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ECONOMICS OF PURCHASING GENETICALLY SUPERIOR BEEF BULLS

G. M. Clary, J. W. Jordan, and C. E. Thompson

Abstract

Net present value analysis is used to derive the marginal bid price for a beef herd sire from after-tax net revenues and cash flow influenced by genetic improvements. Marginal bid price represents the additional amount a producer could pay, above the present value of the current beef herd sire, for a sire expected to exhibit superior performance as reflected by increased average weaning weights of offspring.

An analysis of the profitability of purchasing a breeding bull for a commercial beef cow herd is presented as an application. Several alternative scenarios illustrate the impact of selected determinants on the marginal bid price of a bull.

Key words: beef bulls, genetic progress, after-tax return, bid price.

The decision to purchase a beef herd sire for a commercial or purebred beef herd requires much attention by farmers and ranchers because it involves not only additions to direct costs and revenues, but other financial aspects such as income taxes, cash flow, and leverage. Additional considerations in the herd sire purchase decision include genetic technological progress resulting from crossbreeding and the improvements possible through the selection of performance tested sires.

Much research effort has been devoted to the general principles of firm-level asset replacement by farmers and ranchers. Chisholm, Dillon (Ch. 3), Faris, Perrin, and Winder and Trant have made significant contributions to development of these principles. Studies dealing specifically with replacement strategies in beef cattle herds include Bentley et al., Rister, Kay and Rister, Rogers, and Melton. However, none of these studies specifically address the problem of determining the value of a herd sire based on improved beef herd performance, nor do they incorporate the effects of recent income tax regulations.

Capital budgeting techniques were used in this study to estimate the marginal bid price, defined as the amount a producer could pay above the amount normally spent for a herd sire. Techniques were similar to those used by Kaiser in estimating the profitability of land investments. Modifications were incorporated to account for additional factors associated with the purchase of a herd sire and additional current income tax policies.

Under current tax regulations, the purchaser of breeding stock may receive tax advantages from investment credit that directly reduce their current tax liability and regular annual depreciation allowances that reduce their annual taxable income (Penson et al.). An additional annual tax savings would result from use of financing to purchase breeding stock, since interest paid is a deductible expense.

CAPITAL BUDGETING MODEL

Net Present Value

Profitability of an investment in a herd sire can be estimated using a capital budgeting technique known as the net present value method. Net present value of a herd sire is equal to summation of the discounted net revenues over the purchaser's planning horizon. The theory of net present value and its application to agricultural decisionmaking will not be reviewed in this study because such procedures are well documented in other sources such as Kaiser, Kay, and Penson et al.

Determinants of the net present value of a herd sire include the annual net revenue realized from having the new sire in the herd, the farmer's marginal tax rate, planning horizon, discount rate, and financing arrangements. Incorporation of a genetically superior sire into a herd would impact net revenue through increased weaning weights. The period of time that the farmer plans to retain the sire in the herd (planning horizon) varies with different individuals and different herd sizes (Lasley). In small herds, where one or a few sires are used each year, replacement generally should occur more frequently to avoid inbreeding. The productive life of a sire in a particular herd could be extended if available facilities provided for keeping the sire separate from his daughters

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during the breeding season. However, the additional cost of owning a bull to breed the daughters would have to be evaluated.

The appropriate discount rate for a specific investment is the risk-free opportunity rate of return, such as the after-tax interest yield on certificates of deposit at a commercial bank, plus the risk premium to compensate the purchaser for assuming the additional risks inherent with the investment. Incorporating the above determinants in a net present value formulation gives the net present value of a herd sire purchased with borrowed capital as:

$$(1)\ NPV = \sum_{t=1}^{n} \frac{(1-T)(Y)}{(1+r)^t} + \frac{(.1)(P^*)}{(1+r)} - \frac{(5-n)(.02)(P^*)}{(1+r)^n} + \sum_{t=1}^{n} \frac{(T)(D_t)\left(P^* - \frac{(.05)P^*}{(1+r)}\right)}{(1+r)^t} - \sum_{t=1}^{s} \left(\frac{1}{1+r}\right)^t (1-d)(P^*)\left[\frac{i(1+i)^s}{(1+i)^s - 1}\right] + \sum_{t=1}^{s} \left(\frac{1}{1+r}\right)^t \left[\frac{(1+i)^{s-t+1} - 1}{i(1+i)^{s-t+1}}\right] \cdot (T)(i)\ (1-d)(P^*)\left[\frac{i(1+i)^s}{(1+i)^s - 1}\right] + \frac{(1-T)(SV_n - [(P^*) - \sum_{t=1}^{n} (D_t)(P^*)])}{(1+r)^n} - (d)(P^*),$$

