
Certification			Uniformity		
Certified	1,933	32.07	Uniform	5,983	99.27
Other certified	51	0.85	Not Uniform	44	0.73
Not certified	4,043	67.08	Fill		
Color			Gaunt	30	0.50
Black	3,748	62.19	Average	5,318	88.24
Red	408	6.77	Full	679	11.27
Hereford	101	1.68	Frame		
White/Grey	548	9.09	Large	1,101	18.27
Dairy/Longhorn	73	1.21	Medium/Large	2,130	35.34
Black mixed	577	9.57	Medium	2,796	46.39
Red mixed	94	1.56	Horns		
Mixed	427	7.08	Horns	407	6.75
Other	51	0.85	No Horns	5,620	93.25
Brahman			Health		
Brahman Infl.	471	7.81	Healthy	5,949	98.71
Non-Brahman	5,556	92.19	Not Healthy	78	1.29
Gender			Age & Source		
Steer	3,205	53.18	Verified	302	5.01
Heifer	2,486	41.25	Not Verified	5,725	94.99
Bull/Mixed	336	5.57	Reputation		
Condition			Not Announced	3,887	64.49
Thin	111	1.84	Seller Announced	2,140	35.51
Average	4,654	77.16			
Fleshy	1,267	21.00			

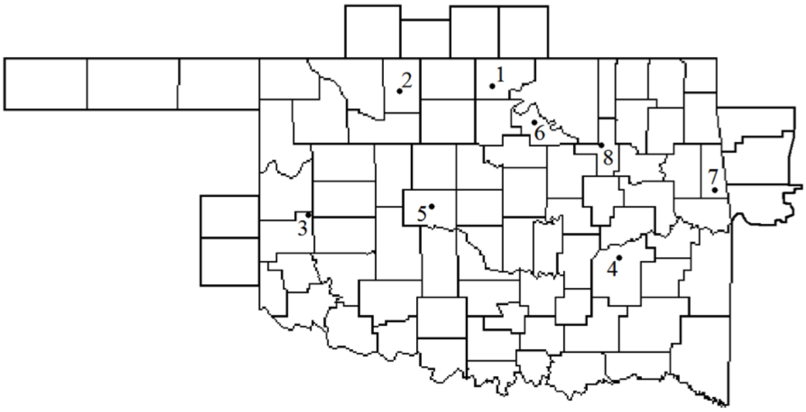

Figure 1. Average Total Planted Wheat Acres by County and Contiguous Counties in Oklahoma, Kansas, Arkansas and/or Texas, 2010–2013

Source: U.S. Department of Agriculture, National Agricultural Statistics Service (2016).
Notes: Data taken using circular areas with 100-mile radii around each sale location.

Location	Average Total Wheat Acres 2010–2013
1	4,397068
2	5,627,258
3	5,011,655
4	350,366
5	3,765,349
6	2,676,978
7	50,637
8	870,605

Table 2. Basis by Year

Year	Units	Futures Price	Average Price Received	Average Basis
2010	$/cwt	$115.33	$112.84	−$2.49
2011	$/cwt	$143.42	$143.27	−$0.15
2012	$/cwt	$145.04	$145.72	$0.68
2013	$/cwt	$164.94	$165.50	$0.46
Avg	$/cwt	$135.64	$134.71	−$0.93

Notes: Futures price indicates futures contract price for nearby contract. Average price received indicates the average price (nominal $s) received for the lots recorded in this data by year. Average basis refers to the futures price-average price received.

Both the Breusch-Pagan and White's heteroskedasticity tests were applied to the data. The variables of *avgwt*, *distance*, *PerValADD*, and *SaleVolumeK* showed signs of heteroskedasticity. The model was corrected for heteroskedasticity (Judge et al., 1988) using the repeated/local command in SAS.

Regression results are shown in table 3. Each coefficient measures its corresponding variable's contributory change in basis in $/cwt. Of the thirty-nine variables in the model, thirty are significant at pâĽd'0.05, while twenty-seven of the thirty are significant at $p \leq 0.01$. Parameter estimates for most lot characteristics are similar in sign and significance to estimates from similar studies (Bulut and Lawrence, 2007; Zimmerman et al., 2012; Williams et al., 2012).

