ESTIMATING THE ECONOMIC VALUES ASSOCIATED WITH EPDS FOR ANGUS BULLS AT AUCTION

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Abstract

The genetic traits that an Angus bull possesses convey the reproductive and economic value of the animal to potential buyers. This paper examines and draws comparisons between the value of actual production weights and production EPDs, while also establishing values for ultrasound EPDs. Results indicate that only one EPD, birth weight, was valued by buyers more than its corresponding actual weight, though actual weights and EPDs significantly impacted price. Ultrasound EPDs were also found to be significant, suggesting buyers of Angus bulls consider carcass information when purchasing bulls.

Key Words: Angus Bulls, Birth Weight, Carcass, EPDs, Hedonic Model.

Introduction

The purebred cattle industry has undergone a period of significant informational change in the last twenty years. The development and use of expected progeny differences (EPDs) has been a primary component of this change. EPDs are complex statistical estimates of performance for a given animal's progeny (Beef Improvement Federation, 2002). Since their introduction in the 1980's, EPDs have been increasingly accepted and used by purebred producers selling breeding stock. However, the impact EPDs have had in the market place and on commercial cattle producers is less clear. Research in this field has demonstrated that some EPDs, specifically birth weight, are valued by producers when they purchase bulls; however the magnitudes for these EPDs were shown to be smaller than the values of the actual underlying phenotypic measures (Chvosta, Rucker, and Watts, 2001).

Value-based marketing has increased the use of genetic estimation for carcass traits by many cow/calf producers. Likewise, premiums for choice and prime graded carcasses have enticed cattle feeders to utilize technology to identify animals possessing these traits. Research has supported this, revealing that producers desire measurements which provide reasonable expectations as to the carcass quality of an animal (Greer and Trapp 2000; Schroeder and Graff, 2000). Thus, the need for more accurate carcass-related information has become increasingly important to producers in recent years.

Purebred bulls are primarily bought and sold at private auctions, where buyers assign a value for an animal based on both its observed physical characteristics and on information that is disseminated to the buyer through the seller. Physical characteristics for an animal include conformation and frame scores, structural soundness, and other valuations of the animal's observable qualities. Information that is provided through the seller often includes actual or adjusted animal weights, EPDs, and ultrasound scan data as well as some information pertaining to the pedigree of the bull. Physically observed traits, as well as an animal's various weights, have been used as evaluation techniques since the inception of purebred bull sales, EPDs however, are a relatively new tool available to producers. It is important to recognize that both actual weights (birth, weaning, and yearling) and EPDs are viewed by buyers as measures of expected performance of a bull's future offspring. From a statistical standpoint EPDs would appear to be a better predictor. However, the relevant question is which of the two do buyers place more faith in?

Objectives of this study are to re-examine the role of performance EPDs in determining value for purebred Angus bulls. Specific consideration will be given to carcass and ultrasound EPDs, in an attempt to define their role in breeding stock selection. These aspects, along with other measures, such as actual weights, ultrasound scores, regional issues, and marketing factors will be examined as they pertain to the value of purebred Angus bulls.

Literature Review

Dhuyvetter et al. (1996) provided the first examination of EPDs as a determinant of a bull's value. Using a hedonic model, they studied data collected from twenty-six multi-breed Kansas bull sales during the spring of 1993. Their model was presented as:

(1) Bull Price = *f*(Physical and Genetic Characteristics, Expected Performance Characteristics, Marketing Factors).

Physical and genetic characteristics included factors such as breed, color, age, and a visual evaluation of the animal. Expected performance characteristics refer to weights and EPDs, and marketing factors represent various techniques used to market bulls, such as semen retention and the inclusion of a bull's picture in the sale catalog.[1]

Models including and excluding EPDs were estimated. Results showed, that in Angus bulls, both EPDs and actual weights were significant, as well as age, sale order, pictures, and semen retention. The R^2 for the model excluding EPDs was 0.69. This increased to 0.72 when EPDs were added. Dhuyvetter et al. were able to compare the value of actual weights with EPDs, but their findings left questions of the relative value of EPDs largely unanswered. Although they concluded that EPDs are valued slightly more than actual weights, the R^2's for the two models showed little change.

Following Dhuyvetter et al., Chvosta, Rucker, and Watts examined EPDs by using a hedonic modeling technique to measure and compare values for EPDs and simple performance measures (SPM's), i.e., physically observed traits, for purebred Angus bulls.[2] Data were collected from animals raised on a single Montana ranch from 1982 – 1997 and for bulls sold on eleven ranches in South Dakota and Nebraska from 1986 – 1996. The model they estimated was

(2) Bull Price = *f*(Beef Price, Feed Price, Age, Performance Measures),

where beef price is the average of the September feeder cattle futures contract for the first five days of March, feed price is the average of the September corn contract for the first

[1] Dhuyvetter et al. did not include yearling weight or yearling weight EPDs in their evaluation. They contended these variables are highly correlated with weaning weight and its corresponding EPD, both of which were included in their evaluation.
[2] The Dhuyvetter et al. and Chvosta, Rucker, and Watts studies were the only ones found estimating the value of production EPDs in purebred bull auctions.

five days of March, age is the age of the animal, measured in days, from birth to January 1st of the year of the auction, and performance measures are a vector of indicators of future performance, including EPDs, SPM's, and herd averages for EPDs and SPM's. Dummy variables for eighteen separate sires and each breeder were also included.

