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# Factors Affecting the Adoption of Value-added Production on Cow-Calf Farms

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ABSTRACT

Factors that affect the decision to feed or sell calves at weaning are analyzed for Arkansas cow-calf operators. A discrete choice logit model is used to analyze the adoption of value-added cattle production. Farm size, human capital, perception of risk/returns and enterprise diversification are hypothesized to explain this decision. Regional factors and land quality are also accounted for. Operator perceptions towards risk, profitability and facilities were important. Production control and attention to marketing were also significant, but farm size and scale of cattle production had a minimal impact. Effects of human capital and off-farm labor opportunities need further investigation.

**Key Words:** backgrounding, cow-calf production, production control vs. marketing, risk/return relationship, technology adoption.

Agricultural policy analysts and extension personnel are often interested in the kind of factors that drive the adoption of value-added production systems on farms. For example, why do some cattle ranchers invest in backgrounding weaned calves while others do not? Further, how can outreach efforts to encourage downstream diversification be targeted given the diversity of agricultural producers? At the heart of the decision to adopt a new farm enterprise is the profitability of the enterprise relative to other investment alternatives. Often adoption is also conditioned by factors such as perceptions of risk, size of operation, and the required knowledge or experience to perform the tasks involved with the enterprise.

The objective of this paper is to examine and rank factors that impact the decision to feed weaned calves to heavier weights as a value-added enterprise on cow-calf farms. Knowing the relative importance of these factors should help decision makers determine which factors to focus on. The emphasis is on on-farm production utilizing unique survey data on retained ownership decisions from a cross section of beef producers in Arkansas. Survey respondents are differentiated between traditional cow-calf enterprises without any downstream diversification and those cow-calf operations that background weaned calves. In addition to conventional information such as farm size and human capital variables, the analysis includes opinion variables concerning farmers' perceptions related to profitability, financing, facilities, the value of performance

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data, and price risk associated with backgrounding calves.

## The Backgrounding Decision

The decision to background calves is not well understood. Cow-calf operators often follow a traditional production-marketing strategy characterized by seasonal calving and subsequent sale of calves at time of weaning (Schroeder and Featherstone). However, agricultural economists frequently suggest other strategies, often with cattle backgrounding systems, that could increase profitability. Most calves produced on cow-calf operations in the United States are not retained even though a large number of empirical studies report improved economic returns from value-added feeding of calves (Lambert; Feuz and Wagner; Johnson, Ferguson, and Rawls; Pardue, Popp, and Garner; Watt, Little, and Petry). These studies typically utilize mathematical programming models and/or partial budgeting techniques to generate optimal marketing strategies, where calf retention for backgrounding and/or finishing are among the alternatives considered (Lambert; Schroeder and Featherstone; Ethridge et al.). Further, Young and Shumway, and Biswas et al. show that rational decision making and profit motivation generally explain the behavior of cow-calf producers, particularly when they are full-time ranchers and accrue a large share of their revenue from cattle.

Researchers suggest various hypotheses for the dichotomy between results of research studies and actual management practices of cow-calf producers. *First,* producers might be very risk averse (Lambert). According to Schroeder and Featherstone the options for calf retention involve dynamic decisions that depend upon stochastic price and rangeland or pasture decisions—the more risk averse the producers, the less attractive calf retention is as a production/marketing strategy. MOTAD and Target MOTAD analysis of Rawlins and Bernardo also showed that calf retention was perceived as more risky and thus some ranchers may opt not to feed their calves because of increased risk.

*Second,* cash flow and labor constraints might limit the ability to retain calves (Lambert). The ability of cow-calf producers to adopt downstream value-added cattle feeding activities may be subject to the same type of complexities encountered with technology adoption (Feder).

*Third,* some production/marketing strategies depend on benefitting from price cycles and seasonal variation, often requiring complex calculations. Not everyone has the skills or managerial ability to follow these strategies. Thus, managers might satisfice rather than optimize (Ethridge et al.). Investment in human capital—education, extension, and technical training—might be one way to turn satisficers into optimizers.