The coefficient for the natural logarithm of overall sale volume (1,000 head) at an individual sale date was -0.18 ($p = 0.0011$). This result differs from Bulut and Lawrence (2007) and Schulz,

Table 3. Parameter Estimates for Hedonic Pricing Model (N=6,028 feeder calf lots)

Variable	Estimate	Standard Error
$Intercept$	188.31	2.38
$\ln(head)$	2.25	0.13
$avgwt$	−0.10	4.8e–3
$avgwt^2$	3.6e–5	3.7e–6
Vac	1.60	0.39
$Wean$	1.67	0.36
$TotalCert$	0.89	0.36
$OtherCert$	2.56	1.21
$HideColor(BlackBase)$		
Red	−4.01	0.45
Hereford	−7.86	0.86
White/Grey	−1.84	0.48
Dairy/Longhorn	−25.05	1.34
Other	−9.99	1.20
Black mixed	−1.65	0.36
Red mixed	−3.05	0.86
Mixed	−3.84	0.44
$Brahman$	−3.86	0.40
$Non-Uniform$	−7.95	1.22
$Horns$	−2.80	0.43
$Unhealthy$	−27.06	0.96
$AgeSource$	−0.40	0.48
$Reputation$	0.25	0.25
$PerValADD$	−1.99	0.46
$\ln(SaleVolumeK)$	−0.18	0.05
$WheatAcres100K$	0.64	0.07
$Distance$	−0.07	0.03
$DaystoMarch$	−0.07	0.01
$Condition(AverageBase)$		
Thin	−9.71	0.97
Fleshy	−0.26	0.28
$Muscling(Medium\#2'sBase)$		
Thick, all #1's	0.19	0.36
Mixed, #1 & #2	0.38	0.32
Mixed, #2 & #3	−2.48	1.20
Light, all #3	−14.13	1.46
$Frame(MediumBase)$		
Large	0.16	0.37
Medium/Large	0.51	0.32
$Gender(SteersBase)$		
Heifers	−9.69	0.22
Bull/Mixed	−4.94	0.46
$Fill(AverageBase)$		
Gaunt	−0.32	1.49
Full	−0.68	0.37

Notes: Bases for unnoted variables are non-vaccinated, non-weaned, non-certified, non-Brahman, uniform, polled/dehorned, healthy, non-age and source verified, and non-seller announced.

Table 4. $bm\ln(head)^1$ **Variable Results**

Head	Change in Basis	Marginal Impact on Basis
1	0.00	2.250
2	1.56	1.125
5	3.61	0.450
10	5.18	0.225
20	6.74	0.113
30	7.65	0.075
40	8.30	0.056
50	8.80	0.045
60	9.21	0.038
70	9.56	0.032
80	9.86	0.028

Notes: $\ln(head)$ is the natural log of the number of calves in each lot sold. Change in basis = $2.25\times$ ln(head). Marginal impact on basis = 2.25/head.

Dhuyvetter, and Doran (2015), who both reported a positive impact on sale size. Anecdotal evidence suggests that producers will haul cattle more miles to sell calves at larger sale barns, apparently to obtain higher sale prices. However, the result cannot be considered in isolation. Larger sale barns also attract larger lots of cattle, likely due, in part, to larger handling facilities, including sale rings and external sorting pens. The correlation between sale volume and average lot size was 0.849. Since the coefficient on the natural log of lot size (head) was 2.25 ($p\leq 0.01$), lot size effects dominated the sale volume effect. For example, average sale volume of all sales with less than 4,100 head was 2,258, with an average lot size of 5 head. The combined effect of these two variables was $3.46/cwt. In contrast, average sale volume of all sales with more than 4,100 was 7,004 head, with an average lot size of 17 head. The combined effect of these two variables was $6.12/cwt. The difference between the average small sale and the average large sale was $2.66/cwt, likely justifying larger producers traveling more miles to sell at larger sale barns.

The coefficient for linear distance from a four-lane road was negative and statistically significant. Schroeder et al. (1993) found a similar result, in sign and significance, with the distance between a packer and a feedyard. This result showed that discounts to basis grow larger as sale barns get farther away from a four-lane road. The coefficient implies that for every linear mile farther from a four-lane road, the basis will decrease by $0.07/cwt. However, caution should be used when interpreting this result, as this variable could proxy for many other unique location traits not included in the model. While not identical, Schulz, Dhuyvetter, and Doran (2015) used diesel fuel price instead of a distance measure. While diesel fuel price impacts more than just transportation expense, it does reflect, in part, transportation expense and was found to negatively influence sale prices in their study.