Models including both EPDs and SPM's together and separately were estimated using OLS for both sets of data. Variables which were significant in explaining price included 205-day weight, 365-day weight, birth and yearling weight EPDs, and age and age squared. The R^2 value for the model including both EPDs and SPM's was 0.40. For the model using only SPM's, the R^2 was 0.37, this value dropped to 0.25 for the model that contained only the EPDs. Based on their results, Chvosta, Rucker, and Watts concluded that, although both EPDs and SPM's are significant in explaining price, SPM's hold more economic information with respect to price. This was shown despite the fact that EPDs contain a superior amount of genetic information.

Walburger (2002) examined the relationship between price and attributes of bulls sold in Alberta, Canada. Data on price, birth and sale weight, average daily gain (ADG), backfat, scrotal circumference, ribeye area, and lean meat yield were collected on nearly 800 bulls of various breeds sold at a single bull test auction in 1989, 1993, and from 1996-2000.[3] A Tobit regression model was used and tests for structural change were conducted. Results of these tests showed three structurally distinct time periods, 1989 and 1993, 1996-1997, and 1998-2000. Birth weight, sale weight and scrotal circumference were significant in all three periods. Ribeye area and backfat were significant in the last time period. Walburger interpreted this as a sign of producer adoption of genetic

[3] This is the only study found that examined the relationship of bull price and carcass characteristics. No study to date that the authors are aware of has related price to ultrasound or carcass EPDs.

technology. The R^2 for 1989 and 1993 was considerably higher, 0.49, than the other two periods, 0.32 and 0.33, respectively.

Data

Data for this study were collected over a four month period from purebred Angus producers across the Midwest, Rocky Mountain, and Northwest regions of the U.S. Producers were contacted by phone, written correspondence, and email requesting sale catalogs and price data from their most recent production sale. Data were collected on 8285 bulls from sixty sales in an eleven state region.

Upon receiving the requested information, data were recorded for each sale. Variables gathered from this process included prices, registration numbers, and various marketing factors specific to each sale. Data relating to actual weights and EPDs were not recorded at this time, although animals found to have incomplete production records were noted for each sale.

The collection of all actual weights, EPDs, and pedigrees was done in cooperation with the American Angus Association (AAA). Registration numbers for each bull were given to AAA, who then generated a database with all relevant genetic information for each bull. This database was then combined with the existing record of prices and marketing factors to create a complete summary of variables for each observation. Summary statistics for price, actual weights, EPDs, and marketing factors are presented in Table 1.

It is important to note that AAA has access to, and provided more information for some bulls than what was reported to buyers at the time of sale. Although AAA encourages breeders to provide as much information to buyers as possible, there is not a standard reporting system followed by every producer. No two sales in this study reported exactly the same number or types of variables in their sale catalogs. These discrepancies were noted and are accounted for in the forthcoming models, but at first glance may appear misleading. An example of this problem appears in Table 1. Even though AAA provided over 7000 observations on adjusted yearling weight, the actual number of observations reported by breeders was far lower. In order to avoid creating models that included information that was unavailable to buyers, tables detailing variables used at each specific sale were generated. Based on these tables, models were then specified using only data that were available to buyers at the time of the sale (i.e., data reported in the sale catalog).

Methodology

The focus of this study is to update and extend the volume of research that has explored the use of EPDs in purebred bull auctions. Given the parallels between this study and previous ones, specifically Chvosta, Rucker, and Watts and Dhuyvetter et al., a similar modeling approach is logical.

Similar to the two previous studies, the data used here describes two different types of genetic measurements, actual production measures and EPDs. Data relating to marketing factors were also collected, as well as information regarding a bull's sire and the identification of the state and sale where each bull was sold, to create a conceptual model that can be specified as

(3) Bull Price = (Actual Production Measures, Production EPDs, Ultrasound EPDs, Marketing Factors, Sire, Sales).

Actual production measures include age, birth weight, and adjusted weaning and yearling weights; ultrasound scans include adjusted intramuscular fat, ribeye area, and 12th rib fat thickness. Production EPDs include birth, weaning, milk, and yearling weights and Ultrasound EPDs include intramuscular fat, ribeye area, fat thickness, and percent retail product. The marketing factors recorded from each sale are sale order, semen retention, season of the sale (fall versus spring), picture, embryo transfer, pathfinder dam, and the inclusion of full brothers and females in the sale. Sire is a series of dummy variables used to capture bulls who are the progeny of highly ranked Angus sires. States/sales are dummy variables used to identify bulls sold in a particular state or sale. A hedonic modeling approach, using OLS regression, is applied to the data to obtain estimates for each of the variables presented in the conceptual model above. Following Dhuyvetter et al. the dependent variable, price, was transformed to log form.

Results

A model including both actual performance measures (birth, adjusted weaning and adjusted yearling weights) and their corresponding EPDs was developed to examine their effect on price. The results of estimating this model are presented in Table 2 and summary statistics for variables included in the model are given in Table 3. The three actual performance measures were all significant and exhibited the expected signs. Reasoning for this follows closely with their related EPDs. As birth weight increases, it is expected that calving difficulties will increase, which will increase costs. Buyers are likely to pay less for higher birth weights because of these considerations. Adjusted weaning and yearling weights provide buyers with a measure of a bull's ability to add additional pounds of gain. This is desirable because it provides a picture of the expected performance of a bull's progeny.

Comparing the coefficients for the EPDs and actual weights reveals larger values for the EPDs relative to the related actual weights. However this comparison is not appropriate because of varying units involved. Elasticities provide a unit less comparison between the two genetic measures and offer a measurement which is readily comparable across variables. The elasticities for the actual weights are greater than the elasticities for the EPDs. The results from the comparison of elasticities are similar to those reached by Chvosta, Rucker, and Watts and possibly provide further confirmation that actual weights receive a higher value from buyers relative to EPDs.