$0 \leq n \leq 5$ and $0 \leq s \leq 5$,

where:

NPV = net present value of a herd sire,
Y = before-tax net revenues,
T = marginal tax rate,
P^* = price of herd sire,
D_t = depreciation rate,
SV_n = salvage value,
n = planning horizon,
s = loan length,
r = desired rate of return,
d = percent of bid price paid down, and
i = interest rate on loan.

The right-hand side of Equation (1) includes the following terms: (1) summation of the discounted annual after-tax increased net revenue; (2) the discounted investment tax credit (ITC) of 10 percent (.1) received at the end of the first year;[1] (3) the discounted proportion (20 percent per year) of the total ITC taken in the first year which is recaptured should the planning horizon (n) be less than 5 years; (4) summation of the discounted benefits from regular annual depreciation of the price (reduced by half of the ITC); (5) summation of the present value of annual loan payments; (6) summation of the present value of the annual tax savings resulting from use of financing;[2] (7) the after tax present value of the difference (gain or loss) between the salvage value of the herd sire and its book value; and (8) the proportion of the purchase price required as downpayment when financing is used.

Marginal Bid Price

Producers are concerned with determining the additional amount they could pay for a genetically superior herd sire based on their individual financial situation and the additional revenues that a superior herd sire would generate (as a result of increased weaning weights). Setting NPV equal to zero and rearranging terms, the price for a herd sire purchased with borrowed capital can be expressed as:[3]

$$(2)\ P^* = \sum_{t=1}^{n} \frac{(1-T)(Y)}{(1+r)^t} + \frac{(1-T)(SV_n)}{(1+r)^n} \div \left\{ d - \frac{(.1)}{(1+r)} + \frac{(5-n)(.02)}{(1+r)^n} - \sum_{t=1}^{n} \frac{(T)(D_t)\left(1 - \frac{(.05)}{(1+r)}\right)}{(1+r)^t} + \sum_{t=1}^{n} \left(\frac{1}{1+r}\right)^t (1-d)\left[\frac{i(1+i)^s}{(1+i)^s - 1}\right] - \sum_{t=1}^{n} \left(\frac{1}{1+r}\right)^t \left[\frac{(1+i)^{s-t+1} - 1}{i(1+i)^{s-t+1}}\right] \cdot \right.$$

[1] This assumes the farmer has a tax liability large enough to use all the ITC in the first year.

[2] Alternatively, the sixth term is the sum of the present value of the product of the loan balance in each year over 5 years, the interest rate, and the tax rate. This term can also be shown as:

$$\sum_{t=1}^{s} (1/1+r)^t (L_t)(i)(T)$$

where L_t = the loan balance in year t.

[3] The model used in this study does not incorporate the benefits or costs associated with a state income tax.

$$(T)(i)\left[\frac{i(1+i)^s}{(1+i)^s-1}\right]+\left.\frac{(1-T)(1-\sum_{t=1}^{n} D_t)}{(1+r)^n}\right\},$$

$$0 \leq n \leq 5 \text{ and } 0 \leq s \leq 5.$$

BULL PURCHASE

Purchase of a breeding bull requires considerable thought and attention because each bull contributes one-half the inheritance of each of its offspring and the bull must be able to settle a large percentage of the cows exposed to him in a short period of time (Lasley). The marginal bid price for a genetically superior breeding bull was determined by applying capital budgeting techniques to the herd sire purchase decision. Marginal bid price represents the additional amount a producer could pay for a bull expected to exhibit superior performance as a herd sire as reflected by increased average weaning weights of calves.

