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RESEARCH ARTICLE

Valuation of Genomic-Enhanced Expected Progeny Differences in Bull Purchasing

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Abstract
We estimate a hedonic pricing model to determine producers' value for bull expected progeny differences (EPDs), genomic-enhanced EPDs, and phenotypic traits. Birth weight EPD, ribeye area EPD, sale weight, age, frame score, and other factors had a statistically significant impact on bull prices. GE-EPDs were not associated with a change in the bull sales prices expect for weaned calf value and birth weight EPDs. Including weaned calf value and GE-EPDs in a bull hedonic pricing model provides a unique contribution. The results from this work will inform educational programming for bull purchasers on using new economic selection indices and GE-EPDs.

Keywords: Beef cattle; bulls; expected progeny difference; genomic; hedonic pricing

JEL Codes: Q12

Introduction

Purchasing a bull for a cow-calf operation is a complex decision that has major implications for an operation's long-term profitability (Clary, Jordan, and Thompson, 1984). The ideal profit-maximizing bull will vary across operations depending on breed composition, marketing plan, average herd cow age, number of heifers, and other factors. For example, a producer retaining ownership through finishing will benefit from purchasing a bull that sires calves with characteristics that increase profitability during the feedlot phase, such as higher average daily gain, lower feed-to-gain ratios, higher dressing percentage, and superior carcass quality (Jones et al., 2008; Lewis et al., 2016; Mark, Schroeder, and Jones, 2000; Tang et al., 2017). Regardless of an operation's goal, a single bull's genetics impact the overall genetic makeup of the herd to a greater degree than individual cows (Wagner et al., 1985). This footprint on the genetic makeup of a herd is even more substantial in herds that retain replacement females.

Today, when a producer is selecting a bull to achieve their production goals and match their herd's needs, the producer has more information to evaluate today than what was available 5 years ago. This information commonly includes phenotypic measurements (e.g., birthweight and carcass ultrasound data), performance measurements (e.g., average daily gain, weaning weight, and yearling weight), and an extensive suite of breed specific expected progeny differences (EPDs). EPDs are statistical estimates of an animal's genetic potential derived from performance and historical data of the individual and its relatives for a specific breed (Henderson, 1975). Producers can use EPDs to compare the expected performance of an animal's offspring with that of another animal from the same population (i.e., comparing the expected performance of calves sired by two bulls in the same breed registry). EPDs complement selection based on phenotypic traits and other visual indicators when selecting a bull and enable more accurate selection decisions than phenotypic measurements alone because they remove variation around phenotype due to environmental factors. This multitool selection approach allows producers to select only on the heritable genetic component of an observed trait. EPDs can help reduce the "unknown" of a sire's genetic potential and minimizes the risk of selecting the "wrong" bull. Numerous studies have attempted to understand producers' valuation of bull information when marketing and developing bulls over the past few decades (Bekkerman, Brester, and McDonald, 2013; Boyer et al., 2019; Brimlow and Doyle, 2014; Chvosta, Rucker, and Watts, 2001; Dhuyvetter et al., 1996; Jones et al., 2008; Kessler, Pendell, and Enns, 2017; McDonald et al., 2010; Tang et al., 2020, 2022; Vanek et al., 2008; Vestal et al., 2013).

An interesting finding from this research is that, when EPDs were introduced, producers placed a small value on them relative to phenotypic and performance measurements (Chvosta, Rucker, and Watts, 2001; Dhuyvetter et al., 1996). This is likely because producers needed time to become educated and confident in using EPD information in their bull purchasing decision (Jones et al., 2008). Recent studies indicate that EPD information is becoming more a key factor in determining bull sale price (Bacon, Cunningham, and Franken, 2017; Boyer et al., 2019; Brimlow and Doyle, 2014; Jones et al., 2008; Kessler, Pendell, and Enns, 2017; McDonald et al., 2010; Tang et al., 2020). Boyer et al. (2019) used bull sale data from 2006 to 2016 to estimate the economic value of phenotypic traits, performance measures, and EPDs over time. Results showed that producers valued growth EPDs, calving ease direct EPDs, milk EPDs, average daily gain, sale weight, and frame score. The impact of EPD on sale prices of bulls was found to go from insignificant to significant over the span of years studied for the sale. Additionally, Tang et al. (2020) showed that, over time, producers' value of EPD information increased for certain traits. However, the value placed on other traits (like milk EPD) demonstrated a quadratic response by increasing until a point, and then declining.