However, a problem with the elasticities is that they only show the effect of the variable at a certain point, here being the mean. This technique ignores the true behavior of most variables by assuming that a 1% change in all variables occurs with equal likelihood. Therefore, it is more reasonable to examine the effect a variable has on price across a standardized range of likely percentage changes. This allows the effects of a variable to be seen at many points while still providing a means for comparison between variables of differing units.

In order to compare the relative value of EPDs versus actual weights premiums were calculated, in log form, by multiplying the parameter estimates for the continuous variables by their mean value. These values were held constant and the variable of interest (e.g. *birthwt* or *birthepd*) was allowed to change across two standard deviations above and below the mean of the variable. The calculated premiums were then transformed from log to linear form, as suggested by Miller (1984). However, because high statistical correlations exist between variables, such as *birthepd* and *birthwt*, an additional step must be taken in the calculation of premiums.

When calculating premiums for a variable, such as *birthwt*, all other continuous variables are held constant at their mean, except *birthepd*. This is done because as *birthwt* moves away from its mean, it is unlikely that *birthepd* will remain at its mean. To account for this, relationships between related variables were estimated using OLS. This relationship was found by regressing *birthepd* on *birthwt* and vice versa, and was also applied to both *yearepd* and *adjyearwt*. These estimated relationships were then used in the calculation of each variable's premium. As an example, when calculating premiums for *birthwt* across a range of +/- two standard deviations of birth weight, the mean value for *birthepd* is replaced by the estimated regression equation (which is a function of birth weight) to more accurately reflect the true relationship between price and birth weight as *birthwt* changes over the two standard deviation range.

Figure 1 depicts the comparison of the premiums for *birthwt* and *birthepd*. Here it is seen that *birthepd* has slightly larger premiums associated with it, relative to *birthwt*, across the range of data. Based on this, it can be argued that *birthepd* is the more significant genetic measure, despite the higher elasticity of *birthwt*.

The same argument cannot be made for *yearepd*, however. Figure 2 shows that *adjyearwt* has larger premiums relative to *yearepd* across two standard deviations when the relationship between these two variables is accounted for. Thus, while buyers may pay higher premiums for the genetic information in *birthepd* relative to *birthwt*, it appears they are unwilling to do so for *yearepd*.

Reasons for the difference in these results are not entirely clear. A possible explanation may lie in the accuracy of the EPDs at the time of sale. Bulls are typically sold at one year of age or older. Buyers may believe that the *yearepd* values for yearling bulls are in fact unreliable. Because *yearepd* is based solely on records of related animals (parents, grandparents, and siblings), they may believe that the possible variation in the EPD is quite large and thus place more confidence in the actual weight. Table 4 shows expected changes in value for EPDs over a two standard deviation range as the accuracy of the EPDs increases. The expected accuracy value for *yearepd* on a year old bull would likely be 0.05. At this level, the possible range of change for this variable would be +/- 16.17 pounds from the current value of the EPD. This represents a large change and gives cause for buyers paying larger premiums for *adjyearwt*.

However a similar argument can also be made for *birthepd* with the exception that a yearling bull's own birth weight may be factored in to its birth weight EPD. The accuracy value for *birthepd* on a yearling bull is also likely to be near 0.05. If buyers place less confidence in *yearepd* because of a low accuracy value, it would stand to reason they would behave in a similar manner when faced with a low accuracy value for *birthepd*. Thus it is interesting that the premiums for *birthepd* and *birthwt* do not follow with those found for *yearepd* and *adjyearwt*. The reasoning for this may lie not in the accuracy value associated with *birthepd*, but instead in the buyer's confidence in the value reported for *birthwt*. Because this is an unobservable trait, (i.e., the buyer is unable to observe the weight of the bull at birth where as they can observe the yearling weight) buyers may be less likely to trust it and thus place more confidence in the value given for *birthepd*, even though it may vary considerably as the age of the bull increases.

A second model including carcass ultrasound EPDs was developed to examine the value buyers place on carcass quality.[4] The results of this model are presented in Table 5, with summary statistics of model variables reported in Table 6. Each of the ultrasound EPDs in this model were significant, indicating that buyers value the information they provide. The variables *uimfepd* and *uribepd* were positive, indicating that additional units of intramuscular fat and ribeye increased the price paid for a bull. The coefficient for *ufatepd* was negative implying that increases in fat thickness decreased value. The sign for *uprpepd* was expected to be positive, given that a bull's ability to sire progeny which yield greater quantities of retail product would be desirable to a buyer, however the estimated coefficient was negative. Reasoning for the negative nature of this variable is unknown. One possible explanation is that buyers are disconnected from the retail end of the cattle they produce and are thus not concerned with increasing retail product. However, if this were true, it is likely that *uprpepd* would be insignificant instead of negative.

Due to the small magnitude and variability of each of these variables, large parameter estimates were predicted by the model. However, elasticities for each variable provide a much clearer picture of the effect of changes in the variable on price. This is evident by the elasticity for *ufatepd*. The large parameter estimate, -3.758, for this variable is reduced to an elasticity measure of -0.015.

Based on elasticities, the variable *uribepd* is found to have the greatest effect on price among the ultrasound EPDs, although its effects are much smaller than any of the actual measures or production EPDs. This shows that the ultrasound EPDs provide

[4] Additional models were estimated using other carcass-related information (i.e., carcass EPDs, ultrasound scans) but these models did not perform as well based on in-sample accuracy measures (Turner).

additional information to buyers, but do not appear to be as important as other factors used in making purchasing decisions. This result is consistent with arguments that producers are more concerned with producing pounds of beef and less concerned with improving the carcass quality of their animals.