Most of the cited studies derived optimal production/marketing plans and then reflected on whether those plans accurately described the general behavior of cow-calf producers. An alternative modeling choice is the double-hurdle model (e.g. Young and Wilson; Haines, Guilkey, and Popkin) which might provide one suitable approach for modeling the calf-retention decision. A double-hurdle model envisions a multi-step process where a simple discrete ("adopt or not") decision is followed by a quantitative ("how many cattle") decision. When these two decisions occur simultaneously and with the same explanatory variables, the double-hurdle model is equivalent to a Tobit model (Young and Wilson). We hypothesize that the two decisions involve different factors. Specifically, a farm's financial condition, its labor situation, and the risk attitude of the farm operator would significantly affect the level of adoption in any given year. Another approach, when micro-level financial, labor, and risk data are not available, is to directly analyze only the first step, the discrete choice decision to retain calves.

The "enterprise adoption/extension" decision of backgrounding has similarities with technology adoption, where explanatory variables such as farm size, human capital (age, education, access to extension services), risk, and relative input/output prices are key factors in the adoption process (Feder and Slade; Caswell and Zilberman; Dorfman; Harper et al.;

Dinar and Yaron). Are these variables plausible candidates for inclusion in a model to explain the adoption of calf retention by cow-calf producers?

Farm size is usually positively related to technology adoption (Feder and Slade; Dorfman), although it may not always be significant (Harper et al.). Dinar and Yaron argued that larger units are more likely to adopt a new technology, although this may depend upon the lumpiness or scale of the investment, and complementarities to other production processes (Feder). However, backgrounding of weaned calves—which is often complementary to other farm activities—can be undertaken on a fairly small scale and typically does not represent a particularly lumpy investment.

Human capital variables can be problematic. Higher levels of human capital (age, experience, education) generally increase the likelihood that new technologies will be adopted, but empirical results tend to be sensitive to the variable used (Dinar and Yaron; Rahm and Huffman) because the impact of education can be complex. For example, higher levels of education should, *ceteris paribus*, increase the likelihood of adoption but better education is also likely to change off-farm labor opportunities. Thus, education is expected to have a positive impact on adoption when the analysis includes a variable measuring off-farm labor supply but may be confounded otherwise (Dorfman). Age and experience can also have intricate effects. Age and experience in cow-calf production tend to decrease the likelihood that profit-motive is a stated goal because operators who have been in the business for a long time may have higher levels of built-up equity (Young and Shumway).

Relative input/output prices, availability of pasture grazing, and hay stocks are primary components of the dynamic benefits to calf retention shown in mathematical programming models (e.g., Schroeder and Featherstone; Ethridge et al.; Rawlins and Bernardo). In a cross-sectional approach, as utilized here, changing input/output prices over time are not relevant but differing forage conditions might play a role in the decision to retain calves. Location dummies (e.g., Harper et al.; Dinar and Yaron) can be used to control for spatial variation.

## Data

In 1996, a mail survey was conducted on Arkansas cow-calf producers to determine their production and marketing practices. A random sample of cow-calf and backgrounding operations across the state with more than 50 and less than 1,000 head of cattle and calves was selected with the help of the Arkansas Agricultural Statistical Service who supervised the mailing and collection of surveys for purposes of confidentiality. Operations in this size category represented approximately 40% of beef producers and nearly 80% of beef cattle in Arkansas. With a 42.3% mail return rate, the data are representative of a major component of the beef industry in Arkansas (Popp and Parsch).

Two respondent categories were established to model the dichotomous choice of adoption of a value-added cattle feeding activity: (1) those who have not adopted value-added production are labeled "traditional cow-calf producers" and (2) those who have diversified downstream by backgrounding calves are "value-added producers"[1]. Both categories operate a cow-calf enterprise but the value-added producers also retain calves for backgrounding. Table 1 provides summary statistics from the survey on all independent variables. Fundamental data—such as the financial condition, risk preferences and labor constraints of respondents—that are hypothesized to determine the scale of adoption were not available. A full double-hurdle model is therefore not estimated[2].

