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FACTORS INFLUENCING FARM INVESTMENT BEHAVIOR

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A knowledge of the investment behavior of farmers should allow policy makers to improve their estimates of farmer response to changing investment stimuli and increase their ability to influence investment through appropriate changes in policy variables. Such knowledge may also allow farm suppliers to influence demand for their products by addressing those factors that influence investment in their product or in items that use their product. For example, an electric company may be able to limit the need to expand generating capacity by encouraging investment in energy saving equipment or facilities.

What we are reporting today is a small part of a study on the Future Directions for the Upstate New York Agricultural Economy with Special Reference to the Potential for Electrical Energy Conservation. The study group conducting this research has five separate tasks, one of which is an investigation of the investment behavior of farmers. We will be discussing: (1) some of the results of our literature review, (2) the data collected, (3) some basic relationships we have found in the data, and (4) two models we have developed relative to investment in specific equipment items.

The Literature

To initiate this study, a comprehensive review of the literature was conducted (Brase and LaDue). The literature identifies a large number of variables as determinants of investment behavior. A partial list appears in the left column of Table 1. When you think about each of these factors individually, there is some economic logic for each of the factors. However, the basic question that is not answered by the literature is which factors are really important, or the most important. Or, there may be a more basic question as to whether there are a limited number of basic underlying forces which influence investment behavior that the variables listed in the literature are attempting to represent. If so, a number of the factors identified may reflect the same basic force.

One approach to this question is to start with a firm level neoclassical model of optimal capital accumulation (Jorgenson) where net worth (N) of the firm is given by:

$$(1) \quad N = \int_0^{\infty} e^{-rt} \left[P(t)Q(t) - w(t)L(t) - q(t)I(t)\right]$$

where:
P = Price of production (output)
Q = Quantity of output produced
w = Price of variable inputs
L = Quantity of inputs used
q = Price of capital
I = Investment in durable goods

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*LaDue is a Professor and Miller and Kwiatkowski are Research Support Specialists in the Department of Agricultural Economics at Cornell University. The authors would like to thank Loren Tauer for his review of an earlier draft. This research was sponsored by Niagara Mohawk Power Corporation, Syracuse, New York.

Table 1 *Variables Identified in Prior Research as Proxies for Factors Directly Affecting Investment*

	Input Prices	Product Prices	Input/ Output Relation	Discount Rate	Effective Planning Horizon	Utility of Expected Income
Age	N	N	I	N	D	I
Farming Experience	N	N	I	N	I	N
Education	N	N	I	N	N	N
Innovation Index	N	N	I	N	N	N
Legal Ownership	N	N	N	N	I	N
Farm Size	N	N	I	N	N	N
Farm Type	N	N	I	N	N	N
Distance to City of 20,000	N	N	N	N	I	N
Village Proximity	N	N	N	N	I	N
Risk Averseness	N	N	N	N	N	I
Interest Rate	N	N	N	D	N	N
Goals	N	N	N	N	I	I
Cash Flow	I	N	N	N	N	N
Income Expectations	I	I	N	N	N	N
Dairy Buyout Program	N	N	N	N	I	N
Management Index	N	N	I	N	N	N
Off-Farm Work	N	N	N	N	N	N
Regional Dummies	I	I	I	N	N	N
Percent Debt	N	N	N	I	N	N
Soil Quality	N	N	I	N	N	N
Decision Analysis	N	N	N	N	N	N
Tax Effects	N	N	N	I	N	N

D: Direct Proxy. I: Indirect Proxy. N: Not a Proxy

From this model it is clear that investment is a function of the prices of output, inputs and capital, the production function which establishes the level of output as a function of the amount of inputs and capital used and the time value of money or discount rate. Since optimal investment at any point in time is a function of future values of these variables, investment is determined by their expected value. Recognizing the lack of correspondence between the sale price of a used asset and the remaining flow of services from the asset implies a finite horizon and makes investment a function of the planning horizon. This lack of correspondence is particularly evident for buildings which often suffer a high level of capital loss upon construction, and new machinery which suffers a large decline in market value upon delivery at the farm.

Since investment is based on expected future income streams which are not known with certainty, expected income is probabilistic in nature. To reflect the fact that operators may value nonuniform probabilistic income streams differently, the model must be placed in a utility framework. Thus, the utility of expected income becomes a basic factor which may influence investment.

