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**Factors Affecting the Decision to Exit Farming:  
A Maine Dairy Industry Study**

**Lisa Bragg**

## **Factors Affecting the Decision to Exit Farming:**

### **A Maine Dairy Industry Study**

Substantial attention has focused on the dairy industry due to concern that current low milk prices are driving many producers out of dairying. Broader research findings reveal there are farm characteristics beyond profitability, both endogenous and exogenous, that affect the decision of an individual producer to exit farming. A binary choice logit regression model, based upon the dependent variable decision to exit or remain in the industry, was utilized to ascertain why Maine dairy producers are choosing to leave the industry. The hypothesis states that the decision is a function of three independent variable categories: demographic, efficiency, and opportunity costs. Results reveal that five variables significantly influence the exit decision: operator's age, milking technology, milking herd productivity, feed efficiency, in addition to net cash profit. Findings from this research support a broader focus of dairy support programs beyond the scope of price supports to reduce farm exits.

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The nation's agricultural sector has experienced a decline in overall farm numbers since the 1940s. "The U.S. milk production industry has been no exception, with increased consolidation and accompanying exit of firms as greater production efficiency has been sought" (Rahelizatovo and Gillespie, p. 333). Concern arises over this decline because the loss "adversely affect(s) agribusiness firms...and the well being of farming-dependent areas" (Stam et al., p. 6).

Technological advances leading to increases in milk production per cow have contributed to industry contraction since 1970. Additionally, current low milk prices are cited as a contributory factor producing a 3.7% decline in national dairy farm numbers during 2001-02 (Olson). Maine experienced a 10.4% decline in total dairy farm numbers over that same period and represented the highest percentage loss for the Northeast region. An additional 19.4% of the state's dairy producers are expected to leave the industry within the next five years (Dalton and Bragg).

Low milk prices, and resulting low on-farm income, influence the exit decision. However, broader research findings from the nation's agricultural sector indicate that there are additional factors, both pull and push, impacting an owner's decision to exit the industry (Bentley and Saupe; Ehrensaft et al.; Gale; Goetz and Debertin; and Rahelizatovo and Gillespie). For example, producers in southwestern Wisconsin identified age as an important factor influencing their decision (Bentley and Saupe).

The purpose of this paper is to derive the determinants influencing the decision to exit the Maine dairy industry. Primary data from the state's producers will be analyzed using a binary logit regression model with two options: exit or remain in the industry.

Independent explanatory variables representing individual farm characteristics are classified into demographic, efficiency, and opportunity cost categories. This model will define those variables significant to the exit decision and allow for prediction of the odds an exit decision occurs. The marginal response will be isolated to evaluate the change in the odds of an exit decision occurring based upon a change in a selected variable.

This research will provide significant support to the industry in their efforts to reduce the decline in dairy farm numbers. More importantly, defining which factors, beyond profitability, that impact an owner's decision to exit the industry provides both the state and dairy industry organizations with powerful policy information. This information can be used to focus resources on maintaining a balanced flow of producer entrants and exits to achieve the goal of a healthy dairy industry in Maine.

## **LITERATURE REVIEW**

Economic theory indicates the shut down decision should be based on the comparison of a product's price in the market relative to an individual producer's short run average variable costs. Producers making the choice to shut down or exit would be those facing a current milk price below their minimum average variable cost. However, producers may not follow the narrowly defined economic shut down rule because milking is a dynamic production process that does not allow for immediate shut down of operations. Rather they might try to lower their average variable costs by exploiting family resources and pay themselves no wage or supplement their negative economic profit with past savings to smooth farm accounts. Additionally, a trigger price might occur at a point higher than the lowest average variable cost which could initiate a

planning process for an anticipated shut down. Also, if the expected long-run price is higher than the cost of production, a producer may continue to milk despite a “temporary” price below the minimum of the average variable cost curve. Previous research analyzing exits from agricultural industries conclude there are a number of factors, other than economic profit, impacting a shut down decision that are of equal importance and provide insight as to why reality differs from theory (Bentley and Saupe; Ehrensaft et al.; Gale; Goetz and Debertin; and Rahelizatovo and Gillespie).

Boehlje’s life-cycle model is empirically tested to “examine effects of farmer age...on farm size and growth” (Gale, p. 115). Gale hypothesized that the farm followed a pattern similar to that of the producer, indicating that an exit decision is influenced by a producer’s age. Regression analysis revealed that industry exits occur with greater frequency among older individuals. Additionally, entry and exit analysis of structural changes on North American farms provides support for the disinvestment stage of the life-cycle model by finding farmland contraction in older age cohorts (Ehrensaft et al.).

Studying the effects of off-farm income on the exit decision indicates that it can provide support during a time of instability or lessen transition costs incurred when moving to alternative employment (Goetz and Debertin). Regression analysis based upon utility theory identified variables influencing the exit rate. Results show that off-farm employment leads to higher levels of farm exits; most notably in counties that were already experiencing farm losses.

