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by

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ABSTRACT

Retained ownership of steer calves is an investment decision for cow/calf producers. Data collected over a three-year period on 845 steer calves reveals that retaining ownership of steer calves is, on average, profitable. Systematic and unsystematic risks associated with retaining ownership of steer calves are identified. Empirical results indicate that unsystematic risk account for 67% of the variability in the rate of return to retained ownership.

Empirical evidence also suggests that retaining ownership is a riskier investment decision than assumed in the earlier literature. This suggests that the lack of enthusiasm for retaining ownership by cow/calf producers is the result of the level of risk associated with retaining ownership rather than producers being too risk averse.

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I. Introduction

The traditional production and marketing strategies of cow-calf operators in the Midwest and Northern Plains are to calve in early spring and sell at weaning in the fall. Retained ownership is a marketing/value adding strategy in which the producer continues to own the calf beyond weaning.

Producer decisions concerning retaining ownership are influenced and constrained by market conditions, the producer's financial condition, the ranch-of-origin production/management regime, the financial risk of retaining ownership, and the producer's economic alternative to not retaining weaned calves. All of these factors affect retained ownership profitability and/or a producer's utility from profit.

Our research investigates retained ownership profitability from a different vantage point relative to previous studies. We view retained ownership as an investment alternative for the producer. Producers can either sell weaned calves as feeders and reinvest the sales proceeds or retain ownership until slaughter. The economic incentive to engage in retained ownership of steer calves is the rate of return earned from retained ownership.[1] Our objective is to investigate the management, production, and market factors affecting the variability in the rate of return on the retained ownership investment decision.

The empirical work presented here first attempts to quantify the rate of return associated with retaining ownership of weaned calves until slaughter. The second objective is to analyze the effect of systematic and unsystematic risks associated with retaining ownership of weaned steer calves on the rate of return earned from retaining ownership. The third objective is to quantify the level of risk associated with retaining ownership of calves.

Literature Review

Retained ownership of weaned calves has been publicized as a value-added strategy and/or a risk management strategy for calf-cow producers (retained ownership combined with a hedging strategy) by academic and commodity interest groups (e.g., NCBA 2001, Feuz and Wagner 1996, Cattle-Fax 1995, Schroeder and Featherstone 1990, Watt et al. 1987). The factors identified (in the literature) as having the greatest influence on determining the optimal retained ownership strategy are: a) profit levels, b) profit variability, c) producer risk preferences, d) marketing alternatives, e) output price risk, f) input price risk, and g) production risk.

Empirical work on retained ownership of weaned calves in the agricultural economics literature has focused primarily on calf production, retention, and marketing decisions within an optimization framework (e.g., Stokes et al. 1981, Lambert 1989, Schroeder and Featherstone 1990, Ethridge et al. 1990, Van Tassell et al. 2000). The goal of this type of study is to determine the optimal strategy, based on historical or simulated market and production conditions, for the production and marketing of calves. For the most part, these programing models conclude that some form of retained ownership is optimal except under poor market or production conditions.

Other empirical contributions to the literature have focused on the development and analysis of primary data sources to investigate factors influencing retained ownership profitability. Feuz and Wagner (1994 & 1996) analyzed feedlot data gathered from a university sponsored retained ownership demonstration program. They focused on the effect of feedlot performance variability and the physical characteristics of weaned calves at time-of-entry into the feedlot on the profit potential of retaining ownership. They also looked at the effect of different feeding regimes on feedlot performance and profitability. They concluded that carcass characteristics at slaughter (quality-grade, dressing percentage) are important determinants of profit along with production performance (average daily gain, total cost of gain).

II. Annualized Rate of Return to Retained Ownership

The producer's decision to retain ownership of steer calves instead of selling them after weaning can be looked upon as an investment decision. The capital being invested is the market value of the calf at time of feedlot placement. The variable *CALFREV* is defined as the per-head estimated market value, based on a linear price slide constructed from USDA-AMS feeder calf price reports for South Dakota, of each calf on the day of entry into a university sponsored ranch to rail program (Calf Value Discovery or CVD program).[2] Retained ownership accounting profit (*AP*) is equal to the difference between profit earned from retaining ownership of a feeder steer until slaughter (the actual per-head price paid at slaughter (*CARPR)* minus the total feedlot costs (*TOTCOST*)) minus the estimated revenue the producer would have received by selling that individual (ith) steer as a calf at time of feedlot placement:

1) $AP_i = CARPR_i - TOTCOST_i - CALFREV_i$.