The coefficient for planted wheat acres in a 100-mile radius around the barn was positive and statistically significant. This result confirms the hypothesis that sale barns with more nearby planted wheat acres have a higher sale price (i.e., larger basis). The coefficient implies that for every 100,000 acres of planted wheat within 100-miles of the location will increase basis by $0.64/cwt. Again caution is warranted when interpreting this coefficient due to the possibility of correlation with omitted local variables.

The coefficient for percentage value-added sale volume at an individual sale date was negative and statistically significant. Our result agrees with Williams et al. (2012), who also reported a negative effect on sale prices. This result does not imply that value-added calves sell for a lower price than other calves as there are other value-added variables to simultaneously evaluate. Instead, it acted to shift the intercept down, implying that non-value-added calves at a value-added sale will be lower priced than at a typical sale.

Table 5. *Avgwt* Variable Results

Weight (lbs)	Change in Basis	Marginal Impact on Basis
350	−30.59	−0.078
450	−37.71	−0.072
550	−44.11	−0.066
650	−49.79	−0.060
750	−54.75	−0.054
850	−58.99	−0.047
950	−62.51	−0.041

Notes: Avgwt is the average weight of the calves in each lot sold.
Change in basis $= -0.10 \times Avgwt + 0.000036 \times Avgwt^2$.
Marginal impact on basis $= -0.10 + 0.000062 \times Avgwt$.

To determine the marginal impact of lot size (*Head*) on basis, the derivative of basis with respect to head must be computed. As the number of head in a lot increases, basis increases but with decreasing marginal returns. A similar result is found in Williams et al. (2012). Table 4 shows a selection of lot sizes and their impact on the basis.

As with lot size, the derivative of basis with respect to average weight (*Avgwt*) must be computed to determine the marginal impact of weight. As the average weight of the lot increases, basis decreases with decreasing marginal returns. Similar results in sign and statistical significance were found in Bulut and Lawrence (2007), Williams et al. (2012), and Zimmerman et al. (2012). Table 5 reports a range of average weights and their impact on basis.

Vaccinated lots of cattle realized an increase in price received of $1.60/cwt versus unvaccinated lots of cattle. A $1.67 increase in basis is received if the lot is announced as weaned versus non-weaned. Similar results were found for vaccinated and weaned cattle in Bulut and Lawrence (2007), Williams et al. (2012), and Zimmerman et al. (2012).

Lots of cattle sold under the OQBN and Noble certification programs received an increase of $0.89 in basis. Zimmerman et al. (2012) found similar results, while Williams et al. (2012) found much higher increases in basis when animals were enrolled in certification programs. The impact of enrolling in the other value-added program is estimated to be a $2.56 increase in basis.[2]

All hide color variables were negative and significant when black hide color was used as the base. As seen in Bulut and Lawrence (2007), Williams et al. (2012), and Zimmerman et al. (2012), lots with black hide color received the highest premiums. The most dramatic discounts were Dairy/Longhorn lots, which received a decrease in basis of $25.05/cwt. Hide colors that received the lowest discount in basis relative to black lots were black mixed lots, with a discount of $1.65, and white/grey lots, with a discount of $1.84.

Lots classified as Brahman received a price $3.86 lower as compared to non-Brahman. Similar results were reported by Williams et al. (2012). The non-uniform variable (*Non-Uniform*) indicated whether the lot appeared to be non-uniform in frame and weight. Lots classified as not uniform received a decrease in basis of $7.95 compared to uniform lots. Williams et al. (2012) found results similar in sign and statistical significance but reported a larger decrease in basis, $15.31.

Lots with horns present received a decrease in basis of $2.80 as compared to polled/dehorned lots. Similar results were found in Bulut and Lawrence (2007), Williams et al. (2012), and Zimmerman et al. (2012). The health variable (*Unhealthy*) indicated whether the lot recorded appeared to be unhealthy. Lots that showed health concerns received a drastic $27.06 decrease in basis compared to healthy lots. Similar results were reported in Bulut and Lawrence (2007) and Williams et al. (2012).

The coefficient on lots with age and source verification was not statistically significant, as in Williams et al. (2012). This may stem from the fact that Japanese age restrictions of less than twenty-one months imposed on beef imports in 2005 changed to thirty months in February 2013, likely

[2] This program was only available at one sale barn in Oklahoma.

lessening the impact of age and source verification in data from 2013. Additionally, few lots in the data were denoted as age and source verified.