If the variables identified from the model represent the basic forces influencing investment, most of the variables identified by the literature as influencing investment are proxies for one or more of the basic forces. Some are more direct proxies than others but few could be called direct proxies for the basic forces influencing investment. Table 1 presents a categorization of the degree to which we believe the variables identified by the literature are proxies for the basic forces influencing investment. In general, studies of investment behavior have not had access to direct measures of the basic forces.

In developing models in this framework, we tried to avoid including more than one proxy for the same basic force in a model unless there was good reason to believe that the proxies would be complementary in reflecting the basic force rather duplicative. In selecting our models we considered: (1) appropriate proxy sets, (2) prior research results, and (3) the specific characteristics of the investment.

The Data

The data used in this study were collected as part of a survey of a random sample of Upstate New York farm businesses. Counties on Long Island and adjacent to New York city were excluded. One survey was used to obtain information to meet the objectives of five different groups of people. Thus, even though a personal interview was used and the survey was long, we were not able to obtain all of the information that may have been obtainable with an instrument that focused solely on investment behavior.

Data on over 1100 farms were obtained. However, some farms refused to provide the more sensitive data on such items as income or investment, which reduced the number of farms with sufficient data for inclusion in a model. The results reported in this paper include only the data on farms for which nearly complete information were obtained.

The data set is cross sectional and was collected at one point in time. The limited number of investment behavior questions that could be asked and the normal problems with respondent recall limited the amount of historical data that could be obtained. The cross sectional nature of the data set prohibits the use of many of the time series analysis procedures frequently used in investment analysis.

Basic Relationships

To obtain a basic idea of some of the general relationships that appear in the data, tables were developed for each of the variables identified in the literature as influencing investment behavior.

An example of those tables is presented in Tables 2 and 3 where investment is related to operator age. The life cycle theory of farm investment indicates that investment would be relatively modest for young farmers because they have few assets for loan security and modest borrowing capacity. Investments increase as the farm operator expands the business with growing income and improved borrowing capacity. As the operator approaches retirement investment declines and in some cases disinvestment takes place. This theory implies that investment should increase with age up to that age where farmers start to consider retirement in their planning and then investment could decline.

The amount of investment made by age group (Table 2) is consistent with life cycle theory although maximum investment occurs at a relatively early age, implying that their ability to invest is apparently important in limiting investment only during early age. Also, farmers may reach an acceptable business size relatively early in life (35-44 years of age). Thus, the lower level of investment for the 45-54 year age group may be the result of less desire to expand further rather than the incorporation of expected retirement in the planning decision process.

Table 2 *Relationship of 1985-86 Investment to Age of Farm Operator Upstate New York*

Age of Operator	Average Investment[a/] Expansion	Replacement	Total	1986 Rate of Expansion[a/]
				--Percent--
25-34	$ 2,900	$11,100	$14,000	2.9
35-44	4,400	14,000	18,400	0.7
45-54	3,400	8,800	12,200	1.1
55-64	2,000	8,500	10,500	0.8
65 plus	4,200	6,900	11,100	1.1
All Farms	$ 3,400	$10,100	$13,500	1.2

a/ For all farms.
Source: 1987 Farm Management and Energy Survey.

Investment by young farmers is clearly restricted, likely by limited income and borrowing capacity. A higher proportion of the young (25-34) expanded their businesses (Table 3) and their rate of expansion (percent increase in assets) was far above that for other age groups (Table 2). However, the amount of investment per farm was less and the size of individual expansions was smaller than that for farmers who were somewhat older.

Table 3 *Relationship of 1980-86 Expansion Investment to Farm Operator Age Upstate New York*

Age of Operator	Percent of All Farms	Percent Expanding Once or more	Percent Expanding Twice or More	Average Expansion[a]
25-34	14	47	20	$ 55,200
35-44	24	44	13	120,000
45-54	29	40	16	68,900
55-64	21	30	11	65,800
65 plus	12	23	15	70,800
All Farms	100	38	15	$ 80,400

[a] For farms that expanded. Most recent expansion only.
Source: 1987 Farm Management and Energy Survey.