The rate of return to retained ownership is defined as the accounting profit divided by the estimated market value of the calf (*CALFREV*) when entered into feedlot. The rate of return for the ith steer is then annualized (ARR) based on the number of days on feed (DOF):

2) $ARR_i = (AP_i / CALFRV_i) / (DOF_i / 365)$,

where DOF_i is the number of days the ith steer calf spent in the CVD feeding program. By annualizing the rate of return on an individual steer, the outcome of the investment decision to

engage in retained ownership can be compared across individual steers like any other investment decision.

Summary statistics are provided in Table I. The summary statistics indicate the selling of calves returns less revenue than retaining until slaughter (on average after feedlot cost are paid). However, per-head revenue variability is greater when calves are retained.

The mean value of accounting profit is $14.16 per head. The mean value of calf per-head sales revenue is $516.43. The average per-head annualized rate of return generated from retaining ownership is 5.56%. For this group of retained steer calves, as in previous studies, a retained ownership strategy (on average) is shown to be profitable. However, annualized rate of return variability was significant, ranging from a minus 109% to a positive 80%. The coefficient of variation is 40% higher for retained ownership revenues (.235) relative to calve sale revenues(.166). This result indicates that retaining ownership incurs additional revenue risk relative to selling calves after weaning.

TABLE I. Mean, standard deviation, coefficient of variation, and range of revenue per head (845 head, $/head).[3]

Marketing Method	Mean	SD	CV	Max	Min
Finished Steer[a] Value After Feedlot Cost	530.60	119.68	0.235	841.25	113.40
Weaned Calf Market Value	516.43	86.07	0.166	728.66	319.15
Accounting Profit for Retained Ownership	14.16	77.93	5.50	248.35	-329.53
Annualized Rate of Return	5.56%	26.26	4.72	80.84	-109.50

a. Steer net revenue: carcass price per head minus total feedlot cost.

The Risk of Retaining Ownership

Retaining ownership of steer calves is an investment decision for the cow-calf producer. The rate of return to retaining ownership is subject to risk like any other investment decision. As with any investment, risk can be divided into two broad categories: a) systematic risk or market risk; and b) unsystematic risk or firm specific risk. For the cow/calf industry, unsystematic risk is ranch and animal specific. In the case of retained ownership, market risk

does include market prices for slaughter cattle and feeder steers, feed cost, market interest rates, and general weather conditions like drought. Producers have no control over systematic risk. Unsystematic risk or individual firm risk would include carcass quality at slaughter, calf quality at time of sale or feedlot placement, feedlot production performance, and feedlot selection. Producers influence unsystematic risks through their management decisions.

Each of these systematic and unsystematic risks can be rearranged into specific periods of an animal's life cycle: a) ranch of origin (RO), b) the feedlot phase of a calf's lifecycle (FP), and c) the harvest or marketing phase of the calf's lifecycle (HP).

Mathematically, variability in the rate of return to retaining ownership can be defined as being a function of the systematic and unsystematic risks associated with different phases of the animal's lifecycle:

$$3)\ \sigma^2(ARR_i) = f[\sigma^2(RO_i), \sigma^2(FP_i), \sigma^2(HP_i), \sigma^2(e_i)],$$

where $\sigma^2(e_i)$ is the variability in ARR not accounted for.[4]

For our purposes, the systematic risks associated with retaining ownership of a calf are: a) the market price of feeder calves, which influences the ranch of origin management decision to retain or sell calves as feeders; b) fed cost, which affects cost of production during the feedlot phase; and c) the market price of fed cattle at harvest. The unsystematic risks associated with retaining ownership of a calf are: a) the calf breed and calf weight; b) feedlot selection, feedlot overhead and medical costs, and production performance; and c) carcass quality characteristics. The management decisions of individual producers affect each of these unsystematic risks.

III. Data Description

The data used in this study were collected from 845 steers from 75 producers enrolled in South Dakota State University's Calf Value Discovery Program (CVD) during the fall of 1998, 1999, and 2000. Each producer entered at least five weaned steer calves into the program.[5] A survey at the time of entry gathered information on management practices at the ranch-of-origin. At entry, steers were implanted, vaccinated, ear tagged, and weighed.