One hundred and seven New York dairy farms were analyzed to determine the relationship between production, financial, and human resource factors and profitability



(Gloy, Hyde, and LaDue). The number of cows, production per cow, and milking system defined the production factor variables and return on assets (ROA) defined the profitability variable. Regression analysis identified all production factors as significantly influencing the ROA ratio. Extending this conclusion one step farther suggests that they could also affect the exit decision.

To maintain a healthy and diverse industry requires, at a minimum, balancing the net effect of owners both exiting and entering dairying. A study of the U.S. farm sector following the 1980s farm crisis reveals that “entry and exit is comprised of three components. First is the regular and predictable component resulting from the aging and eventual retirement of current farmers. Second is the early departure of established farmers.... Third ...is the entry rate of new farmers. These components together account for the net change in the total number of farms” (Stam et al., p. 7). This study of the exit decision, and the factors motivating that decision, provides insight into the first two of these three components.

### **DATA SOURCE AND ECONOMETRIC MODEL**

In 2002, 425 dairy producers in the state were surveyed to determine the cost of producing milk in Maine. One hundred and fifteen dairy farms responded to the survey and were selected for this analysis. Six organic farms and three surveys identified as statistical outliers were separated from the sample population for separate analysis. The final sample yielded 106 farms and represented 25% of the state’s dairy producers.

A binary logit regression model, based upon the dependent variable decision to exit or remain in the industry, was used to ascertain why dairy producers are choosing to

leave the industry. Following Pindyck and Rubinfeld, the logit model can be estimated according to Equation 1:

$$\log \frac{P_i}{1 - P_i} = O_i = Z_i = \alpha + \beta_i X_i \quad (1)$$

where  $P_i$  represents the probability of the exit decision occurring. The log of the probability ratio converts the probability value to the odds value. Therefore, the dependent variable  $O_i$  represents the odds an individual operator will exit based upon independent variables,  $Z_i$ . The assigned value is one if the operator expects to stop milking within the next five years and zero if otherwise.  $\beta_j$  represents an unknown vector of coefficients associated with each explanatory variable,  $X_i$ , and  $\alpha$  is a constant.

This study hypothesizes that the decision is a function of three independent variable categories: demographic ( $D_i$ ), efficiency ( $E_i$ ), and opportunity costs ( $C_i$ ). The vector of category coefficients are represented by  $\lambda$ ,  $\delta$ , and  $\theta$ . The error term is defined as  $\varepsilon_i$  and  $e$  represents the base of natural logarithms. The completed logit equation is specified in Equation 2 and estimated using a maximum likelihood procedure.

$$O_i = F(Z_i) = \frac{1}{1 + e^{-(\alpha + \lambda_r D_i + \delta E_i + \theta C_i + \varepsilon_i)}} \quad (2)$$

### Description of Model Variables

A total of eleven variables, reflecting individual farm characteristics, were selected for this analysis. The demographic category is comprised of age and education variables. The life-cycle model of investment, expansion, and disinvestment, and hence the influence of a producer's life-cycle stage on the exit decision, is captured by the age

variable. Because producers of retirement age or older “may reduce farm size in order to reduce work effort as their health declines or to accommodate reduced income needs”, it is hypothesized that the odds of disinvestment behavior, reflected as the exit decision, should increase with age (Gale, p. 114). Human capital and managerial ability is represented as the producer’s highest year of formal education. Higher levels of education can be positively or negatively correlated to the odds of the exit decision by either creating the chance to access diverse employment opportunities or by increasing the willingness to adopt management intensive systems in an effort to improve efficiency.

The efficiency category can be further separated into two subcategories: technical and financial. Milking herd size, milking system technology, milking herd productivity, and labor efficiency delineate the technical efficiency category. A farm’s milking herd size acts as a reflection of total capital investment and overall farm size. In view of an increasing potential to benefit from economies of scale as a farm size increases, it is hypothesized that producers on smaller farms are more likely to choose to exit. The milking technology variable separates the sample according to milking system employed. Because the stanchion or tie stall milking system requires more labor and less investment, it is hypothesized that producers using this system are more likely to exit the industry.

The milking herd productivity variable implicitly captures all milk-yield maximizing management practices used to improve or maintain herd productivity, such as scheduled veterinary services, balanced feed rations, or herd management records. It is hypothesized that producers not employing herd management techniques would not maximize herd output. Subsequently, lower net revenues are realized and the likelihood

of exit is increased. The labor efficiency variable captures all management practices used to improve labor productivity. Producers better able to manage labor resources increase milk production per worker and, for that reason, it is hypothesized that producers requiring more labor hours per milk cow are more likely to exit.