Education is expected to be positively correlated to investment. The theory is that those with greater education will have better management ability, either because of what they have learned, for those who finish high school or go to a college of agriculture or business, or because of the higher level of intellectual ability required to enter other B.S. or graduate level programs. Economically, higher levels of management ability would be expected to require more other resources to reach an optimum combination of inputs. Operationally, we would expect better managers to have higher incomes making greater investment possible, and to have the ability to plan expansion of, and effectively manage, larger businesses.

The data indicate a clear positive relationship between education and investment, particularly expansion investment (Table 4). Those with more education expanded more frequently and the average size of expansion was larger (Table 5).

We do not have time today to discuss the results obtained for all of the variables investigated. Many of the variables did not have a strong enough relationship to investment to show that relationship through simple categorical tables. The variables for which relationships could be observed through this process were: (1) age, (2) education, (3) risk tolerance, (4) management, (5) size, (6) type of ownership, and (7) region of the state.

Table 4 *Relationship of 1985-86 Investment to Farm Operator Education Upstate New York*

Operator Education	Average Investment[a]			1986 Rate of Expansion[a]
	Expansion	Replacement	Total	
				--Percent--
No High School	$ 1,200	$ 7,200	$ 8,400	0.7
High School	2,700	9,600	12,300	1.0
Some College	3,300	10,300	13,600	0.7
College B.S.	7,600	15,800	23,400	3.2
Graduate	17,200	13,800	31,000	1.5
All Farms	$ 3,400	$10,100	$13,500	1.2

[a] For all farms.
Source: 1987 Farm Management and Energy Survey.

Table 5 *Relationship of 1980-86 Expansion Investment to Farm Operator Education Upstate New York*

Operator Education	Percent of All Farms	Percent Expanding		Average Expansion[a]
		Once or more	Twice or More	
No High School	20	30	11	$ 47,300
High School	50	38	13	54,000
Some College	15	44	14	81,900
College	14	42	23	99,000
Graduate	1	79	64	546,300
All Farms	100	38	15	$ 80,400

[a] For farms that expanded, most recent expansion only.
Source: 1987 Farm Management and Energy Survey.

Models of Investment Behavior

The two models of investment behavior that we are reporting on today have to do with two items of technology. These are energy (electricity) conserving technologies that have been developed during the last several years for use in the dairy industry.

The first is referred to as a heat recovery system. This is a system technology that uses the heat removed from the milk at the bulk tank to preheat water going to the water heater. Heated refrigerant from the bulk tank is used to heat the water which cools the refrigerant before it is cycled back to the bulk tank. Since dairy farms must cool all milk from animal body temperature to 32-40 degrees and use large amounts of hot water in the milking and cleaning process, large amounts of energy are used in these heating and cooling processes.

The second technology is a precooler which uses cold well water to cool milk down while it is being piped from the milking operation to the bulk tank. The milk passes through small tubes or channels that are surrounded by a counterflow of cold water. The water used in this process is frequently used for washing or animal consumption.

Both of these investments reduce energy use and, thus, cost. For most farms of any size, both are profitable investments when viewed in a net present value context.

The models used in this analysis are logit and probit models. Thus, we are dealing with the probability of investment. In reality we are looking at the probability that the farmer has invested in this technology at some point in time since its development.

Heat Recovery Model

The heat recovery model is a binomial logit model, estimated using the supplemental LOGIST procedure from the Statistical Analysis Systems Institute (SAS). The dependent variable was one (1) for farms with a heat recovery system, and zero (0) for those without such a system.

Since one of the objectives of the research was to investigate the importance of various variables to investment behavior, considerable searching within the data was anticipated. Thus, the sample was split into an estimating sample which was used to test alternative model specifications and a holdout sample which was used to determine the statistical properties of the final model. Observations were assigned to the two samples using a computerized random assignment process.

The initial model included six variables that were identified using the procedure outlined in the first (literature) section of this paper. Size of business represented by number of cows was included to reflect the economies of size inherent in such fixed investment. However, we did not expect the probability of investment to increase significantly for sizes larger than that required to establish clear profitability. For this reason, a squared term was included.

Whether a farm has a parlor or pipeline, rather than bucket milker, is expected to be important because ownership of such a system indicates an acceptance of milking system technology. Also, such systems usually use more water that must be heated for milking and cleaning.