Steers were finished at two South Dakota feedlots, one in the eastern and the other in the western part of the state. Production performance, cost, and marketing data were collected on each steer. Steers were marketed on a grade and yield basis, when they reached acceptable weight and finish standards, on 18 different dates during the summers of 1999, 2000, and 2001.[6] South Dakota State University animal and veterinary scientists collected carcass data on the kill floor after the animals were slaughtered. An outline of the data collected is provided in Box I. A complete description of the study and data collected is reported by Grathwohl (2001). See appendix A for variable definitions.

Box I: Description of data collected.

Unsystematic Risks:

A) Ranch of origin: Data on cow-calf ranch management practices before entry into the CVD program were collected from owners. Information collected includes calf inweight and calf breed.

B) Feedlot performance: Data included average daily gain, feedlot overhead cost per day, vet medical cost, and a feedlot effect variable.

C) Carcass characteristics: Yield grade indicators included ribeye area, fat thickness over 12^{th} rib, and kidney-pelvic-heart fat measurements. Quality grade measurements are based on marbling score and a quality grade score of 2 to 8 was assigned (2 indicating a standard carcass and 8 indicating a low-prime carcass). Dressing percentage was calculated by dividing hot carcass weight by live weight at slaughter.

Systematic Risks:

A) The average market price (cwt.) for a 500 pound calf at time of feedlot placement.

B) Feed cost per day. Feed costs were averaged within pen.

C) The Five-Area Hot Carcass Weight (HCW per cwt.) price at time of slaughter. The choice/select spread at time of slaughter was included because steers were sold on a grade and yield grid.

IV. Empirical Methodology and Results:

Systematic and Unsystematic risks affecting the rate of return when retaining ownership of calves to slaughter are grouped into three categories: 1) ranch-of-origin production management decisions; 2) calf feedlot performance; and 3) carcass traits at slaughter.[7] The rate of return on the retained ownership investment is assumed to be a function of the variables defined in these three categories.

The empirical methodology used here is OLS regression analysis. The regression equation (eq.4) to be estimated is assumed to adhere to the standard assumptions. The independent variables (x) in the three categories (listed above) are regressed on the calculated ith steer's annualized-rate-of-return (ARR) to determine which variables help explain the variation in the rate of return across retained calves. Results are provided in Table II.[8]

4) $ARR_i = a + b_1 x_{1i} + ...+ b_k x_{ki} + e_i, e_i \sim N(0,\sigma^2)$

Standardized beta coefficients are computed by dividing a parameter estimate by the ratio of the sample standard deviation of the dependent variable to the sample standard deviation of the regressor. Each beta coefficient reported in Table II indicates the number of standard deviation changes in the dependent variable associated with a standard deviation change in the independent variable, ceteris paribus. The magnitudes of the beta coefficients are not affected by the scales of measurements associated with the independent variables and thus can be used to ascertain the relative importance of the effects of the independent variables on the dependent variable. Partial correlation coefficients were also generated to estimate the individual explanatory power of each variable. See Pindyck and Rubinfeld (1998) for a complete discussion on these topics.

Table II: OLS Estimates:

Dependent Variable: ARR
GLOBAL F TEST STAT = 168.70 P-VALUE= .0001
REG RSQ = 0.7532 Durbin-Watson D = 1.854
ADJ RSQ = 0.7488 Number of Obs.= 845

Lifecycle Category	Variable	DF	Parameter Estimate	Standard Error	T for HO: Par=0	Prob > |T|	Standard Beta Cof	Partial Correlation Coefficients
	INTERCEPT ***	1	-395.36	30.003	-13.18	0.001	0.000	
RO								
	INWEIGHT **	1	-7.950	3.901	-2.04	0.042	-0.047	0.0013
	CONTINENTAL**	1	2.792	1.384	2.02	0.044	0.045	0.0023
	CROSSBREED ***	1	4.178	1.302	3.21	0.014	0.067	0.0041
	ENGCROSS	1	1.075	1.407	0.76	0.445	0.015	0.0002
	CAFPRICE ***	1	-0.795	0.147	-5.39	0.001	-0.317	0.0014
FP								
	AVGFLCOST ***	1	-139.945	9.694	-14.44	0.001	-0.537	0.0378
	ADG ***	1	42.126	1.751	24.05	0.001	0.723	0.2022
	FDLOC ***	1	5.345	1.866	2.86	0.004	0.079	0.0008
	AVGFEEDCOST ***	1	-57.476	6.253	-9.00	0.001	-0.402	0.0785
	VETCOST ***	1	-8.484	1.387	-6.11	0.001	-0.108	0.0112
HP								
	QG ***	1	11.493	0.499	23.03	0.001	0.482	0.3256
	DRESS ** *	1	5.547	0.327	16.97	0.001	0.440	0.0809
	CALCYG	1	-0.417	0.755	-0.55	0.580	-0.016	0.0001
	HCWPRICE ***	1	0.937	0.202	4.63	0.007	0.273	0.0061
	CHOICE/SPREAD *	1	0.580	0.335	1.73	0.084	0.047	0.0010