[1] The "value-added producer" category includes respondents who provided cattle numbers by type (beef or dairy), sex (bull, steer, or heifer calf) from 1994 to 1996. Statistical analysis revealed no trends in the numbers but did show different cattle numbers on feed across years. "Value-added producers" were those who fed calves over a three-year period and "traditional cow-calf producers" were those who sold their calves at weaning. Additional information can be obtained from the lead author upon request.

[2] Ideally several years of data on all independent and dependent variables from each respondent would be needed to estimate the decision to background calves with a double-hurdle model.

The size of the cow herd (*SMALL, MEDIUM,* and *LARGE*) which was collected as categorical data to increase response rate (Salant and Dillman) and the acreage used for cattle (*LAND*) can be used to test whether farm size is an important calf backgrounding determinant. Gross farm income, an alternate measure of farm size, was excluded from the survey, again to increase survey response rates. Because the number of breeding cows in the herd is not a comprehensive measure of farm size, the acreage used for cattle is introduced as an additional measure of operation size.

Table 1 shows that the size distribution of traditional cow-calf operations differs from that of value-added producers. Value-added producers may use more land because (1) the tendency of value-added producers to predominantly use pasture feeding for the backgrounding enterprise has implications in regions where pasture land is scarce (Popp and Parsch) and (2) the use of different types of pasture allows for different stocking rates. Two other variables—the potential use of pasture land for crops and a regional dummy variable—are used to control for regional land use differences.

Age and education may influence a producer's ability to adapt to changing market and production conditions. Because the effect of age is not expected to be constant over the entire age range, a categorical variable (default age of 61 years or older) is used. The other two age categories were *YOUNG* (less than 40 years old) and *MIDDLE* (between the ages of 41 and 60). For education, *UNIV* was used[3] to categorize respondents into those having attended university and those who have not.

Similar to Young and Shumway we use an opinion variable to measure attitudes toward risk. The operator's opinion regarding price risk associated with backgrounding calves (see *RISK* in Table 1) is hypothesized to capture differences across the two operation types. As the *RISK* variable captured a problem with backgrounding and was scaled from strongly agree = 1 to strongly disagree = 5, we expect a positive coefficient on the likelihood that backgrounding will take place.

Another risk management strategy is business diversification through other farm enterprises (*NOTHER*). We hypothesize that operations that are already involved with value-added production may follow a similar path in their beef operation by feeding their calves to heavier weights. To test for this, the number of livestock raised commercially on farm, other than commercial beef cattle, was generated from yes/no responses on livestock categories of purebred cattle, poultry, horses, swine, dairy, and other.

Responses pertaining to producer perceptions of both benefits and costs of backgrounding were elicited. Benefits included access to animal performance data to adjust the breeding program in the cow herd (*BREED*) and the relatively higher average profitability of feeding calves to heavier weights as compared to selling calves at weaning (*PROFIT*). Costs were measured using opinion statements regarding a lack of feeding facilities (*FAC*) and the cost of financing the feeding venture (*FIN*), constraints similar to those modeled by Feder.

To model innovation, the effort devoted to forecasting prices was selected to represent sophistication in marketing. The number of sources—feeder cattle futures, auction market prices, livestock reports, market trends, contracted prices or other sources—a producer uses to forecast prices (*NPF*) is used to proxy the producer's level of attention to marketing.

Innovation in the management of calving was captured with the control over calving period(s) as a management practice and the timing of production for marketing considerations. First, the *CONTROL* variable separates producers by their use of control over calving periods. Those who restrict calving periods to a single season (any single season or two adjoining seasons) and those who practice spring and fall calving are grouped into the category that control calving periods (*CONTROL* = 1).

[3] Prior regression results with additional education variables—attendance at high school, community college, and special training seminars—were invariant to the current model specification. That is, additional education variables available from the survey did not add to the explanatory power of the model and were therefore excluded.