Age was included to reflect the planning horizon of the operator. Also included was a direct measure of management which incorporated observations on a number of management functions such as obtaining price quotes, tracking market prices, recordkeeping and record use, managing personnel and reviewing performance toward goals. Better managers were expected to be more likely to observe and calculate the advantage of a heat recovery system, that is, determine whether it was a good investment. They were also likely to adopt new technology that would improve the efficiency of their business and be able to identify methods of managing the timing of water use and milk cooling to make the system effective for their farm situation.

However, when a model using these variables was estimated, a number of variables were insignificant and added little to the models ability to predict investment in a heat recovery system. Several alternate specifications were tried and evaluated based on the Chi Square value for individual variables, model statistics and the classification ability of the model.

The probability cutoff point for forecast classification of farmers as to whether they would be expected to invest or not was the sample probability of investing, which was 38.6 percent. This procedure is appropriate where the misclassification costs of type I and type II error are equal (Maddala, 1987).

Using these criteria, the "best" model contained fewer variables (Table 6), but was not particularly "behavioral" in nature. All the variables have the expected sign and are significant at the .01 level. The overall model has a high chi square. The estimated adjusted pseudo R value appears quite low, but is good for logit models with individual farm data. The C statistics[1/] is .791 which is also acceptable for this type of study. The model classified 68.5 percent of all farms correctly for the estimating sample with 66.3 percent of farms with heat recovery being correctly classified and 73.5 percent of the farms without the system being correctly classified. The classification efficiency of the model was 70.7 percent which is significantly greater than the conditional probability naive model rate of 52.6 percent.[2/]

[1/]The C statistic has a range of .5 to 1 with .5 indicating no apparent discriminatory power and 1 indicating perfect discriminatory power. It represents the probability that a randomly chosen farm with a heat recovery system will be correctly rated with greater probability than a randomly chosen farm without a heat recovery system.

[2/]The prior probability of investment is 38.6 percent, thus, the conditional prior probability of correctly classifying a farm given this knowledge is (0.386)(2.386) + (0.614)(0.614) = 52.6 percent.

Table 6 *Heat Recovery Model (Estimating Sample)*
261 Observations

Variable	Coefficient	Chi Square	P Value
Intercept	-1.93840	30.56	0.00
Cows	0.01616	21.98	0.00
Cows Squared	-0.00001	9.89	0.00
Pipeline	2.55233	11.65	0.00
Parlor	3.11514	15.35	0.00
<u>Model Statistics</u>			
Chi Square with 4 D.F.		64.09	
P Value		0.000	
Pseudo R		0.405	
C Stat		0.791	
<u>Correct Classification Percentages</u>			
Total		70.9%	
With Heat Recovery		66.3%	
Without Heat Recovery		73.5%	
Classification Efficiency		70.7%	
Conditional Naive Model Rate		52.6%	

The holdout sample results were as expected (Table 7). The coefficients differed somewhat but not significantly. The herd size squared term did become statistically significant at only the 0.05 level. The overall fit of the model was similar. The overall classification rate did decrease modestly. Surprisingly, the holdout sample model predicted farms with heat recovery systems at a much higher rate but did much poorer in classifying farms without such a system.

From this analysis, it appears that the expected profitability of these systems can be sufficiently predicted from the type of milking system and herd size that the other variables thought to influence investment add very little to the predictive ability of the model.

Precooler Model

Use of a precooler is possible only on farms with a parlor or pipeline. By making the milking system decision, farmers may simultaneously eliminate the possibility of precooler ownership. Thus, we have self-selectivity bias. We can only observe precooler ownership with farmers who have the appropriate milking system. To correct for this bias, a model of self-selectivity is used. (Maddala, 1987).

Table 7 *Heat Recovery Model (Holdout Sample)*
267 Observations

Variable	Coefficient	Chi Square	P Value
Intercept	-3.33828	28.61	0.00
Cows	0.01235	7.58	0.01
Cows Squared	-0.00001	4.97	0.03
Pipeline	2.22352	12.55	0.00
Parlor	3.55575	12.89	0.00
<u>Model Statistics</u>			
Chi Square with 4 D.F.		66.33	
P Value		0.000	
Pseudo R		0.401	
C Stat		0.772	
<u>Correct Classification Percentages</u>			
Total		68.5%	
With Heat Recovery		84.8%	
Without Heat Recovery		56.8%	
Classification Efficiency		56.8%	
Conditional Naive Model Rate		67.6%	

To estimate the likelihood of adopting a precooler, the probability of having a parlor or pipeline must be accounted for. Including this information corrects for the bias that would occur from use of only farms with a parlor or pipeline, which are effectively non-randomly selected farms because it is limited to farms with a parlor or pipeline (Heckman, 1979). Therefore, this model is a simultaneous probit model which will simultaneously estimate the likelihood of selecting a parlor or pipeline milking system and of the probability of investing in a precooler.