Genomic-enhanced EPDs (GE-EPDs) were introduced to the beef industry in 2009 by the American Angus Association and have become a new resource for producers to use when evaluating cattle (Scharpe, 2016). GE-EPDs combine traditional EPD calculations with molecular genetic information on the animal, resulting in more accurate predictions of genetic merit (Meuwissen, Hayes, and Goddard, 2001). GE-EPDs can be interpreted exactly like standard EPDs, but they serve as more accurate estimates of the animal's genetic merit. Vestal et al. (2013) estimated bull buyers' preferences for EPDs, Igenity scores, and ultrasound information traits. Results showed that bull buyers significantly value EPD information, test performance, and ultrasound information, while newer DNA profile information (Igenity scores) was unrelated to buyers' preferences. Even though the Igenity scores are different from GE-EPDs, this finding does indicate that producers might not value this new metric. However, no study has attempted to measure the value producers place on GE-EPDs.

Therefore, the objective of this study is to estimate the value producers place on GE-EPDs relative to phenotypic traits, performance measurements, and traditionally calculated EPDs when selecting and purchasing replacement bulls. We estimate a hedonic pricing model using 9 years of bull sale data (2013–2021) from a public first-price auction in Tennessee. The results could educate purebred seedstock providers on the economic value of individual bull selection criteria and to determine if commercial producers associate a value to GE-EPDs. Understanding if and how producers value EPD accuracy will help extension personnel develop education programs and material to address their questions about GE-EPDs.

Data

Each year, the Middle Tennessee Research and Education Center in Spring Hill, Tennessee markets performance-tested senior bulls in January (University of Tennessee Department of Animal

Science, 2019). Senior bulls are born from the first of September to mid-December; therefore, these bulls are between 13 and 17 months old when sold. Breeders deliver their bulls to the test station in August before the sale. The bulls go through a 2-week adjustment period, and then an 84-day weight gain test where they are fed a commercial bull developing ration containing 12% crude protein.

After the test period, phenotypic measures for each bull are recorded including hip height, scrotal circumference, sale weight, frame score, and on-test average daily gain. These measurements, along with pretest information such as actual birth weight and weaning weight, the full suite of EPDs, and carcass ultrasound data (fat thickness, ribeye area, and intramuscular fat), are published in a catalog and online to potential buyers for each bull. Bulls are sold in a public first-price auction.

Data used in this study are from the 2013 to 2021 sales. Since most of the bulls in this sale being purebred Angus, we restrict this study to Angus animals. We used information from a total of five hundred Angus bulls that were sold over the 9-year time. This span of sale data included bulls with EPDs and GE-EPDs. From 2013 to 2016, none of the bulls in this study had a GE-EPD. From 2017 to 2021, all bulls used in this study had a GE-EPD. A description of variables considered to impact sale price is shown in Table 1. Table 2 shows the summary statistics for these variables. Bulls were only considered if their information in the data set was complete. The average sale price was \$3,383 per head, with a range of \$1,250–\$8,250. Figure 1 shows the mean sale price for bulls in the years 2013–2021. The average weight was 1,403 pounds, and the average age was 433 days old.