Several assumptions were required to facilitate application of net present value methods to the bull purchase analysis. Such assumptions include:

1. increased before-tax net revenue equals the estimated increase in average weaning weight provided by the new bull times the number of calves sired times the expected calf price,[4]
2. the effects of genetic progress are limited to improvements provided by the purchased sire in the first generation of offspring; i.e., average weaning weight increases remain constant over the planning horizon,[5]
3. planning horizon and loan length are equal for this analysis and are limited to a maximum of 5 years so that ITC recapture, depreciation recapture, and lending institution policies could be accurately represented,[6]
4. ITC is taken in the first year and is recaptured proportionately as required by law if the bull is kept less than 5 years,
5. the "accelerated cost recovery system" (ACRS) depreciation schedule is used to figure annual depreciation allowances and excess depreciation is recaptured as taxable regular income if the bull is sold for more than its book value,[7]
6. the downpayment rate for financed purchases is 25 percent,
7. the discount rate specified by producers exceeds the loan interest rate representing a margin to cover investment risk, and
8. the salvage value of the purchased bull is $800 if sold after 5 years use and increases $150 for each year the bull is held less than 5 years.[8]

Cash Purchase

Buyers opting for a cash purchase do not face loan repayments, but they relinquish the annual tax benefits associated with the deduction of annual interest expense. Marginal bid prices for the cash purchase of a breeding bull calculated for alternative marginal tax rates, planning horizons and expected increased average weaning weights are shown in Table 1.[9] Additional tables would be necessary as assumptions regarding discount rates, number of calves sired, and expected calf prices are varied. Consider the following example: a farmer expects to buy a breeding bull which will be kept for 2 years and will sire 15 calves per year with an average weaning weight 60 pounds heavier than calves sired by the old bull; expected calf price is $.60 per pound (liveweight basis) and the discount rate is 11 percent. The marginal bid price for a bull purchased with cash was $1,119 for a 25 percent marginal tax rate, $991 for a 40 percent marginal tax rate, and $888 for a 50 percent marginal tax rate, Table 1.

Calculations for a marginal tax rate of zero were included in all tables for purposes of comparison. These marginal bid prices include discounted salvage values and increased net revenues, but do not include benefits from depreciation and ITC.[10] Marginal bid prices associated with a zero increase in average weaning weight represent the additional amount a producer would be willing to pay based on reve-

[4] The purchased bull sires the same number of calves and has equal maintenance costs as the old bull, and calf prices are considered constant over the planning horizon. Net revenue is lagged an additional 6 months to account for the time between incorporating a new bull in the herd and the sale of his calves.

[5] The analysis does not reflect the longrun benefits derived from the subsequent retention and use of genetically superior dams in the herd.

[6] Production Credit Association personnel indicated that livestock loans typically are for 3 to 5 years. The analysis could be modified to include a nonequal planning horizon and loan length.

[7] The ACRS allows for 15, 22, 21, 21, and 21 percent depreciation during the first through the fifth years of ownership, respectively. Various alternative strategies concerning the claiming and recapture of depreciation are available to producers. This assumption is intended to represent one of the most likely scenarios. An illustration of depreciation recapture is given in Penson et al.

[8] Salvage values are based on the premise that the typical, progressive, commercial cattle producer would purchase young performance-tested bulls and resell them to another producer on a per head basis. The present analysis is not designed to treat situations in which bulls are sold for more than the initial purchase price.

[9] Marginal tax rates may vary from year to year due to changes in income or tax deductions; however, rates were assumed constant over all years for this study.

[10] Terms in equation (2) dealing with ITC and depreciation must be deleted when estimating marginal bid prices for producers with no tax liability.

TABLE 1. MARGINAL BID PRICE FOR PURCHASED BULL BY ESTIMATED GAIN IN AVERAGE WEANING WEIGHT, MARGINAL TAX RATE, AND PLANNING HORIZON ASUMMING AN 11 PERCENT DISCOUNT RATE, $60 PER CWT. CALF PRICE, 15 CALVES SIRED, AND NO FINANCING

Marginal tax rate (MTR) and planning horizon	Gain in average weaning weight (pounds per head)					
	0	20	40	60	80	100
	..... dollars per head					
0 percent MTR						
2 years	1,014	1,307	1,599	1,892	2,184	2,477
3 years	804	1,221	1,639	2,056	2,474	2,891
4 years	625	1,155	1,685	2,215	2,745	3,276
5 years	474	1,106	1,737	2,369	3,000	3,631
25 percent MTR						
2 years	600	773	946	1,119	1,293	1,466
3 years	570	866	1,162	1,458	1,754	2,050
4 years	531	982	1,433	1,883	2,334	2,784
5 years	484	1,127	1,771	2,415	3,059	3,703
40 percent MTR						
2 years	531	684	837	991	1,144	1,297
3 years	510	775	1,040	1,306	1,571	1,836
4 years	484	895	1,305	1,716	2,126	2,537
5 years	451	1,051	1,652	2,252	2,853	3,453
50 percent MTR						
2 years	476	613	751	888	1,026	1,163
3 years	462	702	942	1,182	1,422	1,662
4 years	445	821	1,198	1,575	1,952	2,329
5 years	422	985	1,547	2,110	2,673	3,235

nues derived from resale of the bull and from income tax benefits associated with the purchase.