The remainder are those producers that essentially practice no control over breeding. The second variable, the number of calving periods (*NSEASON*), reflects the flexibility and potential profitability associated with taking advantage of seasonally high prices by marketing throughout the year. The more calving periods, the more marketing flexibility.

Dummy variables are introduced to (1) reflect the potential use of pasture for crops (*PASTCROP*) as a land quality measure and (2) account for differences in topography, proximity to feedlots, etc. by differentiating across regions. Eight dummy variables (*D2* through *D9*) are used to control for differences across the nine districts in Arkansas.

## Methodology

The decision to sell calves at weaning or to keep feeding calves to heavier weights is modeled by the following equation:

$$OPT_i = a_0 + a_k X_{ki} + \epsilon_i$$

$$k = 1, 2, \ldots, K; \qquad i = 1, 2, \ldots, N,$$

where $OPT_i$ is the $i^{th}$ producer's decision to sell calves at weaning ($OPT = 0$ for traditional cow-calf) or to keep feeding the animal ($OPT = 1$ for value-added producers), $k = 1 \ldots K$, is the number of explanatory variables ($X$), $a_0$ is a constant term, $a_k$ are the coefficient estimates, and $\epsilon_i$ is the error term for each of $i = 1 \ldots N$ observations.

Linear probability models (LPM) that use discrete dependent variables are often used to capture this type of relationship. Coefficient estimates show the impact of a one-unit change in the explanatory variable on the probability[4] that a particular choice will be made. The simplicity of this type of model, however, comes at the cost of the statistical problem of heteroskedasticity (Gujarati).

Instead, logit analysis, where the logarithm of the odds ratio in favor of feeding weaned calves $[P(OPT = 1)/(1 - P(OPT = 1)]$, is used because it removes the problem of heteroskedasticity (Gujarati; Aldrich and Nelson). In this model, the unobserved[5] chance that an operator chooses to feed calves, $P_i$, is regressed against the decision factors (explanatory variables) as shown in the following equation:

$$\ln[P_i/(1 - P_i)] = a_0 + a_k X_{ki} \equiv Z_i,$$

where

$$P_i = e^{Z_i}/(1 + e^{Z_i}) = 1/(1 + e^{-Z_i}).$$

The $\chi^2$-statistic, based on the log-likelihood ratio, is used to determine the overall fit of the model. In addition, groups of variable coefficients are tested using the same test statistic. Finally, t-statistics serve to evaluate the statistical significance of individual variables (Aldrich and Nelson).

In a logit model, the interpretation of coefficient estimates is more complex than in linear probability models. The direction of the effect is determined by the sign of the coefficient, but the magnitude of the effect of the explanatory variable on the dependent variable changes with values of the explanatory variables as follows (Aldrich and Nelson):

$$W_{ki} = \frac{\partial P(OPT = 1)}{\partial X_k} = \frac{e^{Z_i}}{(1 + e^{Z_i})^2} \cdot a_k$$

where $Z_i$ is calculated at various levels of $X_{ki}$ to show changes in $W_{ki}$, the marginal impact at various levels of the independent variables. To simplify, we report $W_k$, the average of the marginal impacts using all observations except for the binary dummy variables where the marginal impact is reported at $X_{ki} = 0$ or $1$ depending on the variable. $W_k$ indicates the av-

[4] "Probability" is used here in the sense that the average, $E(OPT_i) = \Sigma OPT_i/N$, is equal to the probability that operators choose to feed weaned calves $P(OPT = 1)$. Coefficient estimates therefore capture changes in the probability, $P(OPT = 1)$, with a one-unit change in the explanatory variable in question, holding everything else constant. This impact is constant across all levels of the explanatory variables.

[5] "Unobserved" because $P_i$, the $i^{th}$ producer's probability of feeding calves, $P(OPT_i = 1)$, is not actually observed. In the survey, producers only indicate whether they feed weaned calves or not.