Statistical Analysis

A hedonic pricing model was used to determine whether, or not, phenotypic traits and EPD's influence the sale price of bulls (Boyer et al., 2019; Brimlow and Doyle, 2014; Dhuyvetter et al., 1996; Jones et al., 2008; Kessler, Pendell, and Enns, 2017; Vestal et al., 2013). We specify a log-level model by using the log-transformed the sale price to correct non-normal distribution (Wooldridge, 2013). Since all bulls are sold individually, we estimate the model using the bull as the experimental unit impacted over time. The model is shown as

$$\ln(P_{it}) = \alpha + \delta_1 GE_{it} + \sum\nolimits_{j=1}^{6} \beta_j X_{itj} + \sum\nolimits_{j=1}^{6} \gamma_j X_{itj} GE_{it} + \sum\nolimits_{k=1}^{7} \theta_k Z_{itk} + v_t + u_l + \varepsilon_{it} \quad (1)$$

where P_{it} is the sale price (\$/head) of bull *if* in year *t*; GE_{it} is an indicator variable equal to one if the bull had GE-EPD and zero otherwise; and X_{itj} are *j* EPD covariates including weaned calf value, birth weight, milk, marbling, fat thickness, and ribeye area. The interaction between GE-EPD and EPD covariates is represented within the model multiplying X_{itj} by GE_{it}; Z_{itk} are *k* phenotype covariates including sale weight, frame score, age, scrotal circumference, ribeye area, intermuscular fat, and fat thickness; v_t is the year trend variables (linear, squared, and cubic); u_l is the sale order effect; α, β, δ, γ, v, u, and θ are coefficients to be estimated; and $\epsilon_{it} \sim N(0,{\sigma_\epsilon}^2)$ is the random error term. Interaction between GE-EPD and EPD covariates to determine if the GE-EPD test was significant for any specific EPD although a GE-EPD test is for all EPDs.

Parameter estimates can be converted to a dollar change in the dependent variable with a one-unit change in the independent variable of interest by multiplying the parameter estimates by the average predicted selling price of the bulls in the sample (Wooldridge, 2013). This conversion yields a marginal effect of a change in the independent variable at the average price. A one-unit change in the independent variable would be unlikely for some bull traits. These marginal effects at the average price were converted into realistic unit changes for each variable of interest.

We also specify our model to have standardized independent variables with a level dependent variable (Kessler, Pendell, and Enns, 2017; Lewis et al., 2016; Mark, Schroeder, and Jones, 2000; McDonald et al., 2010). This transforms regression coefficients from units to being standard

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Table 1. Definition of independent and dependent variables

Variable	Symbol	Definition
Log Price	Price	Sale price of bull
Genomic-Enhanced EPD	getest	Indicates whether a bull has a GE-EPD.
Weaned calf value	dollw	An index, expressed in $ per head, to predict profitability differences in progeny due to genetics from birth to weaning.
Birth weight EPD	birthepd	Predicts sire's ability to transmit birth weight to his progeny compared to that of other sires (in lb).
Milk EPD	milkepd	Predicts difference in weaning weight (lb) of the sire's daughters' progeny due to milking ability.
Marbling EPD	marbepd	Predicts differences in average USDA marbling scores between different sire's progeny.
Ribeye Area EPD	ribepd	Predicts differences in ribeye area between different sire's progeny.
Fat EPD	ftepd	Predicts the difference in fat thickness between the 12th and 13th ribs between different sire's progeny.
Weight	wt	Weight of bull (lb).
Frame Score	frame	Hip height at 365 days converted to 1–9 scale.
Age	age	Age of the bull measured in days.
Scrotal Circumference	scrir	Circumference of scrotum (cm).
Ribeye Area	rea	A measurement of the total muscle in the carcass (%).
Intramuscular Fat	imfat	An indicator used when determining USDA marbling scores (%).
Fat	fat	Thickness between the 12th and 13th ribs.
Sale order	order	The order in which the bull was sold
Time	time	The year the sale occurred (1, . . . ,9)

deviations, which is helpful for making relative comparison of impact across the independent variables. This approach is commonly done for hedonic animal pricing models since independent variables are in different units. We standardized regression coefficients by subtracting the mean from the observed value and dividing that by the standard deviation. This is the same transformation followed by others (Brimlow and Doyle, 2014; Kessler, Pendell, and Enns, 2017; Lewis et al., 2016; Mark, Schroeder, and Jones, 2000; McDonald et al., 2010). Therefore, the coefficients are interpreted as a one-unit standard deviation would result in a change in the standard deviation of the bull sale prices by the value of the coefficient.