1) Three asterisks indicate the variable is significant at the 1% level. Two asterisks indicate the variable is significant at the 5% level. One asterisk indicate the variable is significant at the 10% level.
2) A test for heteroscedasticity was performed [Newbold (1995)] and its presence was not detected.
3) Variance Inflation Factor analysis indicated that there was no significangt evidence of multicollinearity in the model. Market price variables for calves and steer had VIF values of 11, indicating a marginal colinear relationship between those two variables in the model.
4) SAS (1990) software was used to conduct the statistical analysis.

The regression results in Table II provide statistical evidence that systematic and unsystematic risks in each of the three categories do influence the rate of return to retained ownership. All of the significant independent variables have signs consistent with previous empirical studies discussed in the literature review. Only the calculated yield grade variable and the English Cross dummy variable were insignificant.

The standardized beta coefficient estimates provide an indicator of variability. In the unsystematic risk category, the variables: a) average daily gain; b) average feedlot overhead cost per day; c) carcass quality grade; and d) carcass dressing percentage, had the greatest influence on rate of return variability. In the systematic risk category, the variables: a) average feed cost per day; b) the market price for fed cattle; and c) the estimated average market price for 500 pound calves at the time of feedlot placement, had the greatest influence on rate of return variability.

Summing the regression partial correlation estimates with respect to lifecycle phases reveals that: 1) the variables associated with the harvest phase of an animal's lifecycle account for 41.37% of the variability in the dependent variable. The feedlot phase accounts for 33.05%. The ranch of origin phase accounts for only 0.93%.

Summing the regression partial correlation estimates with respect to systematic and unsystematic risk reveals that the variables associated with systematic or market risk account for only 8.6% of the variability in the dependent variable. Furthermore, variability in feed cost per pound gain accounts for most of the explanatory power of the systematic risk group rather than market prices for livestock. The variables associated with the unsystematic risk group explain 66.73% of the variability in the rate of return.

The regression residual accounted for 24.68% variability in the rate of return, implying that almost 25% of the variability in the annualized rate of return to retained ownership is unaccounted for. The inclusion of market prices for calves, fed steers, and feed in the model implies that unknown risk factors not included in the model are an issue for future research.

At first glance, this finding seems to be a direct contradiction to the conclusions arrived at in the retained ownership literature concerning the importance of market prices (systematic) in developing the optimal retained ownership strategy. Our empirical findings do not suggest that high or low cattle prices do not affect retained ownership profitability. When market price fluctuations are accounted for, then a change in the market price affects all per-head transactions equally at the time of sale. Market price fluctuations therefore have a minimal effect on the per-head rate of return variability across individual animals during any particular transaction period. When market prices change over time, then market price fluctuations contribute to per-head rate of return variability across transaction periods. Unsystematic risk, however, affects per-head rate of return variability both within a transaction period and across transaction periods.

VI. Implications for Retained Ownership:

The economic insight gleaned from this study indicates that management decisions made by individual cow-calf producers concerning herd genetics, herd management, and feedlot selection account for almost 67% of the variability in the rate of return to retaining ownership of steer calves. The risk associated with retained ownership is often cited in the literature as a major barrier to the widespread adoption of a retained ownership strategy by cow-calf producers (Lambert 1989). Our findings suggest that producers could reduce unsystematic risk by: 1) making herd management decisions (for example, in production performance and carcass quality)

that increase the uniformity of calf production, and 2) select a feedlot firm for calf placement on cost efficiency criteria.

The empirical results indicate that when considering retaining ownership of weaned calves, producers need to assess the feedlot production performance potential of the calves and weigh that against the current cost of feeding calves to slaughter weight. Feedlot performance data of previous calf crops is critical information that needs to be evaluated when the retained ownership decision is made. These results are consistent with the Van Tassel (2000) study, where it was found that calf progenies from "high growth potential sires" were retained more often than calf progeny from "moderate growth potential sires" in their optimization study.