**Table 1.** Description of Variables Across Operation Type in Arkansas, 1996

| Category/ Variables | Description | All Producers | Traditional Cow-calf | Value-added Producer |
|---|---|---|---|---|
| *Farm Size* | | | | |
| *SMALL* | cow herd size dummy variable (1 = 50 or fewer cows, 0 = otherwise) | 10.7%[a] | 10.5% | 11.8% |
| *MEDIUM*[b] | cow herd size dummy variable (1 = between 51 and 149 cows, 0 = otherwise) | 71.4% | 73.2% | 63.8% |
| *LARGE* | cow herd size dummy variable (1 = 150 or more cows, 0 = otherwise) | 17.9% | 16.3% | 24.4% |
| *LAND* | owned and rented acreage used for cattle enterprise in 1995 | (454.3, 384.0)[c] | (427.7, 297.7) | (566.0, 618.0) |
| *Human Capital* | | | | |
| *YOUNG* | producer age dummy variable (1 = up to age 40, 0 = otherwise) | 10.9% | 9.9% | 15.0% |
| *MIDDLE* | producer age dummy variable (1 = age 41 to 60, 0 = otherwise) | 58.9% | 58.6% | 59.8% |
| *OLD*[b] | producer age dummy variable (1 = older than age 60, 0 = otherwise) | 30.3% | 31.5% | 25.2% |
| *UNIV* | operator education (1 = has attended university, 0 = otherwise) | 3.89% | 3.67% | 4.80% |
| *Risk and Diversification* | | | | |
| *RISK*[d] | operator's opinion on *The **problem** with feeding calves on my farm is that prices of feeder cattle change too much (too risky)* | (2.45, 0.96) | (2.32, 0.91) | (3.00, 0.96) |
| *NOTHER* | number of livestock enterprises on farm (other than commercial beef production) | (1.20, 0.67) | (1.19, 0.65) | (1.22, 0.76) |
| *Benefits and Costs of Backgrounding* | | | | |
| *BREED*[d] | operator's opinion on *The **benefit** of feeding calves is that I can better adjust my breeding program since I know how animals perform* | (2.35, 0.76) | (2.40, 0.77) | (2.17, 0.66) |
| *PROFIT*[d] | operator's opinion on *The **benefit** of feeding calves is that it is on average more profitable than selling weaned calves* | (2.71, 0.93) | (2.87, 0.89) | (2.06, 0.77) |
| *FAC*[d] | operator's opinion on *The **problem** with feeding calves on my farm is that I don't have the facilities to feed weaned calves* | (2.78, 1.17) | (2.57, 1.11) | (3.65, 0.96) |
| *FIN*[d] | operator's opinion on *The **problem** with feeding calves on my farm is that financing the feeding is too costly* | (2.09, 1.00) | (1.97, 0.95) | (2.61, 1.05) |

**Table 1.** (Continued)

| Category/ Variables | Description | All Producers | Traditional Cow-calf | Value-added Producer |
|---|---|---|---|---|
| *Management* | | | | |
| *NPF* | number of sources used to forecast prices for end of feeding period | (2.52, 1.18)[c] | (2.38, 1.13) | (3.08, 1.21) |
| *CONTROL* | level of control over calving (1 = one or two distinct calving periods; 0 = no control over calving period or year-round calving) | 65.2% | 62.6% | 76.4% |
| *NSEASON* | reported # of seasons (spring, summer, fall, winter) calving took place | (2.51, 1.17) | (2.56, 1.19) | (2.30, 1.06) |
| *Region* | | | | |
| *PASTCROP* | alternative land use (1 = crop land used as pasture, 0 = pasture can't be used for crops) | 4.8%[a] | 3.4% | 11.0% |
| *D1*[b] | Producer district dummy variable (1 = Northwest district, 0 = otherwise) | 28.3% | 27.5% | 31.5% |
| *D2* | Producer district dummy variable (1 = North central district, 0 = otherwise) | 14.1% | 14.6% | 11.8% |
| *D3* | Producer district dummy variable (1 = Northeast district, 0 = otherwise) | 8.2% | 7.9% | 9.4% |
| *D4* | Producer district dummy variable (1 = West central district, 0 = otherwise) | 19.1% | 19.5% | 17.3% |
| *D5* | Producer district dummy variable (1 = Central district, 0 = otherwise) | 6.8% | 6.2% | 9.4% |
| *D6* | Producer district dummy variable (1 = East central district, 0 = otherwise) | 2.0% | 2.1% | 1.6% |
| *D7* | Producer district dummy variable (1 = Southwest district, 0 = otherwise) | 15.1% | 16.5% | 9.4% |
| *D8* | Producer district dummy variable (1 = South central district, 0 = otherwise) | 4.5% | 4.7% | 3.9% |
| *D9* | Producer district dummy variable (1 = Southeast district, 0 = otherwise) | 2.0% | 1.1% | 5.5% |
| *Dependent Variable* | | | | |
| *OPT* | Operation type dummy variable (1 = value added, 0 = traditional) Number of observations | 661 | 534 | 127 |