Heteroscedasticity is a frequent problem for estimating cattle hedonic pricing models (Jones et al., 2008; Kessler, Pendell, and Enns, 2017). The likelihood ratio test was used to determine if heteroscedasticity was present from year and actual weight. If heteroscedasticity was present, we corrected it using multiplicative heteroscedasticity in the variance equation (Wooldridge, 2013). Additionally, multicollinearity is an issue in hedonic pricing models for bulls (Boyer et al., 2019; Brimlow and Doyle, 2014; Kessler, Pendell, and Enns, 2017; Vanek et al., 2008). Failing to correct for this issue can result in flawed conclusions. Person correlation coefficients were estimated for all variables. As anticipated, birth weight EPD and calving ease direct EPD were highly correlated. Therefore, we dropped calving ease direct EPD and included birthweight EPD in the model. Additionally, this study includes weaned calf value index, which is an index that expresses in dollar per head of predicted profitability differences in progeny due to genetics from birth to weaning. This value is highly correlated with weaning weight EPD. Therefore, we drop

Table 2. Summary statistics of independent and dependent variables

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
Dependent Variable					
price	500	3383	1160.12	1250	8250
Expected Progeny Difference					
getest	500	0.53	0.50	0	1
dollw	500	50.58	17.77	0.28	98
birthepd	500	1.54	1.34	−2.1	4.8
milkepd	500	26.74	5.47	2	47
marbepd	500	0.49	0.27	−0.30	1.25
ribepd	500	0.50	0.28	−0.80	1.36
ftepd	500	0.00	0.03	−0.10	0.40
Phenotypic Traits					
wt	500	1403	127.57	1088	1802
frame	500	5.75	0.54	4.80	8.00
age	500	433	29.12	348	501
scrir	500	37.47	2.27	31.80	44.50
rea	500	12.84	1.36	0.13	17
imfat	500	0.28	0.76	0.01	4.81
fat	500	0.26	0.09	0.10	0.95

weaning weight EPD to contribute to the literature by analyzing weaned calf value index.[1] These models were estimated using maximum likelihood with the MIXED procedure in SAS 9.4 (SAS Institute, 2013).

Hypotheses for Variable Sign

We hypothesize that bull sale price will increase as weaned calf value EPD increases. We base this hypothesis on the weaned calf value index indicates higher profit potential per offspring. Previous studies have shown that weaning weight EPD positively correlated the sale price of bulls (Chvosta, Rucker, and Watts, 2001; Dhuyvetter et al., 1996). However, no study has explored the impact of the weaned calf value economic selection index on bull sale price.

Studies have shown that an increase in birthweight EPD can decrease the price of bulls (Brimlow and Doyle, 2014; Jones et al., 2008; Vestal et al., 2013). Likely, a producer selecting sires to be used on all females or exclusively virgin heifers will desire a bull with a lower birth weight for calving ease. Calving ease direct EPD is highly correlated with birthweight EPD, as calves with smaller birth weights are less likely to have calving complications. As mentioned above, we chose to use birthweight EPD in our analysis due to this correlation. Studies have used either calving ease direct EPD (Boyer et al., 2019), but it is more common in the literature to see birth weight EPD (Brimlow and Doyle, 2014; Kessler, Pendell, and Enns, 2017; Tang et al., 2020, 2022). We follow

[1]The results have the same interpretation if calving ease direct EPD replaces birth weight EPD. Also, the results are the same for weaned calf value and weaning weight EPD.