Total asset turnover ratio, feed cost efficiency, and net cash revenue encompass the financial efficiency category. The total asset turnover (TAT) ratio is a measure of the producer's ability to utilize capital to generate sales and it is hypothesized that producers earning lower ratios would have a greater likelihood of exiting the industry.

“Measur(ing) the effectiveness of management in controlling the largest cost items in producing milk” is done through the feed efficiency variable (OSU). Those producers experiencing higher purchased and produced feed costs per cow are hypothesized to be more likely to exit the industry.

A direct measure of farm profitability is included as the net cash profit variable. Cash costs are defined as explicit cash expenses on a per cwt measure and can be segmented into four different expense categories: herd health management, crop and feed, farm maintenance, and labor. It is important to note that family labor is not included in the labor expense calculation based upon indications that “small farmers exploit their own labor or capital rather than going out of business when prices fall” (Zepeda, p. 838). Cash revenue is defined as net cash income generated solely from milk sales on a per cwt measure. Based upon the economic shutdown rule, it is hypothesized that those producers earning lower net cash revenues would choose to exit the industry.

The opportunity cost category is comprised of the importance of off-farm income and diversity of on-farm income variables. Producers are predicted to perceive lower transaction costs when transitioning out of the industry to alternative employment whether they, or another family member, is currently employed off the farm. As a result, it is hypothesized that the likelihood of exit increases among producers who earn 50% or more of total farm income off-farm. Determining the percent contribution of milk, crop, and livestock sales to total on-farm revenue using the Herfindahl index defines the diversity of on-farm income. Successful diversification can be positively or negatively correlated to the exit decision by either lowering the transition costs of moving into a different agricultural activity or by reducing volatility of farm income during a period when the milk price falls below the average variable cost of production, respectively.

A summary of the variables used in the model is presented in Table 1.

Comparison, through a t-test, of the mean values of all variables reveals the cohort of producers exiting the industry is different than the cohort remaining in the industry. Exiting producers are older, employ a stanchion or tie-stall barn, have fewer livestock holdings, and diversify on-farm income to a greater degree.

### **LOGIT MODEL RESULTS**

Regression analysis identified five significant determinants. The accuracy of the model as a predictor is 82.9%. And, the results of the model are presented in Table 2. The negative signs of the milking system technology and milking herd productivity variables indicate the odds of exit increase by employing a stanchion or tie-stall milking system or by decreasing the levels of output per milk cow. The stanchion or tie stall

system, being less capital-intensive than a parlor system, allows the producer to carry a smaller debt load, which in turn allows for a relatively easier exit from the industry. Lower milk production per cow bears broader consequences on realized net revenue due to lower total herd yields, thereby increasing the likelihood of exit.

The positive signs of the age and feed efficiency variables indicate the odds of exit are reduced if a producer is younger or feed costs per milk cow are lower. Results from the age variable support the life-cycle model and indicate that the older a producer is, the more likely they are to exit. The positive sign of the feed efficiency variable indicates that as feed costs per milk cow increase, exit becomes more likely. While the herd size variable is not significant in the regression model, the difference in mean statistical values between the two cohorts is significant, thus allowing a weak inference that producers not exiting the industry might benefit from economies of scale due to the fact that exiting producers have smaller livestock holdings and higher feed costs.

The positive sign of the net cash profit variable is unexpected. This signifies that as the farm's net cash profit increases, the likelihood of industry exit increases as well. Assuming perfect competition, the increase in net cash profit is achieved through expenditure reduction indicating that producers managing costs more efficiently are more likely to exit the industry.

#### Marginal Analysis

The method used to evaluate the marginal change in the odds of a particular producer making the exit decision requires a minor transformation of the log odds formula. The goal is to isolate a variable from the others to determine the impact a

change in the factors underlying that variable will have on an owner's odds of exit. The marginal impact of that change is determined using Equation 3.

$$\frac{\partial \hat{O}_i}{\partial X_i} = 100(e^{\beta_j}) - 1 \quad (3)$$

Calculated is the estimated percentage change in the odds an operator will choose to exit the industry given a one-unit change in the selected variable<sup>1</sup>. The results are reported in the 3<sup>rd</sup> column of Table 2.

Results indicate that as a producer's age, feed efficiency, and net cash profit increases, the likelihood the exit decision will occur also increases. Increasing milk production per cow reduces the likelihood of an exit decision. And, any change of milking technology swamps all other changes in marginal odds. The odds of a producer exiting are significantly reduced if a parlor system is implemented or already employed. The capital-intensive nature of such a system may create a disincentive to exit and provide an explanation for this result.