*Notes:*

[a] Percentages of all producers, traditional cow-calf and value-added producer respondents with the indicated characteristics (i.e. response of 1).

[b] Not included to avoid singular matrix.

[c] Numbers in parentheses represent the average and standard deviation of the variable in question, respectively.

[d] Survey respondents could choose among five levels of agreement (Strongly Agree = 1, Agree = 2, Neutral = 3, Disagree = 4, Strongly Disagree = 5).

erage impact of a one-unit change in the explanatory variable on the likelihood that an operator chooses to background calves. Finally, the relative importance of each variable is directly related to the absolute value of the coefficient estimate.

## Results

Table 2 shows the results of the logit estimation. The log-likelihood ratios and associated p-values indicate that all attribute categories—with the exception of human capital and region—were statistically significant. Likewise, the overall model was highly significant and had an overall accuracy of 85%, predicting the traditional cow-calf operation type correctly 94% of the time and the value-added producer operation type 46% of the time. Discussion of results for the different variables are grouped into farm size, human capital, risk and diversification, benefits and costs of backgrounding, management, and regional categories.

### *Farm Size*

As a group, the farm size variables were significant. The coefficient for the *LAND* variable was very small and positive as expected. The larger the acreage used for beef cattle, the more likely an operator chose to feed weaned calves. On average, a 100-acre increase in land would lead to a 1% (100 units × $W_{LAND}$) increase in the likelihood that an operator will background calves. The coefficients of the *SMALL* and *LARGE* operations were insignificant, suggesting that there are no significant economies of size in feeding weaned calves. Because capital investments for this type of feeding activity are not substantial, this result is similar to Feder's lumpiness of investment contentions for the likelihood of technology adoption across different size operations.

### *Human Capital*

None of the age and education variables was effective in capturing differences among traditional cow-calf and value-added producer operations. The coefficients were not statistically significant either individually or as a group of variables. Confounding influences in human capital variables may underlie this lack of significance. For example, off-farm employment opportunities may be a factor (Dorfman) that would justify the sign on the *UNIV* variable. Younger operators or those with a university education may view off-farm labor opportunities differently than older producers or those who are not as educated. Unfortunately, the survey did not include more precise variables to capture operator experience, off-farm employment opportunities, and the labor situation on farm to offer more insights into human capital issues.

### *Risk and Diversification*

The operator's opinion on the price risk associated with the backgrounding of calves was an important determinant of the likelihood that backgrounding took place on farms. Operators who reported that price risk was not a significant problem were more likely to feed than those who did. This shows that there may be important differences in the perception of price risk between producers who operate a cow-calf enterprise and those who also feed weaned calves. The result indirectly supports the results of Schroeder and Featherstone who argued that a cow-calf operation's overall risk can be reduced if backgrounding takes place. On the other hand, the question revealing risk perception (see *RISK* in Table 1) may include elements of an objective risk measure (price variation) *and* attitude towards risk (belief that prices change too much). In that sense, the significant coefficient for *RISK* suggests that ranchers who are optimistic—that is, they do not perceive risk as excessive—tend to invest in value-added cattle production. The second variable, *NOTHER*, was not significant, which indicates that producers who have already diversified into other value-added enterprises are not more likely to background than those who have not. This may suggest that synergies across value-added enterprises are not important factors in the decision to invest in another value-added enterprise.