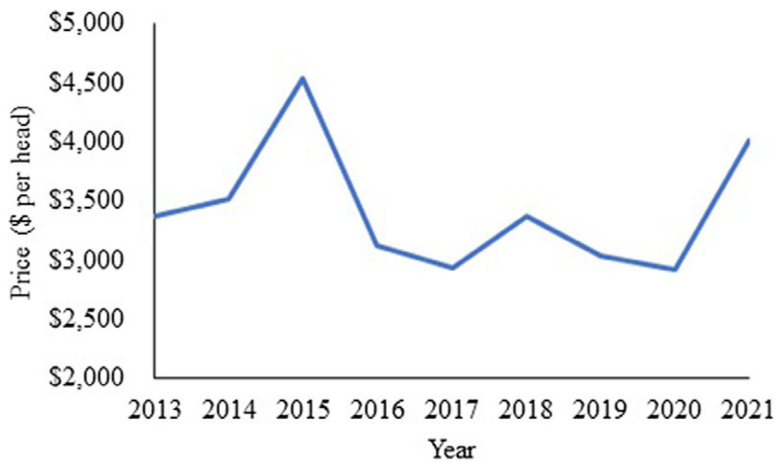

Figure 1. Average annual sale price of angus bulls sold from 2013 to 2021 in the University of Tennessee's Middle Tennessee Research and Education Center Bull Sale.

these studies and hypothesize that an increase in birth weight EPD is correlated with decreased sale price.

An increase in milk EPD has also been reported to increase bull sale price (Boyer et al., 2019; Jones et al., 2008; Vestal et al., 2013); however, Kessler, Pendell, and Enns (2017) found the converse to be true. Milk production also requires a higher nutritional demand, which can increase feed costs for a sire's daughters. A moderate milk EPD is ideal, but the optimum will rely on an operation's environment and management. Marbling, ribeye, and fat thickness EPD were hypothesized to be insignificant based on previous work (Tang et al., 2020, 2022).

For the phenotypic traits, studies have reported that higher sale weights tended to increase a bull's sale price (Boyer et al., 2019; Brimlow and Doyle, 2014; Kessler, Pendell, and Enns, 2017). The expected impact of frame score is unclear since studies commonly find this trait to be insignificant factors for influencing the price of a bull (Kessler, Pendell, and Enns, 2017; Vestal et al., 2013). Scrotal circumference is an estimate of reproductive performance and is sometimes found to be positive (Tang et al., 2020). This is important to many producers since reproductive failure can result in substantial economic losses (Boyer, Griffith, and DeLong, 2020).

Results

Table 3 shows the parameter estimates for the hedonic pricing model. The model was estimated with five hundred observations. Heteroscedasticity was also detected in the data across years and sale weight. Therefore, results are estimated using multiplicative heteroscedasticity in the variance equation. The values of all the coefficients were consistent with their expected sign. The table also shows the standardized regression results.

The binary variable for GE-EPD was insignificant, but the interactions with weaned calf value and birth weight EPD were significant (Table 3). The interactions were used to see if having a GE-EPD had significant price effects given the bulls EPD data. These results indicate that a genomic test does not impact the overall sale price of the bull, even though the EPD accuracies are improved with this test. This could indicate a need to provide additional producer education on the role and value of GE-EPDs and accuracy in making selection decisions. Boyer et al. (2019) and Tang et al. (2020) showed that EPD values changed over time with the values being low in early years of use but increasing in value over time. More targeted education on GE-EPDs

Table 3. Estimated parameters for the bull hedonic pricing model with standardized independent variables ($n = 500$)