The *Reputation* variable was not statistically significant, similar again to Williams et al. (2012). Data collected for reputation are likely not detailed enough to capture true reputation effects on basis. Lots classified as thin received a $9.71 decrease in basis compared to average-fleshed lots. Lots classified as fleshy were not priced significantly different from average-fleshed lots. In Williams et al. (2012), lots classified as thin received similar discounts and lots classified as fleshy were not statistically significant. Lots classified as fleshy received discounts in Bulut and Lawrence (2007).

Lots with levels of muscling less than medium #2 were statistically significant, showing discounts of $2.48 and $14.13 for Mixed #2 and #3 and Light #3, respectively. Lots with #1 and #1–#2 muscling were not statistically different from the base of #2 muscling. These results are similar to Williams et al. (2012). The frame score coefficient was not statistically significant, as in Williams et al. (2012). It should be noted that little variation in frame score was found in the data. Only lots of cattle scored as large, medium and large, or medium were recorded during the collection period.

Heifer lots received a decrease in basis of $9.69 in comparison to steers, while lots made up of bulls or mixed gender saw a decrease in the basis of $4.94. Similar results are found in Bulut and Lawrence (2007) and Williams et al. (2012). Lots labeled as gaunt were statistically insignificant compared to lots of average fill, though few gaunt lots were observed. Lots labeled as full received a decrease in the basis of $0.68 (p=0.0725) compared to lots labeled average. Williams et al. (2012) reported that all fill variables were statistically insignificant.

Finally, the *DaysToMarch* variable was significant at -$0.07. This demonstrates the seasonality of feeder calf sales and fewer opportunities for wheat pasture grazing. Our sale dates ranged from October 11 (141 days from March 1 for leap year) to December 13 (76 days to March 1) and averaged 99.2 days. In wheat grazing areas, the most common date for cattle removal is March 1. Though a number of variables impact the ideal date for cattle removal, many producers use this date as a rule of thumb. Sale dates nearer to March 1 imply fewer days of gain on wheat pasture for feeder calves.

Conclusions

Recent research has measured differences in market prices due to differences in feeder cattle characteristics (Bulut and Lawrence, 2007; Coatney, Menkhaus, and Schmitz, 1996; Schroeder et al., 1988; Schumacher, Schroeder, and Tonsor, 2011; Williams et al., 2012, 2014). Williams et al. (2012) reported that sale barn location impacts price received by feeder calf sellers, but offered no explanation for why those differences in sale price exist. The purpose of this study was to determine, in part, why feeder calf prices differ among Oklahoma sale barns. Knowing the value of location characteristics can help producers make decisions on when and where to market their cattle to receive the highest price possible for their product.

Data were collected one thirty-one separate auction dates at eight unique locations across the state of Oklahoma. Data on 53,731 head of cattle in 6,027 lots were collected from October 27, 2010, to December 14, 2013.. A hedonic model was employed to measure the value of characteristics of market cattle in Oklahoma sale barns and to identify differences in basis due to location.

Sale barns in areas with more planted wheat acres receive higher sale prices (i.e., larger basis) relative to areas with less planted wheat acres. This is likely due to the common practice of grazing stocker calves on wheat pasture over the winter in the U.S. Southern Plains. Results also indicated that as a sale barn's linear distance from a four-lane road increases the price received for cattle decreases. The distance needed to travel to a sale barn coupled with lower weight limits on two-lane roads contributes to higher cost of transportation. Both buyers and sellers seek to reduce transportation cost, and sellers desire to reduce shrink that could occur while the cattle are in transit. Longer hauls increase both transportation costs and shrink. Transportation on two-lane roads is often subject to lower weight restrictions, increasing the number of trips needed to haul calves to and from a sale barn located on two-lane roads.

Local supply was captured by overall sale volume at a particular sale date and by the corresponding percentage of value-added cattle. Both variables' coefficients were negative and significant, likely due to supply effects. While there is a potential demand effect as larger sales attract more and larger buyers, the negative supply effect outweighed any demand effect (if it is present). However, these variables should not be considered in isolation. Larger sale volumes are highly correlated with larger lot sizes. The impact of larger lot size was more than sufficient to offset supply effects at mean effects.