Empirical evidence from previous studies (e.g., Feuz and Wagner 1994, 1996) suggests carcass merit variables do affect profit levels. The empirical evidence presented above suggests that carcass quality does affect the rate of return to retained ownership. Quality grade and dressing percentage are significant at the one percent level and have positive coefficients. The implication of enhancing carcass merit characteristics is an improvement in the profit potential of retaining ownership. Carcass merit data from past calf crops is necessary to make a prudent decision about retaining ownership of weaned calves.

The progeny/breed effect reported here is consistent with the study by Van Tassell et al. (2000). In the Van Tassell study, Hereford sires represented the "moderate-growth potential sires" and Charolais sires represented "high-growth potential sires." Van Tassell reported that the Charolais progeny was retained more often than the Hereford progeny. Van Tassell's finding is consistent with our finding that retaining ownership of Continental and Crossbreed progeny, on average, had higher rates of return relative to retaining ownership of straight English progeny. Our findings are also consistent with those of Stokes et al. (1981). In the Stokes study, "large frame cattle" produced progeny that were more profitable under retained ownership than smaller framed cattle.[9]

The Stokes et al. study also found higher profit rates when weaned calves were placed directly into the feedlot and retained until slaughter rather than the alternatives of: 1) selling at weaning; 2) owning through the stocker stage; or 3) backgrounding and then feeding out the steer until slaughter. The negative coefficient estimate for INWEIGHT is consistent with the Stokes et al. study. The implication is that the longer the delay in the weaning of steer calves, the longer weaned calves are backgrounded, and the heavier a steer calf is at time of entry into the feedlot, the lower the rate of return to retained ownership. However, our empirical results suggest that the frame size effect dominates the inweight effect on the dependent variable.

Retained Ownership and Producer Risk Preferences

For this group of CVD steers, retained ownership generated, on average, an annualized rate of return of 5.56% per head. This per-head rate of return represents the return on investment when a steer calf is retained until slaughter. However, the economic rate of return to the producer when retaining calves is closer to 2.5% on an annual basis if the interest income from the sale of calves is included in the calculation of the producer's rate of return calculation. That

is, the producer can invest the proceeds from the sale of his/her weaned calves in a risk-free interest bearing instrument (e.g., short-term government securities or certificates of deposits at approximately 3% annually). The issue of opportunity cost associated with selling calves allows the topic of risk to be introduced into the discussion.

Lambert (1989) noted that, although studies indicate greater profitability when a retained ownership strategy is adopted, only a small minority of conventional cow-calf producers use this management strategy, preferring instead to sell calves. This contradiction is not resolved even when an attempt is made to incorporate risk into the modeling structure employed by economists (Van Tassell et al. 1987, Rodreguez and Taylor 1988). Lambert offers three possible theories on why cow/calf producers don't engage in retained ownership more often: a) producers are more risk averse than assumed in the empirical literature; b) cash flow problems are a barrier to retaining ownership; and c) producers are satisfied with weaned calf crop profit levels.

We suggest an alternative to Lambert's risk aversion conjecture may be that retained ownership of calves is a riskier investment alternative for the cow/calf producer than previously hypothesized in the literature. An average positive rate of return from retaining ownership over time may not be enough compensation for the additional financial risk.

To explore this issue the data are separated by year. For each calf, a retained ownership risk premium is calculated. The risk premium is then converted into a rate of return on capital. Next, the coefficient of absolute risk aversion is estimated for each year in the study. The estimated risk aversion coefficient is an indicator of what level of risk preference a producer would have to exhibit to be indifferent toward the choice of retaining ownership versus selling calves.

The retained ownership risk premium is defined as retained ownership profit minus the opportunity cost of retaining ownership. The opportunity cost of retaining ownership is defined as the foregone interest income based on the market value of the calf at the time of placement in the feedlot. The forgone interest income is derived by multiplying the total number of days a calf is in the feedlot by the daily risk free interest rate. The daily interest rate is the assumed risk free rate of 3% divided by 365.[10]

The risk premium is then converted into a measure that reflects the annual economic rate of return to capital. The risk premium is first converted into a rate of return by dividing the risk premium by the market value of the calf. The market value of the calf is the capital being put at risk when the producer makes the decision to retain ownership. Transforming the risk premium into an annualized economic rate of return to capital standardizes the risk premium across individual animals. When data were separated by year, the average rate of economic return to capital (annualized risk premium) in: a) 1998 was -1.43%, b) 1999 was 11.94%, and c) 2000 was -10.60%.