Variable	Log-Level Model		Standardized Coefficient Model	
	Parameter Estimate	Standard Errors	Parameter Estimate	Standard Errors
Intercept	10.2559***	1.7274	3090.54***	247.85
getest	−0.1153	0.1377	−90.17	169.82
dollw	0.0012	0.0014	1.85	82.79
birthepd	−0.0823***	0.0097	−368.73***	44.30
milkepd	0.0010	0.0027	43.95	49.83
marbepd	−0.0017	0.0048	−14.11	51.56
ribepd	0.1077**	0.0513	146.51***	46.07
ftepd	−0.7624	0.7687	−90.91	85.69
getest × dollw	0.0055***	0.0020	305.11***	113.77
getest × birthepd	0.0281*	0.0149	196.28**	62.81
getest × milkepd	−0.0068	0.0040	−87.89	70.16
getest × marbepd	−0.0080	0.0129	−54.49	107.50
getest × ribepd	−0.0619	0.0821	−81.62	69.69
getest × ftepd	0.7080	0.8454	82.28	92.19
wt	0.0017***	0.0001	657.45***	54.64
frame	0.0818***	0.0225	149.91***	39.69
age	−0.0229***	0.0081	−1371.42***	323.06
age squared	0.0000**	0.0000	2101.03**	925.63
scrir	0.0094**	0.0044	55.60*	31.95
rea	0.0193**	0.0077	71.26**	33.40
imfat	0.0509**	0.0256	138.87**	62.89
fat	−0.1742	0.1197	−19.75	34.94
time	0.2178***	0.0640	612.53***	204.53
time squared	−0.0772***	0.0179	−208.17***	56.47
time cubed	0.0060***	0.0013	16.00***	4.16
order	0.0000	0.0003	−0.26	0.98
−2 Log likelihood	−145.4		7689.4	

Note: Significance 90%*; 95%**; 99%***.

will help producers feel more confident in realizing the value of this test. However, the GE-test did impact how producers value specific EPDs.

A one-unit increase in birth weight EPD results in the bull sale price decreasing by $278 per head. This finding was expected since studies have reported lower birthweight EPDs tend to increase the price of bulls (Brimlow and Doyle, 2014; Jones et al., 2008; Vestal et al., 2013) and birthweight EPD. However, if the bull had a GE-test, the one-unit change in birth weight EPD resulted in sale price declining only $7.82 per head. This is an interesting finding for several reason but will need future research to understand more clearly. The higher accuracies of

Table 4. Dollar value of unit and standard deviation changes of statistically significant variables in the model ($n = 500$)

Variable	Dollar Value	Dollar Value
birthepd	One-pound increase in expected progeny's birth weight	−$278.38
ribepd	One-pound increase in expected progeny's ribeye area	$364.35
getest × dollw	One-unit increase in the weaned calf value index with a GE-test	$18.63
getest × birthepd	One-pound increase in expected progeny's birth weight with a GE-test	$7.82
wt	One-pound increase in weight	$5.59
Frame	One-unit increase in frame score (1–9 scale)	$276.69
rea	One-unit increase in ribeye area	$65.36
imfat	One-unit increase in ribeye area	$172.06

GE-EPDs lower the impact of the one-unit change in price, suggesting the more producers overvalue the impact of birthweight EPD with less accurate information. Birth weight EPD is a predictor of weaning weight EPD, thus, buying a low-birthweight EPD bull will likely mean weaning weights will be lower. Having more accurate birth weight measurements for progeny might give producers more confidence in purchasing a bull with higher calf birth weights (i.e., more pounds to sale) without exceeding a birth weight threshold for their cows.