**Table 2.** Summary of Statistical Results of the Logit Model

| Category/ Variables | Coefficients[a] | Standard Errors | Marginal Impact $W_k$[b] (in %) | Log-Likelihood Ratios (p-value) |
|---|---|---|---|---|
| Constant | −6.5953** | 1.4124 | — | — |
| *Farm Size* | | | | |
| *SMALL* | 0.3413 | 0.4130 | 3.674 | 6.9480* |
| *LARGE* | −0.2974 | 0.3304 | −3.921 | (0.0736) |
| *LAND* | 0.0009** | 0.0004 | 0.010 | |
| *Human Capital* | | | | |
| *YOUNG* | 0.438 | 0.4266 | 5.729 | 3.1396 |
| *MIDDLE* | 0.1412 | 0.2880 | 1.449 | (0.3706) |
| *UNIV* | −0.3830 | 0.2623 | −3.703 | |
| *Risk and Diversification* | | | | |
| *RISK* | 0.4185** | 0.1469 | 4.311 | 10.3643** |
| *NOTHER* | 0.2704 | 0.1848 | 2.785 | (0.0056) |
| *Benefits and Costs of Backgrounding* | | | | |
| *BREED* | 0.2454 | 0.1924 | 2.528 | 100.6812** |
| *PROFIT* | −1.0321** | 0.1669 | −10.633 | (0.0000) |
| *FAC* | 0.6772** | 0.1244 | 6.976 | |
| *FIN* | 0.2110 | 0.1346 | 2.173 | |
| *Management* | | | | |
| *NPF* | 0.2797** | 0.1101 | 2.882 | 12.1473** |
| *CONTROL* | 1.1753* | 0.6502 | 9.916 | (0.0069) |
| *NSEASON* | 0.5797** | 0.2711 | 5.972 | |
| *Region* | | | | |
| *PASTCROP* | 0.6309 | 0.4803 | 10.594 | 14.0450 |
| *D2* | −0.7513* | 0.4156 | −7.084 | (0.1207) |
| *D3* | −0.4882 | 0.4613 | −6.024 | |
| *D4* | −0.3867 | 0.3682 | −3.602 | |
| *D5* | −0.1235 | 0.5010 | −1.453 | |
| *D6* | −0.8331 | 0.9786 | −7.559 | |
| *D7* | −0.8583** | 0.4335 | −6.599 | |
| *D8* | −0.3446 | 0.6436 | −3.386 | |
| *D9* | 1.2377* | 0.7185 | 22.889 | |
| Log-Likelihood | −220.5989 | | | |
| Restricted ($a_k = 0$) Log-Likelihood | −323.4282 | | | |
| $\chi^2$-value | 205.6586 | | | |
| Calculated Significance Level | 0.000 | | | |
| McFadden's $R^2$ | 0.3179 | | | |
| Number of Observations | 661 | | | |

*Notes:*

[a] * and ** indicate significance at the 10% and 5%, respectively.

[b] For the binary dummy variables, *SMALL, LARGE, YOUNG, MIDDLE, PASTCROP*, and regional dummy variables *D2 . . . D9* the marginal impact is calculated at $X_{ki} = 1$ and at $X_{ki} = 0$ for *CONTROL* and *UNIV*.

### *Benefits and Costs of Backgrounding*

This category contained four variables which measured producer attitudes about the perceived benefits and costs of backgrounding. Among the benefits to feeding calves were access to information on livestock performance and the perceived profitability of such an enterprise. The sign of the coefficient on the *BREED* variable was not significant. Cow-calf producers may be more interested in other cattle characteristics, such as calving ease and milking ability, than in the performance of their weaned calves on their own farms in choosing their breeding program (Sy et al.).