The risk faced by producers who engage in retained ownership is hypothesized to be the uncertainty over the rate of return to retained ownership (ARR). In the economics of uncertainty

literature, Pratt (1964) demonstrated that the insurance risk premium (RP) is equal to one-half the variance of the risk undertaken (ARR) multiplied by the coefficient of absolute risk aversion (r):

5) $RP = \frac{1}{2} [VAR(ARR) * r]$.[11]

Rearranging equation 5 allows the risk aversion coefficient "r" to be derived:

6) $r = 2RP / VAR(ARR)$.

Table III provides an estimate for the three-year average of the coefficient of absolute risk aversion and for each year individually.

TABLE III. Average Risk Premium and Coefficient of Absolute Risk Aversion for the years 1998, 1999, 2000, and for the three year period (845 head).

Year	Number of head	Risk Premium % Return	Coefficient of Absolute Risk Aversion
1998	386	-1.43	-0.0039
1999	299	11.94	0.0501
2000	160	-10.60	-0.0343
3-Year Average	845	1.56	0.0045

Table III provides empirical support for the supposition that the retained ownership alternative may be a riskier value-added strategy for cow/calf producers than assumed in the earlier literature. The coefficient of absolute risk aversion values listed in table III indicates the risk preference level necessary for a producer to be indifferent to the choice of retaining ownership or selling calves. Any producer who is more risk averse than the coefficients listed in table III would sell calves at weaning. Notice that in 1998 and 2000 only risk preferring producers would be willing to engage in the retained ownership alternative. Clearly, for these years and data, the retained ownership alternative is an investment alternative that many risk averse cow/calf producers would pass on.

Summary:

Empirical evidence indicates that the average rate of return on retaining ownership of CVD calves until slaughter is positive. Coefficient of variation for per-head revenue from retaining ownership, however, is higher than the estimated average revenue generated from calf sales. This indicates greater revenue risk associated with the retained ownership alternative.

The methodological framework identifies and quantifies sources of risk associated with retaining ownership. With respect to variability in the rate of return, unsystematic risks clearly outweigh systematic risks when producers retain ownership.

The empirical results suggest that the retained ownership alternative is too risky for many cow/calf producers. This finding helps explain their lack of interest in retaining ownership. The only way to encourage cow/calf producers to engage in retained ownership is to provide guidance on risk reduction. The risk education focus should be on reducing unsystematic risks associated with retaining ownership. This conclusion is based on empirical evidence suggesting that the majority of the variability in the rate of return to retained ownership is the result of unsystematic risk.

Appendix I: Variable Description:

A) The variable HCW is defined as the hot carcass weight of the steer at slaughter (in lbs.). The variable DRESS is defined as the dressing percentage and is equal to hot carcass weight divided by live weight at slaughter. The literature suggests dressing percentage has a positive relationship with ARR. The variable REA is defined as the size of the ribeye area in sq. inches, measured at the time of slaughter. The variable FT is defined as fat thickness in inches over the 12^{th} rib of the steer at slaughter. The variable KPH is defined as percent kidney, pelvic, and heart fat (KPH%). The variables REA, FT, HCW, and KPH were used to estimate the carcass yield grade (CALCYG). The literature suggests calculated yield grade has a negative relationship with ARR. The variable MARB is defined as the amount of fat within the muscle or intramuscular fat. Marbling score is based on intramuscular fat in the ribeye muscle at the 12^{th} rib. The variable MARB was used to determine the quality grade category (standard=1 to low prime=8) of a carcass. The literature suggests a positive relationship with ARR.

B) The variable INWEIGHT is defined as the live weight of the calf upon entry into the CVD program. The literature suggests calf inweight has a negative relationship with ARR. The dummy variables CONTINENTAL, CROSSBREED, and ENGCROSS refer to three categories of breed type and is based on a calf's genetic background. Four general categories were developed to identify the calf's breed background: English, English Cross, Crossbred, and Continental. Straight English breed is the reference point. Only 2% of the steers were Continental crosses and they were combined with straight continentals. The breed dummy variable provides a general indication of frame size of the calf. The literature indicates that frame size has a positive relationship with ARR.