Figure 3 compares the premiums received for *uribepd*, *birthepd*, and *adjyearwt*. The results indicate that the premiums recieved for *uribepd* are considerably higher than those received by *birthepd* or *adjyearwt* at sales which report all three measures. This contradicts the earlier conclusion, derived from the elasticities, but again provides a more reasonable examination of the effects of the variables. Based on the findings in Figure 3, the inclusion of ultrasound EPDs should be considered by sales which failed to report them, given the high premiums received for bulls possessing large ultrasound ribeye EPDs.

Variables pertaining to various market factors were also included in the models. These factors were shown to be as significant in determining value as genetic measures and indicate that bulls that are aggressively marketed will likely bring premiums relative to bulls not benefiting from marketing. Additional variables used to describe the sire of the bull and sale at which he was sold, showed varying levels of significance as well. The significance of the sire variables indicates that buyers believe additional information, not contained in the bull genetic record, is captured by the bull's sire. Significance of several sale variables lends to the reputations of breeders and suggests that buyers recognize and are willing to pay premiums or discounts for comparable animals sold at different sales.

Conclusion

The two primary objectives of this study were to re-examine the economic values of production EPDs and how they relate to the values assigned to actual weights and to assess the impact that ultrasound EPDs have on Angus bull prices.

The results of this research, with regards to the first objective are mixed. Though the elasticities associated with actual weights were consistently higher than those associated with their corresponding production EPDs, the predicted premiums/discounts for *birthepd* were found to be greater than those associated with *birthwt*. These results indicate that buyers consider *birthepd* more important than its related actual measure when selecting bulls. These results did not hold true for the remaining production EPDs however, and indicate the continued importance of actual measures in bull selection.

This study also examined the value of carcass quality measures. All four ultrasound EPDs were highly significant, with three out of the four exhibiting the expected sign. Comparisons between premiums/discounts associated with ultrasound and production EPDs and actual weights showed one ultrasound EPD, *uribepd*, to have significantly larger price responses than either *birthepd* or *adjyearwt*. This finding is significant because it suggests that buyers understand and place a high value on ultrasound data when making purchasing decision. Based on this finding, breeders that currently fail to report this data should consider its inclusion in future production sales.

Marketing factors were also examined in this study. These factors were found to bring added premiums/discounts in addition to those received for actual weights and EPDs. The significance of the sire variables suggests that the pedigree of the bull is important to buyers. Several sale variables were also found significant and may point to buyers considering the reputation of the breeder when purchasing a bull. Other variables pertaining to the inclusion of a picture, the order of the sale, and the retention of semen rights were also significant.

The results of this study allow for the estimation of bull prices. It is important to note however, that other considerations, such as physical appearance and structural soundness, are often used by buyers to determine price and that these factors are not included in our models. These subjective measures may be as important to buyers as the genetic information contained in EPDs and actual weights and at times are certainly significant in determining value. This does not imply that the exclusion of this information damages the results of this study. The large sample sizes used in the models provide enough variation among the observations to prevent biased estimates.

This study has continued the examination of the value of EPDs, but should not be considered an end point for research in this field. Additional studies are needed to further explore the role of carcass measures as a component of a bull’s value. The groundwork laid here suggests their importance to buyers, but is unable to accurately draw comparisons between measures. Finding an economically significant means of conveying a bull’s genetic carcass potential will further the cattle industry’s drive to improve carcass quality.

As a final note, more interest should be given to breeding stock issues, such as differences between live auctions and private treaty sales of bulls and markets for purebred females. These fields have yet to be examined by economists and should be considered for future research. Gaining an economic understanding of purebred cattle markets will benefit not only purebred producers, but the industry as a whole.

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Table 1 – Summary Statistics

Variable	N	Mean	Std Dev	Minimum	Maximum
price	8285	2564.8100	1908.1000	875.000	51500.000
Production Measures					
age	8285	447.211	124.726	98.000	1829.000
age^2	8285	215552.320	144818.150	9604.000	3345241.000
birthwt	7986	83.470	9.894	40.000	124.000
adjweanwt	8063	659.967	71.860	378.000	988.000
adjyearwt	7380	1168.310	113.814	636.000	1742.000
adjpctimf	7255	3.706	0.859	0.810	10.450
adjribeye	7243	12.368	1.569	6.500	18.800
adjribfat	7259	0.269	0.100	0.010	0.770
EPDs					
birthepd	8227	2.553	1.562	-3.800	9.600
weanepd	8253	38.256	6.688	11.000	71.000
milkepd	8253	20.284	4.622	0.000	36.000
yearepd	8252	72.592	11.358	19.000	125.000
cwtepd	4575	5.185	6.327	-16.000	30.000
marbepd	4575	0.182	0.121	-0.130	0.750
ribepd	4575	0.129	0.127	-0.350	0.590
fatepd	4575	0.002	0.015	-0.045	0.054
prpepd	4575	0.059	0.242	-0.870	0.770
uimfepd	7814	0.065	0.135	-0.400	0.740
uribepd	7814	0.123	0.212	-0.620	1.000
ufatepd	7814	0.004	0.015	-0.059	0.064
uprpepd	7814	0.020	0.279	-0.960	1.200
Marketing Factors					
saleorder	8285	0.501	0.289	0	1
sementhird	8285	0.197	0.398	0	1
semenhalf	8285	0.078	0.267	0	1
seasonofsale	8285	0.771	0.421	0	1
picture	8285	0.108	0.311	0	1
et	8285	0.214	0.410	0	1
fullbrother	8285	0.101	0.301	0	1
pathfinder	8285	0.058	0.234	0	1
femaleinsale	8285	0.456	0.498	0	1