Marginal bid prices declined as marginal tax rates increased, primarily because tax liabilities were not fully offset by tax benefits. Results indicate that tax liability on the increased net revenue attributed to the new bull was greater than the tax benefits derived from depreciation and ITC.

The marginal bid price for a bull more than doubles, from $510 to $1,040 per head, with the initial 40-pound gain in average weaning weight per head, assuming a 40 percent marginal tax rate and a 3-year planning horizon, Table 1. Results such as these illustrate the value of purchasing a genetically superior bull. In order to evaluate the purchase of a bull that increases weaning weights by 40 pounds, the producer must select a bull that has been raised in an environment similar to what would be encountered after purchase and that has an adjusted weaning weight which is 268 pounds more than the purchaser's herd.[11]

Determinants directly affecting net revenues, such as the number of calves weaned and expected calf price have a substantial impact on the value of a breeding bull. Marginal bid prices were $1,466 for a 25 percent marginal tax rate, $1,297 for a 40 percent marginal tax rate, and $1,163 for a 50 percent marginal tax rate, using assumptions similar to those in the initial example, except that the number of calves expected to be weaned was increased from 15 to 25. However, these marginal bid prices represent a reduction of over 20 percent in the cost per calf weaned since the cost of the bull is divided among a greater number of calves.

An increase of nearly 17 percent, from $60 to $70 per hundredweight, in expected calf price is translated into a 7 percent increase in marginal bid price. Marginal bid prices comparable to the initial example, except for assuming a calf price of $70 per hundredweight were $1,206 for a 25 percent marginal tax rate, $1,067 for a 40 percent marginal tax rate, and $957 for a 50 percent marginal tax rate.

Physical productivity and economic efficiency are important in determining the optimal planning horizon. Marginal bid price generally increased as the length of time the bull remained in the herd increased, Table 1. However, the rate at which marginal bid price increased and the price per unit of production (either per calf or per additional weaned weight) depended on production levels and marginal tax rates. The planning horizon need not be limited to 5 years; however, all tax benefits associated with the bull purchase are accrued within the first 5 years of ownership.

Increasing the desired rate of return (discount rate), while holding other values constant, decreased the marginal bid price. The amount an individual is willing to pay would decrease as a greater rate of return is required, while holding constant the stream of revenue generated by the investment. Marginal bid prices were $1,076 for a 25 percent marginal tax rate, $949 for a 40 percent marginal tax rate, and $848 for a 50 percent marginal tax rate, based on assumptions of the initial example, except for increasing the discount rate from 11 to 14 percent.

Financed Purchase

Marginal bid prices were also estimated for the financed (leveraged) purchases of a bull, Table 2. These prices reflect specific assumptions regarding loan interest rates, discount rates, calf prices, and number of calves weaned as

[11] The amount of response that can be expected is equal to the product of the heritability of a trait multiplied by 0.5 (the bull accounts for one-half the genetic inheritance of the calf) multiplied by the selection differential (difference between the herd average and the bull that is to be used for breeding). Since heritability of weaning weight in beef cattle is approximately 30 percent, the response = 0.3 x 0.5 x 268 pounds or 40 pounds additional calf weight attributed to the bull. An additional benefit of purchasing a superior bull is in the daughters that he produces as herd replacements, although this is not covered in this paper. In addition, if one considers purchasing a bull of a different breed, normally 5 to 20 percent additional pounds of calf can be weaned due to heterosis or hybrid vigor.