C) The variable DOF is defined as the calf's number of days on feed in the CVD program. The variable ADG is defined as the average daily gain (in lbs.) of the calf during the feedlot stage of its life. The literature suggests average daily gain has a positive relationship with ARR. The variable AVGFLCOST is defined as all feedlot accounting costs (in $) associated with raising the calf to slaughter weight except feed and vet medical costs divided by days on feed. The variable AVGFEEDCOST is defined as total feed cost divided by days on feed. The variable VETCOST is a dummy variable, if VETCOST=1 then a steer had been provided with veterinarian care and charged, zero otherwise implies no medical costs were charged to an animal. The literature suggests that feedlot cost has a negative relationship with ARR.

D) To remove a potential feedlot effect, the variable FDLOC is defined as being equal to one if a calf was placed in a feedlot located in eastern South Dakota or zero if the feedlot location is west river. No *a priori* relationship is assumed between FDLOC and ARR. The variable CALFREV is defined as the estimated market price per head for a particular calf upon entry into the CVD program based on a price slide estimates generated from auction barn sales data. The market for calves at feedlot placement is based on the estimated price slide value of a 500 pound calf. The variables HCWPRICE and CHOICE/SELECT are publicly reported USDA market prices. These market prices correspond to slaughter date. The relationship between the Choice/Select discount and ARR is dependent on the distribution of carcass quality grade in the

sample. The average quality grade for this group of steers is 4.09. The mean falls between high select and low choice. Thus, no *a priori* sign is assumed. Higher fed cattle market prices are assumed to have a positive relationship with ARR. Calf market price is expected to have a negative relationship.

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Endnotes:

1. We have assumed here that it does not make any difference to the producer whether they earned a profit or incurred a loss as a result of raising calves to the feeder stage of development because at the time of the retained ownership decision they cannot change that outcome.

2. South Dakota State University's Calf Value Discovery Program (CVD) is a ranch to rail program run by the Animal and Range Science Department at SDSU.

3. Observation outliers were not removed from the data. For example, the finished steer that generated a net revenue value of $113.40 had a veterinarian and medical charge of $166.00, and received a quality grade of standard. However, feedlot deaths were not included in the data set because only those finished steers with complete records from birth to slaughter were included.

4. There is a host of other unsystematic risks we cannot account for. For example, the financial condition of the producer will affect financing costs, particular unknown genetic traits, pasture conditions at the ranch of origin, etc.

5. Feedlot entry occurred anywhere from one to eighty-one days after weaning. The average was twenty-one days after weaning.

6. The CVD steers were sold to PM Beef in Windom, MN. See Grathwohl (2001) for a complete description of the CVD project from 1998 to 2000.

7. For the CVD cattle, the degree of marbling included Traces, Slight, Small, Modest, Moderate, and Slightly Abundant. A numerical number was assigned to the degrees of marbling: Traces = 300-399, Slight = 400-499, Small = 500-599, Modest = 600-699, Moderate = 700-799, Slightly Abundant = 800-899.

Quality Grade	Marbling Score	QG Number
Standard	300-399	2
Low Select -	400-499	3
High Select +	450-499	4
Low Choice -	500-599	5
Avg. Choice 0	600-699	6
High Choice +	700-799	7
Low prime -	800-899	8

8. It is assumed for simplicity that the producer's next best alternative to selling calves at weaning is to retain ownership until slaughter. However, producers often sell weaned calves after they have been backgrounded but before slaughter. See Watt et al. (1987) or Fausti et al. (1998) for a brief discussion of the marketing alternatives available to cow-calf producers.

9. The data set contained 35% English, 25% Continental, 23% Crossbred, and 16% English Cross. English and English Cross were approximately 16 lbs HCW lighter than Crossbreds and over 60 lbs. HCW lighter than Continentals. English and English Cross spent approximately 4% fewer days in the feedlot. No statistical difference in adg or dressing percentage across breeds.

Price slide estimates of calf market value per head indicate that Continental and Crossbreed calves had (on average) a market value of $25 more than English calves. This is due to Crossbreed calves averaging 30 lbs and Continental calves averaging 55 lbs heavier at feedlot entry as compared to English calves. The profit advantage of larger framed cattle seems to be the result of heavier carcass weights at slaughter.

10. The risk premium is inversely related to the risk free rate or return.

11. Empirical estimation of risk aversion coefficients using this approach has appeared in previous livestock marketing studies (Elam 1992, Feuz et al. 1995).