Table 2 - Regression Results for Actual Weights & Production EPD's by Sale

Variable	Parameter Estimate	Standard Error	t-statistic	P-value	Marginal Effect at Average Price	Discrete Variable Shifts	Elasticities at Variable Averages
Intercept	4.824690	0.240200	20.09	0.0000			
Production Measures							
*age****	0.003220	0.000443	7.28	0.0000	8.61		1.44
*age2****	-0.000002	0.000000	-4.76	0.0000			
*birthwt****	-0.001810	0.000700	-2.59	0.0100	-4.84		-0.15
*adjweanwt****	0.000588	0.000124	4.75	0.0000	1.57		0.39
*adjyearwt****	0.001330	0.000098	13.57	0.0000	3.56		1.59
EPDs							
*birthepd****	-0.052010	0.005043	-10.31	0.0000	-139.06		-0.13
weanepd	0.000048	0.001622	0.03	0.9760	0.13		0.00
*milkepd****	0.004490	0.001234	3.64	0.0000	12.00		0.09
*yearepd****	0.005110	0.000998	5.12	0.0000	13.66		0.38
Marketing Factors							
*saleorder****	-0.345070	0.019870	-17.37	0.0000	-922.60		-0.16
*picture****	0.226080	0.020790	10.88	0.0000		989.25	
*et***	0.045310	0.018190	2.49	0.0130		180.76	
*sementhird****	0.163960	0.031120	5.27	0.0000		694.79	
*semenhalf****	0.519760	0.099390	5.23	0.0000		2658.11	
fullbrother	0.011270	0.023210	0.49	0.6270		44.20	
*pathfinder**	0.044420	0.024870	1.79	0.0740		177.13	
*seasonofsale***	-0.266420	0.104600	-2.55	0.0110		-912.07	
Sires							
sr1	0.018420	0.028560	0.64	0.5190		72.50	
sr2	-0.014670	0.027070	-0.54	0.5880		-56.79	
*sr3***	-0.051540	0.023470	-2.20	0.0280		-195.90	
*sr4**	0.051590	0.029210	1.77	0.0770		206.46	
*sr5**	0.072590	0.038750	1.87	0.0610		293.61	
sr6	0.073330	0.047860	1.53	0.1260		296.71	
sr7	-0.009380	0.058940	-0.16	0.8740		-36.41	
*sr8***	0.056620	0.025650	2.21	0.0270		227.17	
*sr9***	0.087860	0.039680	2.21	0.0270		358.13	
sr10	-0.003350	0.035720	-0.09	0.9250		-13.04	
sr11	0.019470	0.040780	0.48	0.6330		76.67	
sr12	-0.004200	0.030680	-0.14	0.8910		-16.34	
*sr13****	0.200030	0.060010	3.33	0.0010		863.54	
*sr14****	0.119590	0.043130	2.77	0.0060		495.39	
*sr15***	0.090250	0.043900	2.06	0.0400		368.32	
sr16	-0.094660	0.113900	-0.83	0.4060		-352.21	
sr17	-0.085420	0.071980	-1.19	0.2350		-319.28	
*sr18****	0.166290	0.041150	4.04	0.0000		705.51	
*sr19****	0.289240	0.042380	6.83	0.0000		1308.00	

Table 2 – Continued

Variable	Parameter Estimate	Standard Error	t-statistic	P-value	Marginal Effect at Average Price	Discrete Variable Shifts	Elasticities at Variable Averages
sr20	0.000708	0.036330	0.02	0.9840		2.76	
sr21	0.016050	0.057230	0.28	0.7790		63.09	
*sr22****	0.167700	0.040670	4.12	0.0000		712.01	
*sr23**	0.063780	0.034550	1.85	0.0650		256.82	
sr24	0.077310	0.057430	1.35	0.1780		313.44	
sr25	-0.013770	0.061070	-0.23	0.8220		-53.33	
Sales							
*sale2****	-0.299080	0.050090	-5.97	0.0000		-1008.07	
sale6	0.018690	0.050590	0.37	0.7120		73.57	
sale7	0.006470	0.048430	0.13	0.8940		25.31	
*sale10****	-0.502890	0.065620	-7.66	0.0000		-1541.23	
*sale11****	-0.289390	0.109800	-2.64	0.0080		-979.91	
*sale12****	-0.292490	0.038960	-7.51	0.0000		-988.95	
*sale13***	-0.256520	0.110100	-2.33	0.0200		-882.34	
*sale15****	-0.353470	0.136100	-2.60	0.0090		-1161.14	
*sale16***	-0.134510	0.056110	-2.40	0.0170		-490.80	
*sale18****	0.190250	0.054960	3.46	0.0010		817.19	
*sale19****	0.162840	0.055410	2.94	0.0030		689.65	
*sale20****	0.305420	0.055740	5.48	0.0000		1392.95	
*sale21****	0.257810	0.047080	5.48	0.0000		1146.87	
*sale22****	0.321280	0.046780	6.87	0.0000		1477.56	
*sale23****	0.202470	0.046370	4.37	0.0000		875.18	
*sale24****	0.184600	0.046570	3.96	0.0000		790.61	
*sale26****	0.160090	0.042750	3.75	0.0000		677.05	
*sale28**	0.108910	0.056110	1.94	0.0520		448.70	
sale29	0.045880	0.044600	1.03	0.3040		183.09	
sale30	-0.021650	0.053200	-0.41	0.6840		-83.52	
*sale34***	-0.099870	0.045830	-2.18	0.0290		-370.64	
*sale36****	-0.352000	0.055990	-6.29	0.0000		-1157.11	
*sale37****	0.140290	0.047200	2.97	0.0030		587.32	
*sale38**	-0.215630	0.120400	-1.79	0.0730		-756.41	
*sale39****	-0.598000	0.118800	-5.03	0.0000		-1755.20	
*sale41****	-0.394050	0.046030	-8.56	0.0000		-1270.05	
*sale42****	-0.349330	0.044880	-7.78	0.0000		-1149.78	
*sale43****	0.263350	0.060250	4.37	0.0000		1174.90	
*sale44****	-0.145100	0.036420	-3.98	0.0000		-526.71	
sale46	0.046980	0.059790	0.79	0.4320		187.58	
sale48	0.018100	0.045950	0.39	0.6940		71.23	
sale49	-0.037320	0.062010	-0.60	0.5470		-142.85	
*sale51****	-0.487100	0.116500	-4.18	0.0000		-1503.69	
*sale52****	0.366290	0.069070	5.30	0.0000		1725.11	
sale53	0.079720	0.049260	1.62	0.1060		323.61	
*sale54***	-0.154150	0.073800	-2.09	0.0370		-557.09	
sale55	0.043340	0.049880	0.87	0.3850		172.73	