TABLE 2. MARGINAL BID PRICE FOR PURCHASED BULL BY ESTIMATED GAIN IN AVERAGE WEANING WEIGHT, MARGINAL TAX RATE, AND PLANNING HORIZON, ASSUMING AN 11 PERCENT LOAN, 13 PERCENT DISCOUNT RATE, 25 PERCENT DOWN PAYMENT, $60 PER CWT. CALF PRICE, AND 15 CALVES SIRED

Marginal tax rate (MTR) and planning horizon	Gain in average weaning weight (pounds per head)					
	0	20	40	60	80	100
	..... dollars per head					
0 percent MTR						
2 years	998	1,286	1,574	1,862	2,150	2,438
3 years	782	1,192	1,602	2,012	2,423	2,833
4 years	601	1,120	1,640	2,160	2,680	3,199
5 years	450	1,068	1,686	2,304	2,922	3,540
25 percent MTR						
2 years	607	782	957	1,132	1,307	1,482
3 years	577	880	1,183	1,486	1,789	2,092
4 years	528	985	1,442	1,899	2,356	2,813
5 years	480	1,139	1,798	2,456	3,115	3,774
40 percent MTR						
2 years	546	703	861	1,018	1,176	1,333
3 years	531	810	1,089	1,367	1,646	1,925
4 years	492	918	1,344	1,769	2,195	2,621
5 years	465	1,104	1,742	2,381	3,019	3,658
50 percent MTR						
2 years	496	639	782	925	1,068	1,212
3 years	492	750	1,008	1,266	1,524	1,782
4 years	461	859	1,258	1,656	2,055	2,454
5 years	451	1,071	1,690	2,310	2,929	3,548

did prices estimated for a cash purchase. Consider the following example: a farmer wishes to buy a bull with money borrowed at an interest rate of 11 percent and determines the appropriate discount rate (interest cost plus risk premium) to be 13 percent; the bull sires 15 calves which will be sold at $.60 per pound (liveweight basis) and will have an average weaning weight 60 pounds heavier than calves sired by the old bull; the farmer will keep the bull 2 years and must supply a 25 percent down payment. The estimated marginal bid price for the bull was $1,132 for a 25 percent marginal tax rate, $1,018 for a 40 percent marginal tax rate, and $925 for a 50 percent marginal tax rate, Table 2. A comparison of the financed (leveraged) purchase to a non-financed purchase indicated that the marginal bid price was generally greater for a financed purchase. The marginal bid price for a financed purchase would always be greater than for a cash purchase with a comparable discount rate as long as the discount rate has been specified as greater than the after-tax loan interest rate (Kaiser).

Estimating marginal bid prices while varying assumptions similar to the cash purchase would illustrate the impact of increases in the number of calves weaned, the calf price, the discount rate, and the loan interest rate. As anticipated, increasing the number of calves weaned and/or the calf price resulted in higher marginal bid prices due to increased net revenues. Alternatively, increases in discount rates and/or loan interest rates resulted in lower marginal bid prices.

It would be difficult to present all possible scenarios regarding the purchase of a herd bull, as each farmer and rancher faces his/her own unique physical and financial situations. Additional marginal bid prices may be estimated by changing parameter values included in the net present value formulation.

SUMMARY AND CONCLUSIONS

Present value analysis was used to determine the marginal price that could be paid for a herd sire given a producer's desired rate of return, planning horizon, marginal tax rate, expected annual before-tax net revenue, length of loan, down payment requirement, and loan interest rate. Analyses included income tax effects in terms of investment tax credit (ITC) and depreciation, allowing for recapture of these items depending on the planning horizon, and annual interest expense.

An analysis of the profitability of purchasing a breeding bull in a beef cattle herd was presented to illustrate the application of capital budgeting techniques to the herd sire purchase decision. The marginal bid price was calculated to represent the additional amount a farmer could pay, above the value of the bull currently in the herd, for a genetically superior bull. Several alternative scenarios were designed to illustrate the impact of selected determinants on the marginal bid price of a bull. Results of additional scenarios would be useful to producers in applying this analysis to their individual farming or ranching operation.

The rather wide variation in marginal bid prices reported in this study generally resulted from the assumptions of specific situations. The length of time farmers or ranchers plan to keep the purchased bull proved to be an important determinant. Marginal bid prices often more than doubled between a planning horizon of 2 years and 5 years, especially at higher marginal tax rates and average weaning weight increases.

Certain aspects of this study point to other areas of needed research. Calculations of increases in net revenue were based on short-run improvements provided by a genetically superior bull. Further research is required to accurately incorporate long-run herd improvements into the income segment of the net present value formulation. Also, additional studies should incorporate innovative breeding programs designed by animal scientists with regard to the age at which bulls should be purchased, how long a bull should remain with a particular herd, and the expected salvage value of the bull. Changes suggested by such innovative programs could have a significant impact on the marginal bid price for a breeding bull.

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