Implications

Market transactions include both explicit transaction costs and implicit transaction costs. In this model, location variables may capture both types. Livestock auctions perform many functions for buyers and sellers, including assembly of cattle, connecting multiple buyers and sellers, and price discovery. Higher basis for more wheat acres reflects the notion that the market assembles suitable calves in an appropriate location for the grazing function, lowering the search costs for potential buyers. Value-added calves are perceived to be less risky, with better future health and performance, than calves raised with fewer health management attributes, lowering uncertainty and transaction costs for buyers. These often-omitted local factors may increase or decrease transaction costs for buyers and sellers, impacting the basis between prices at the local market and a base market.

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References

Bailey, D., M. C. Peterson, and B. W. Brorsen. "A Comparison of Video Cattle Auction and Regional Market Prices." *American Journal of Agricultural Economics* 73(1991):465–475. doi: 10.2307/1242731.

Blank, S. C., L. C. Forero, and G. A. Nader. "Video Market Data for Calves and Yearlings Confirms Price Discounts for Western Cattle." *California Agriculture* 63(2009):225–231. doi: 10.3733/ca.v063n04p225.

Bulut, H., and J. D. Lawrence. "The Value of Third-Party Certification of Preconditioning Claims at Iowa Feeder Cattle Auctions." *Journal of Agricultural and Applied Economics* 39(2007):625–640. doi: 10.1017/S1074070800023312.

Coatney, K. T., D. J. Menkhaus, and J. D. Schmitz. "Feeder Cattle Price Determinants: An Hedonic System of Equations Approach." *Review of Agricultural Economics* 18(1996):193–211. doi: 10.2307/1349432.

Free Map Tools. "Measure Distance on a Map." Available online at https://www.freemaptools.com/measure-distance.htm.

Judge, G. G., R. C. Hill, W. E. Griffiths, H. Lutkepohl, and T. Lee. *Introduction to the Theory and Practice of Econometrics*. New York: Wiley, 1988, 2nd ed.

Kutner, M. H., C. Nachtsheim, and J. Neter. *Applied Linear Regression Models*. New York: McGraw-Hill, 2004, 4th ed.

Leupp, J. L., G. P. Lardy, R. Daly, C. L. Wright, and J. A. Paterson. "Factors Influencing Price of North Dakota, South Dakota and Montana Feeder Calves." *Range/Wildlife* 7415(2009):46.

Livestock Marketing Information Center. "Member Reports." 2015. Available online at http://www.lmic.info.

Peel, D. S. "Economics of Stocker Production." *Veterinary Clinics: Food Animal Practice* 22(2006):271–296. doi: 10.1016/j.cvfa.2006.03.007.

SAS Institute, Inc. *SAS Enterprise Guide 5.1*. Cary, NC: SAS Institute, Inc., 2012.

Schroeder, T., R. Jones, J. Mintert, and A. P. Barkley. "Factors Affecting Feeder Cattle Price Differentials." *Review of Agricultural Economics* 15(1993):325–337.

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

Schulz, L., K. Dhuyvetter, and B. Doran. "Factors Affecting Preconditioned Calf Price Premiums: Does Potential Buyer Competition and Seller Reputation Matter?" *Journal of Agricultural and Resource Economics* 40(2015):220–241.

Schumacher, T., T. C. Schroeder, and G. T. Tonsor. "Value of Preconditioned Certified Health Programs to Feedlots." 2011. Available online at http://www.agmanager.info/livestock/marketing/bulletins_2/marketing/feeder_cattle/MF3017_6pp.pdf.

U.S. Bureau of Labor Statistics. "Producer Price Index (PPI) Databases." n.d. Available online at http://www.bls.gov/ppi/#data.

U.S. Department of Agriculture, National Agricultural Statistic Service. "Oklahoma Wheat County Estimates." 2007–2013. Available online at https://quickstats. nass. usda.gov/?source_desc=CENSUS.

U.S. Department of Agriculture, National Agricultural Statistics Service. "CropScape – Cropland Data Layer." 2016. Available online at https://nassgeodata.gmu.edu/CropScape/.

Williams, B. R., E. A. DeVuyst, D. S. Peel, and K. C. Raper. "Reducing Self-Selection Bias in Feeder Cattle Premium Estimates Using Matched Sampling." *Journal of Agricultural and Resource Economics* 39(2014):124–138.

Williams, G. S., K. C. Raper, E. A. DeVuyst, D. S. Peel, and D. McKinney. "Determinants of Price Differentials in Oklahoma Value-Added Feeder Cattle Auctions." *Journal of Agricultural and Resource Economics* 37(2012):114–127.

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