Table 2 – Continued

Variable	Parameter Estimate	Standard Error	t-statistic	P-value	Marginal Effect at Average Price	Discrete Variable Shifts	Elasticities at Variable Averages
*sale58****	0.219500	0.046120	4.76	0.0000		957.19	
*sale59****	-0.196740	0.049820	-3.95	0.0000		-696.47	
*sale60****	0.256410	0.046410	5.53	0.0000		1139.81	
R^2	0.6363						
Observations	4150						

***Denotes Significance at the 0.01 level.
**Denotes Significance at the 0.05 level.
*Denotes Significance at the 0.10 level.

Table 3 - Summary Statistics for Model 1

Variable	N	Mean	Std Dev	Minimum	Maximum
price	4151	2673.66	2089.56	950.00	45000.00
age	4151	446.31	108.51	298.00	1107.00
birthwt	4151	83.05	10.14	45.00	120.00
adjweanwt	4151	666.97	72.22	408.00	988.00
adjyearwt	4151	1192.17	104.03	784.00	1676.00
birthepd	4151	2.49	1.51	-2.50	7.80
weanepd	4151	38.53	6.84	11.00	71.00
milkepd	4151	20.48	4.59	5.00	34.00
yearepd	4151	73.44	11.82	19.00	125.00
saleorder	4151	0.46	0.28	0.00	1.00

Table 4 - Changes Associated with EPD Accuracy Values

Accuracy Value	Production EPDs				Carcass EPDs					Ultrasound EPDs			
	Birth	*Wean*	*Milk*	*Year*	*Carcass*	*Marbling*	*Ribeye*	*Fat*	*%Retail*	*%IMF*	*Ribeye*	*Fat*	*%Retail*
0.05	2.73	11.01	9.21	16.17	15.42	0.25	0.27	0.03	0.53	0.18	0.30	0.02	0.35
0.10	2.59	10.43	8.73	15.32	14.61	0.23	0.26	0.03	0.51	0.17	0.29	0.02	0.33
0.15	2.44	9.85	8.24	14.47	13.80	0.22	0.25	0.03	0.48	0.16	0.27	0.02	0.32
0.20	2.30	9.27	7.76	13.62	12.99	0.21	0.23	0.03	0.45	0.15	0.26	0.02	0.30
0.25	2.15	8.69	7.27	12.77	12.17	0.19	0.22	0.03	0.42	0.15	0.24	0.02	0.28
0.30	2.01	8.12	6.79	11.92	11.36	0.18	0.20	0.03	0.39	0.14	0.22	0.02	0.26
0.35	1.87	7.54	6.30	11.06	10.55	0.17	0.19	0.02	0.36	0.13	0.21	0.01	0.24
0.40	1.72	6.96	5.82	11.21	9.74	0.16	0.17	0.02	0.34	0.12	0.19	0.01	0.22
0.45	1.58	6.38	5.33	9.36	8.93	0.14	0.16	0.02	0.31	0.11	0.18	0.01	0.20
0.50	1.44	5.80	4.85	8.51	8.12	0.13	0.14	0.02	0.28	0.10	0.16	0.01	0.19
0.55	1.29	5.22	4.36	7.66	7.30	0.12	0.13	0.02	0.25	0.09	0.14	0.01	0.17
0.60	1.15	4.64	3.88	6.81	6.49	0.10	0.12	0.01	0.22	0.08	0.13	0.01	0.15
0.65	1.01	4.06	3.39	5.96	5.68	0.09	0.10	0.01	0.20	0.07	0.11	0.01	0.13
0.70	0.86	3.48	2.91	5.11	4.87	0.08	0.09	0.01	0.17	0.06	0.10	0.01	0.11
0.75	0.72	2.90	2.42	4.26	4.06	0.06	0.07	0.01	0.14	0.05	0.08	0.01	0.09
0.80	0.57	2.32	1.94	3.40	3.25	0.05	0.06	0.01	0.11	0.04	0.06	0.00	0.07
0.85	0.43	1.74	1.45	2.55	2.43	0.04	0.04	0.01	0.08	0.03	0.05	0.00	0.06
0.90	0.29	1.16	0.97	1.70	1.62	0.03	0.03	0.00	0.06	0.02	0.03	0.00	0.04
0.95	0.14	0.58	0.48	0.85	0.81	0.01	0.01	0.00	0.03	0.01	0.02	0.00	0.02