This model was estimated using the Bivariate probit option of LIMDEP by William Green. The two simultaneously estimated equations include one for investment in a precooler and one for ownership of a parlor or pipeline system.

Since the precooler has similar technological and investment characteristics to a heat recovery system, the precooler equation is based on the "best" heat recovery model. The probability of investment is a function of herd size and education.

Education was added to represent the likely affinity for adaption of new technology because ownership of a parlor or pipeline milking system is being handled through the second equation.

The milking systems equation includes four variables. Parlors are usually profitable for larger farm businesses and are almost an economic necessity for very large herd sizes. Pipelines are frequently used to allow milkers to handle more animals than can be handled with a bucket system. Management was included for the same reasons that it was initially included in the heat recovery system model.

Table 8 *Bivariate Precooler Model*
497 Observations

Equation 1: Y = Precooler

Variable	Coefficient	T Ratio	Significance
Intercept	-2.758	-4.231	0.00
Cows[a/]	0.908	3.799	0.00
Cowsa/ Squared	-0.083	-2.903	0.00
Education	0.102	2.642	0.01

Equation 2: Y = Parlor or Pipeline vs. Bucket

Variable	Coefficient	T Ratio	Significance
Intercept	-1.769	-6.216	0.00
Cows[a/]	2.263	10.054	0.00
Management	0.267	3.368	0.00
Region 1	0.660	2.987	0.00
Region 2	0.515	2.728	0.01
Region 4	0.452	2.059	0.04
Cash Income[b/]	0.515	1.489	0.14

Correlation = -0.752; Significant at 0.00 Level
Correct Classification Percentages

Total	65.8%
With Precooler	85.4%
Without Precooler	60.2%
Conditional Naive Model Rate	65.2%
Model's Classification Efficiency	65.8%

a/ Number of Cows/100.
b/ Cash income = (25% 1980 cash farm income + 50% 1985 cash farm income + 25% 1986 cash farm income)/100,000.

Investment in a parlor or pipeline system represents a major investment that is expected to have a relatively long life. Thus, income expectations would likely play a large part in the decision to make such an investment. Within a naive expectation framework, current net income can be used as an indicator of expected income. Thus, net cash income was included. Investment in a parlor or pipeline system could have occurred any time during the 1980-86 period so the cash flow variable used combined the farmer's estimate of net cash income for 1980, 1985 and 1986, weighted 25 percent, 50 percent and 25 percent, respectively. For those who invested before 1980 the variable represents the results of that investment and, thus, would be appropriate only if their expectation at the time of investment were fulfilled.

Regional dummies were included to reflect differences in soil and climate resources between geographical regions of the state.

All the variables in the milking system equation, except cash income, are significant at the usually accepted levels of significance (Table 8). The correlation of the error terms of the two equations was significant at the .01 level, confirming the importance of correcting the precooler equation for the selection bias that would result from estimating the precooler equation using only farms with a parlor or pipeline.

The variables in the precooler equation were all significant at the .01 level. The model does a good job of classifying farms with a precooler (85.4 percent correct). However, it is much less efficient in classifying farms without precoolers (60.2 percent). The model's overall classification efficiency is 65.8 percent which is above but likely not significantly different from the conditional naive model rate of 65.2 percent.

Conclusions

The results presented today are preliminary and, thus, our conclusions are tentative. However, most of the variables identified by the literature as important in investment behavior are of little value in predicting investment in heat recovery systems or precoolers. It appears that size of herd is the most important determinant. Size combined with some measure of milking technology adoption, either the presence of a parlor or pipeline, or level of education, provide as much explanatory power as models including more variables. This might be interpreted to say that the basic expected profitability of these investments is determined by herd size and that fact determines adoption with some modification of adoption rates depending upon the operators receptiveness to new technology. These results may be specific to the particular investments considered, which are generally modest in price. But, based on the results of the analyses conducted, it appears that while the variables listed in the literature may be important to some farmers, their importance is not generalizable to the entire dairy farm population.

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