## CONCLUSION

Attention has focused on the Maine dairy industry due to concern that current low milk prices are driving many producers out of dairying. The state has taken proactive steps to try to slow the number of producers choosing to exit through the implementation of price support programs. Recognizing that these supports benefit the industry to the

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<sup>1</sup> The marginal impact of an explanatory variable on the probability is not a constant, therefore the marginal impact upon the odds ratio is chosen instead. This is due to the nonlinear and nonadditive properties of the logit model (Demaris).

greatest degree when used only in the short-run, the goal of this research is to identify additional issues that, if addressed, would bolster the strength of the industry.

A binary choice logit regression model was utilized to derive the determinants that play a role in the exit decision for Maine dairy farmers. Findings confirm that there are factors, in addition to net cash profit, influencing an individual's exit decision. These additional factors are operator's age, milking system technology, feed cost efficiency, and milking herd productivity. Regression analysis returned expected signs on four of these significant variables indicating that the likelihood of exit is increased as the producer ages and as feed costs rise and that the likelihood of exit is lowered when a parlor milking system is employed or productivity of the milking herd increases.

Based upon these results, three courses of action are recommended to supplement the price support programs as well as provide long-run industry support options. Linking exiting producers, wishing to transfer the farm outside of the family, to younger potential entrants addresses the predictable component of producer retirement. Exploring methods to lower feed costs is a second means of reducing the likelihood of exit. However, careful evaluation at the farm level, based on strengths, weaknesses, and potential for feed production, is required to determine the best mix of produced versus purchased feed. And, supporting programs designed specifically to foster use of practices such as scheduled veterinary service, balanced feed rations, and herd management records reduces the odds of exiting by improving overall herd productivity.

Results pertaining to the net cash profit variable run counter to economic theory and the hypothesized result. The positive sign on the coefficient indicates that as short



run cash profits increase, the odds of a producer choosing to exit increases as well. In other words, producers managing farm costs more effectively are more likely to exit the industry. This unexpected result is most likely due to the exclusion of family labor from the net cash profit variable. Further research should be conducted on this variable to ensure family labor, which implicitly contributes greatly to total farm costs, is captured.

Additionally, this result holds important implications for the price support systems previously discussed. These supports act as mechanisms to increase net revenue through supplementing the market price for milk. The positive correlation between net cash profit and industry exit indicates these supports have the potential to generate the unintended effect of causing more producers to exit.

Findings from this research support a broader focus of dairy support programs beyond the scope of price supports to reduce farm exit. A healthy and diverse industry is maintained through a balanced flow of exits and entrants. Unique challenges and solutions are presented because factors impacting exiting producers influence entering producers as well. Defining those factors provides direction for further public policy action.

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**Table 1:** Description of determinants selected for regression analysis.

Variable	Description	Mean	Std. Error
Age	Operator's age (year)	53***	11
Edu	Operator's highest year of formal education	13	2
Herd mlk	Milking herd size (# of cows)	149*	217
Dum sys	Milking technology (0= Stanchion or tie stall) (1= Parlor)	0.4*	0.5
Eff prod	Milk production (cwt/milk cow)	117	32
Eff lab	Labor hours utilized for milking and feeding (hrs/yr)	41	28
Eff tat	Total asset turnover (farm sales \$/ capital assets \$)	1.3	2.6
Feed mcw	Total feed costs (\$/milk cow)	\$597	\$411
Dif cash	Net cash profit (\$/cwt)	\$4.99	\$4.48
Dum inc	Off-farm income importance (0=<50% of total income) (1=50% or more of total income)	0.2	0.4
Herfindahl index	Diversity of on-farm income	8901***	940

N=76

\*, \*\*, \*\*\* Indicates means are statistically different at a 1%, 5%, and 10% level, respectively.

**Table 2:** Logit model estimates of the odds of an exit decision.

Variable	Coefficient	Std. Error	Marginal Value
Age (operator's age)	0.060***	0.035	6.2
Edu (owner's highest year of formal education)	0.095	0.154	10.0
Herd mlk (milking herd size)	-0.003	0.006	-0.3
Dum sys (0 = stanchion or tie stall) (1 = parlor system)	-1.736***	1.044	-82.4
Eff prod (cwt/milk cow)	-0.023***	0.012	-2.3
Eff lbr (labor hrs/yr. used milking and feeding)	-0.009	0.014	-0.9
Eff tat (total asset turnover ratio)	-0.125	0.151	-11.8
Feed mcw (\$/milk cow)	0.003***	0.002	0.3
Dif cash (\$/cwt)	0.249***	0.136	28.2
Dum inc (importance of off-farm income)	0.604	0.845	82.9
Herfindahl index (diversity of on-farm income)	-0.001	0.0004	-0.1
Constant	-0.543	5.101	na

N=76

Nagelkerke  $R^2$ : 0.42

Percentage of correct predictions: 82.9%

\*, \*\*, \*\*\* Indicates means are statistically different at a 1%, 5%, and 10% level, respectively.