Source: www.angus.org/sireeval/accuracy.htm

Table 5 - Regression Results for Ultrasound EPDs

Variable	Parameter Estimate	Standard Error	t-statistic	P-value	Marginal Effect at Average Price	Discrete Variable Shifts	Elasticities at Variable Averages
Intercept	5.663660	0.153	37.020	0.0000			
Production Measures							
*age****	0.001950	0.000208	9.375	0.0000	5.17		0.891
*age2****	-0.000001	0.000000	-5.431	0.0000			
*birthwt****	-0.002760	0.000735	-3.753	0.0000	-7.32		-0.230
*adjweanwt****	0.000437	0.000122	3.602	0.0000	1.16		0.291
*adjyearwt****	0.000807	0.000098	8.238	0.0000	2.14		0.961
EPDS							
*birthepd****	-0.048550	0.005034	-9.645	0.0000	-128.78		-0.125
weanepd	0.000470	0.001691	0.278	0.7810	1.25		0.018
*milkepd****	0.006460	0.001148	5.625	0.0000	17.14		0.134
*yearepd****	0.004080	0.001111	3.672	0.0000	10.82		0.301
*uimfepd****	0.279700	0.042070	6.649	0.0000	741.90		0.020
*uribepd****	0.695340	0.086760	8.014	0.0000	1844.39		0.098
*ufatepd****	-3.758050	0.799200	-4.703	0.0000	-9968.23		-0.015
*uprpepd****	-0.365540	0.074640	-4.898	0.0000	-969.59		-0.014
Marketing Factors							
*saleorder****	-0.270650	0.020260	-13.360	0.0000	-717.90		-0.134
*picture****	0.246400	0.022100	11.150	0.0000		723.75	
*et****	0.055660	0.017660	3.152	0.0020		148.26	
*sementhird***	0.091100	0.039600	2.301	0.0210		247.06	
*semenhalf****	0.390340	0.075680	5.157	0.0000		1236.82	
fullbrother	-0.012560	0.021370	-0.588	0.5570		-32.33	
pathfinder	0.040890	0.026990	1.515	0.1300		108.11	
Sales							
*sale2****	-0.284630	0.039270	-7.249	0.0000		-641.63	
*sale4****	-0.282470	0.059190	-4.773	0.0000		-637.42	
*sale10****	-0.537660	0.064810	-8.296	0.0000		-1077.26	
*sale11***	-0.205610	0.090510	-2.272	0.0230		-481.40	
*sale12****	-0.242700	0.037440	-6.482	0.0000		-558.19	
sale15	-0.081500	0.071990	-1.132	0.2580		-202.73	
*sale16****	-0.140600	0.054610	-2.575	0.0100		-339.75	
*sale23***	0.101810	0.049930	2.039	0.0420		277.61	
*sale24****	0.156120	0.050670	3.081	0.0020		437.67	
*sale27***	-0.143670	0.069380	-2.071	0.0380		-346.65	
*sale28**	0.101730	0.054170	1.878	0.0600		277.38	
sale29	-0.039970	0.049270	-0.811	0.4170		-101.49	
*sale34****	-0.101940	0.042710	-2.387	0.0170		-251.04	
*sale36****	-0.261310	0.051270	-5.097	0.0000		-595.66	
*sale37****	0.131130	0.050080	2.619	0.0090		362.94	
sale38	0.045470	0.060710	0.749	0.4540		120.50	
*sale39****	-0.364370	0.059440	-6.130	0.0000		-790.98	

Table 5 – Continued

Variable	Parameter Estimate	Standard Error	t-statistic	P-value	Marginal Effect at Average Price	Discrete Variable Shifts	Elasticities at Variable Averages
*sale41****	-0.367990	0.042380	-8.683	0.0000		-797.49	
*sale42****	-0.354450	0.037730	-9.393	0.0000		-773.05	
*sale44****	-0.138050	0.034070	-4.052	0.0000		-334.00	
sale46	0.033910	0.057060	0.594	0.5520		89.34	
sale48	-0.030620	0.047150	-0.649	0.5160		-78.11	
*sale51****	-0.234240	0.055340	-4.233	0.0000		-540.92	
*sale52****	0.387810	0.052840	7.339	0.0000		1227.15	
sale53	0.081670	0.055170	1.480	0.1390		220.43	
*sale54****	-0.275670	0.058180	-4.738	0.0000		-624.09	
sale55	0.037280	0.052180	0.715	0.4750		98.39	
*sale60****	0.250160	0.052150	4.797	0.0000		736.24	
R^2	0.6286						
Observations	3760						

***Denotes Significance at the 0.01 level.
**Denotes Significance at the 0.05 level.
*Denotes Significance at the 0.1 level.

Table 6 - Summary Statistics for Model 2

Variable	N	Mean	Std Dev	Minimum	Maximum
price	3768	2652.50	2157.25	875.00	40000.00
age	3768	456.91	121.22	285.00	1829.00
birthwt	3768	83.29	10.14	45.00	120.00
adjweanwt	3768	664.07	70.92	408.00	930.00
adjyearwt	3768	1190.09	103.53	842.00	1742.00
birthepd	3761	2.58	1.48	-2.50	7.80
weanepd	3761	38.53	6.34	14.00	59.00
milkepd	3761	20.77	4.50	1.00	34.00
yearepd	3761	73.86	11.18	29.00	108.00
uimfepd	3768	0.07	0.14	-0.40	0.74
uribepd	3768	0.14	0.22	-0.58	1.00
ufatepd	3768	0.00	0.02	-0.06	0.06
uprpepd	3768	0.04	0.28	-0.87	1.20
saleorder	3768	0.50	0.29	0.00	1.00