The opinion on profitability of the backgrounding enterprise was a significant and numerically important factor in deciding to feed weaned calves. Results show that the perception of profitability of backgrounding has a large positive[6] impact and leads an operator to adopt the value-added enterprise. The profitability question might be a tautology—you background if you think it profitable and do not otherwise. Although profit no doubt influences the decision, inspection of mean values in Table 1 suggests the effect is not that direct. On average traditional cow-calf operators did *not* disagree with the statement even though they did not background calves. This supports the contention that producers are motivated by profits as argued by Biswas et al. and Young and Shumway.

Among problems that producers might face when making the decision to feed weaned calves on their own farm are a lack of facilities (*FAC*) and the high cost of financing the feeding enterprise (*FIN*). The signs of the coefficient estimates were positive as expected. A lack of facilities was a significant factor while the cost of financing was not. Given the access to relatively low-cost financing during the time of this survey, credit scarcity does not appear to be a major constraint to adoption.

[6] Given the scaling of the attitude variables, a negative coefficient on the *PROFIT* variable actually implies a positive relationship between the attitude towards higher profitability with backgrounding and the likelihood that backgrounding takes place.

### *Management*

Both marketing (*NPF* and *NSEASON*) and production (*CONTROL*) variables were significant. These results indicate a direct relationship between the effort expended on forecasting prices and the likelihood that an operator will engage in the feeding of weaned calves. The causality between *NPF* and *OPT* is tenuous. These results must therefore be considered preliminary, with no implications of causality but merely association, until data for a better specified model are available. Nonetheless, attention to marketing in light of the importance of price risk identified above is an important attribute of the backgrounding decision.

More important, by the absolute value of the coefficient, is the need to control calving periods as measured by the *CONTROL* variable. The results also indicate that additional marketing flexibility (*NSEASON*) increases the likelihood that calves are fed on farms. This result appears to be at odds with the results on the *CONTROL* variable. Implicitly, there is a trade off between cost savings and production efficiencies derived from controlled breeding and the gains from additional marketing flexibility. Both results are significant and show that production control and marketing flexibility are prerequisite to backgrounding. Perhaps controlled spring *and* fall calving offers a solution to this tradeoff as both control and marketing flexibility are present. These results also support Harper et al.'s insight into the direct relationship between adoption and the existing level of innovation in management.

### *Region*

Land quality as measured in the *PASTCROP* variable had an insignificant impact on the likelihood of backgrounding. The regional dummy variables show some significant and large deviations from the base production district in the Northwest of Arkansas. For *D2* and *D7*, both largely forested regions, a lack of available pastures may be the cause. In the case of *D9*, access to relatively cheap feed sources is conjectured to have caused the deviation.

## Conclusions

The results of this study suggest that producer perceptions about profitability, risk, and facilities are significantly associated with calf retention decisions. After we controlled for farm size and human capital differences, the perceptions of producers were significant and numerically important factors in the decision to invest in downstream value-added cattle production. Generally, producers that perceive the investment as profitable, without additional price risk, and within the capacity of their physical facilities tend to invest in backgrounding. This suggests that extension efforts should be focused on price risk management, feeding technology, and ways to convert existing facilities to accommodate feeding. Benefits to feeding do not necessarily lie in superior access to performance information but rather in the belief that feeding is more profitable than selling at weaning. Contrary to popular belief, farm size and scale of cattle production have minimal impacts on the decision to invest in cattle backgrounding. Control over production and marketing flexibility was also critical to the adoption of backgrounding.

Additional research on human capital issues is required to more explicitly model operator experience and labor utilization in the feeding enterprise in relation to the rest of the farm operation. Also, the analysis was limited to a discrete data choice to adopt (or not) backgrounding because data limitations prevented the estimation of a full double-hurdle model. The specification of the second stage, to explain the actual magnitude of the backgrounding activity, would require more specific information about the financial and labor situation on the farm as well as knowledge about the operator's risk preferences.

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