Weaned calf value was found to be insignificant with GE-test but positive if the bull had GE-EPDs, indicating an increase in weaned calf value the sale price increases. To our knowledge, this is the first study that presents an estimate of the economic value for this selection index. A one-unit increase in this index, if the bull has GE-EPDs, results in the bull sale price increasing $18.63 per head (Table 4). Our results indicate that bull buyers in this sale do take this EPD into account when purchasing if the bull has GE-EPDs. In addition to weaned calf value EPDs, the American Angus Association also reports multitrait economic selection indexes that predict differences in profitability between sires in certain production scenarios (i.e., terminal, maternal, or both) (American Angus Association, 2022). Little is known about how producers utilize and value these EPDs, and more education on the value of this and other selection indices could improve the selection pressure multiple profit-influencing traits at once.

Ribeye area EPD is the only other EPD that was significant and positively impacted prices. A one-unit change in ribeye area EPD resulted in a $364.35 per head price increase of bulls. A one-unit change would be unlikely for this EPD, and our data range was between −0.8 and 1.36. Thus, for example, a 0.1 unit change in ribeye area results in a per head price increase of $6.5. These estimates in similar ranges of other findings (Tang et al., 2020, 2022). Milk EPD was insignificant as expected given previous studies have shown mixed results, which differs from Boyer et al.'s (2019).

Phenotypic traits that were significant price determinants included weight, frame score, age, and ribeye area (Table 3). Our results are like what others have observed for phenotypic traits (Boyer et al., 2019; Brimlow and Doyle, 2014; Kessler, Pendell, and Enns, 2017; Tang et al., 2020). Sale weight and frame score positively impacted price (Table 3). A one-pound increase in sale weight increased the sale price $5.59 per head (Table 4). A one-unit increase frame score increased price by $277 per head (Table 4). A whole one-unit increase is unlikely, but a 0.1-unit increase would result in a bull sale price increase of $29 per head (Table 4). We also found that a one-unit increase in ribeye area increases price by $65.61 on average (Table 4). Scrotal circumference was significant (Table 3), and a one-unit change resulted in prices increasing $31 per head. These findings suggest that producers have a higher value for larger and more mature bulls, which is consistent with findings from previous studies (Brimlow and Doyle, 2014; Kessler, Pendell, and Enns, 2017).

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The standardized coefficients allow for a relative comparison of impact in price. While weight and age had the largest impact on bull sale price, birth weight EPD had the next largest impact followed by weaned calf value from a bull with a GE-EPDs. These EPD values were ranked above several other phenotypic traits.

Conclusions

Data were collected from the University of Tennessee's Middle Tennessee Research and Education Center bull sale catalog, from years 2013 to 2021, to estimate the impact of specific phenotypic traits and EPDs of the angus bulls sold. We were specifically interested in determining how GE-EPDs impact bull sale prices. A log-level hedonic pricing model was specified and estimated with GE-EPD, EPDs, interactions of GE-EPD and EPDs, and with phenotypic traits.

Genomics provide an inherent benefit to producers by increasing the accuracy of genetic predictions, but their adoption in the industry has been slow. The two unique contributions of this paper are including weaned calf value and GE-EPDs in a bull hedonic pricing model. The results will inform need educational program to bull purchasers on using the newer weaned calf value index and GE-EPDs.

The major findings included the significance of birth weight EPD, ribeye area EPD, weight, frame score, age, and ribeye area in determining bull sale prices. The expected signs match what was estimated. However, GE-EPDs were insignificant, indicating producers are not valuing these test results. The weaned calf value was significant if the bull had GE-EPDs. This study contains key insights not only for producers but also for future studies. Either scenario assumes that the producers want to utilize the information to make a better decision for them, but they cannot do so perfectly. Our research and previous studies suggest that research should be done to understand why GE-EPD technology is not adopted and utilized more by producers. For example, using experimental methods to evaluate how producers value GE-EPDs with and without education could provide insight into how these values could be valued with educational efforts. Additionally, new indexes and EPDs are frequently being introduced. It could be interesting to estimate values of new EPDs for traits like foot score and hair scores.

Data availability statement. The data that support the findings of this study are available on request from the corresponding author, C.N.B. The data are not publicly available due to these data coming from a bull test that producers pay to use.

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