Figure 1 – Predicted Premiums for Birth Weight and Birth Weight EPD

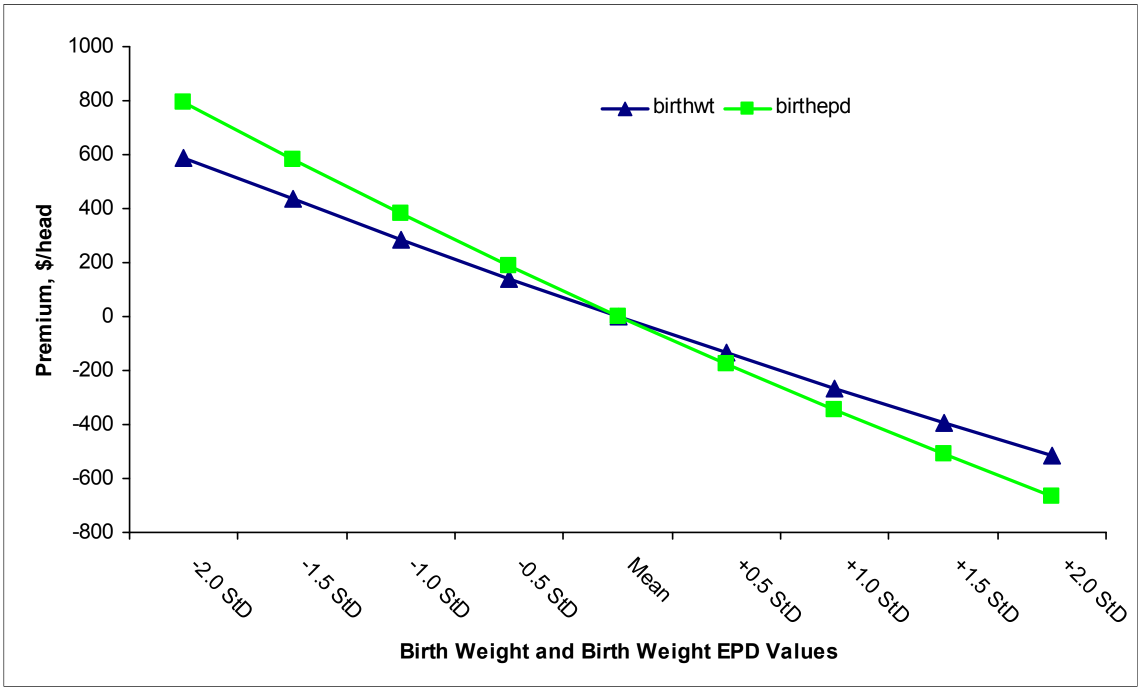

Figure 2 – Predicted Premiums for Adjusted Yearling Weight and Yearling Weight EPD

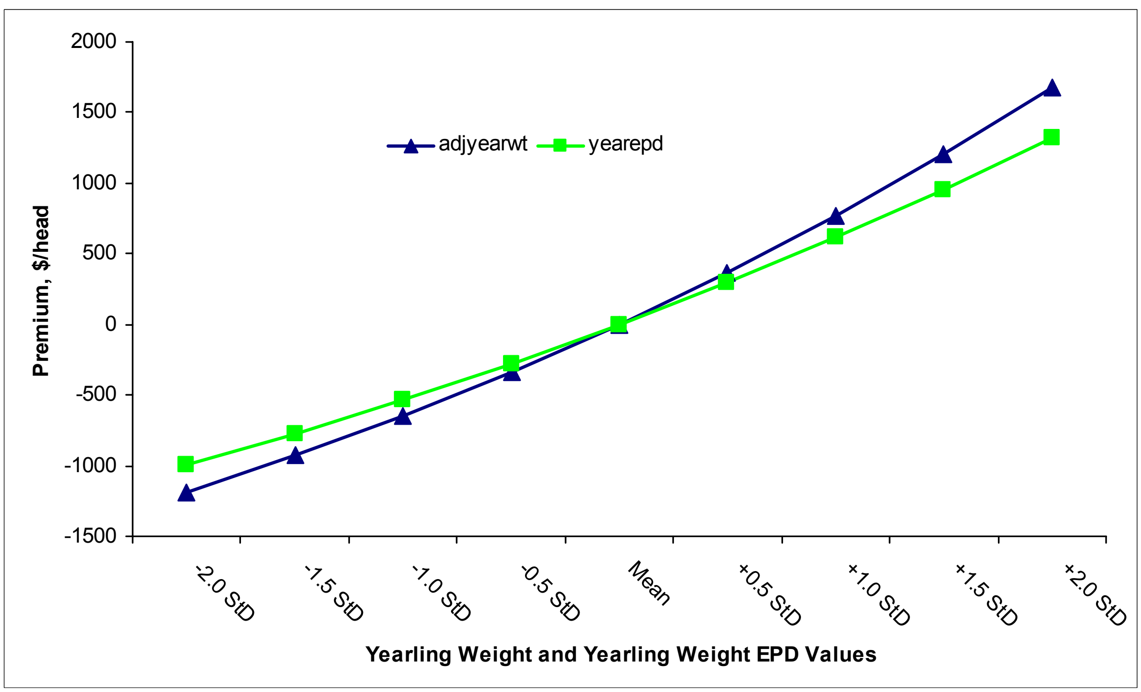

Figure 3 – Predicted Premiums for Ultrasound Ribeye EPD, Birth Weight EPD, and Adjusted Yearling Weight