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Defining and Characterizing Approaches to Farm Management

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Exploratory factor analysis was used to identify approaches to farm management based on a list of management questions posed to a sample of U.S. cash-grain farmers. Three approaches were identified by the factor analysis: price negotiation, long-term cost control, and input adjustment. Estimated factor scores regressed against farm and operator characteristics indicate a profile of producers using each approach that is closely related to stage-of-life of the farm operator and farm business. In addition to operator age and planning horizon, operator risk preference and farm organization and location were other important determinants of the approach to management.

Key Words: cash-grain farms, factor analysis, farm management, latent variables, management approach

JEL Classifications: Q12, Q10, D21, C40

Differences in management affect the financial performance and environmental impact of farms facing similar resource and production conditions. These relationships, however, are not easily discerned because management is difficult to define and measure. Further complicating the matter is that management varies from farm to farm because of differences in farm size, enterprise mix, resource situation, and climate, among other reasons. Even farms of a similar type, size, and location are managed differently. Human-capital characteristics of farm operators, such as age, education, and off-farm employment, influence farm-operator goals for the business and thus the approach to management. Understanding what influences farm management is important for understanding how differently farmers may respond to changing economic conditions and farm programs.

Success in farming requires a clear sense of what the business is about and the direction in which it is headed. The study of successful farm management has increasingly focused on the importance of strategic planning for positioning the farm business. Miller, Boehlije, and Dobbins characterize strategic planning as a different way of thinking about management. In the past, farming success depended primarily on the ability of management to develop an efficient operation, such as achieving a cost of production lower than the industry average. The continued introduction of new products and/or technologies provided significant rewards for concentrating on efficient production or "doing things right." Miller, Boehlije, and Dobbins argue that, while important, efficient production will not be sufficient to assure success in an increasingly industrialized environment. Their point is that the continued

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industrialization of farming makes strategic decisions such as farm product mix, market linkages, financial structure, and relationships with input suppliers and product buyers more important. In this environment, success in farming will continue to require that operations be efficient, but there will be a growing payoff to strategic decisions or "doing the right things."

This study attempts to define and characterize approaches to farm management according to the strategic decisions made by farm operators as indicated by the set of management practices and techniques employed by farmers. Objectives of this study are to describe the management approaches employed by farmers and to characterize the farms that use each approach. The empirical procedure uses data from a sample of U.S. farmers to define measures of latent, or unobservable, approaches to management, and then examines the characteristics of farms that utilize each approach. Results of this analysis add to the understanding of the different management approaches used by farm operators and how the approaches are related to the unique organizational and human capital traits of individual farms. The results also provide insight about defining and characterizing management for the study of successful farm management.

Previous Research

Several attempts have been made to define and measure farm management in order to relate management to farm business success. Typically, management has been represented in models regressing measures of farm production and/or financial performance against farm efficiency, demographic, and/or production practice variables used as proxies for the unobserved level of management. For example, Purdy, Langemeier, and Featherstone studied financial performance on a sample of crop and livestock farmers using operator characteristics and financial efficiency and solvency variables as indicators of management. Mishra, El-Osta, and Johnson specified operator education as a proxy for management ability in a model of financial performance on cash-grain farms. They also specified the ratio of operating expenses to farm production value as representing the cost-control aspect of management and technology adoption variables as indicative of innovativeness.

Kauffman and Tauer attempted to identify successful farm-management strategies using records from dairy farms. They specified output, cost, price, technology, and financial variables in a logit model of financial success to encompass the production, marketing, and financial areas of farm management. Using the estimated coefficients on these variables, they concluded that cost control, selective technology adoption, and financial leverage were important aspects of successful dairy-farm management. Mishra and Morehart also studied financial success on dairy farms and found that various components of management, specified by operator education, cost control, farm business organization, and risk management, were important to farm business success.

Nivens, Kastens, and Dhuyvetter sought to determine the components of good management using 10 years of farm business records. They used measures of farm performance, production practices, and farm characteristics relative to other farms in local areas in order to specify various aspects of management in a model of farm profitability. Cost management, planting intensity, and technology adoption were found to have had the greatest impact on farm profits, whereas cash price management for farm outputs had the smallest impact. More recently, Ramsey et al. studied factors affecting production and financial performance on beef-cow operations. They specified management using measures of herd performance, including calving percentage and death loss, and length of the breeding season. Each of these proxies for management had a statistically significant impact on farm performance.

In a concerted effort to model the effect of management ability on farm financial success, Ford and Shonkwiler related three types, or factors, of latent management ability—financial, dairy, and crop management—to financial performance on a sample of dairy farms.

To develop measures of management, a structural equation model was constructed using confirmatory factor analysis. The factor analysis determined how the set of observed management variables, including various measures of farm efficiency, loaded on (i.e., correlated with) each of the latent factors. The analysis illustrated the difficulties involved with managing all facets of dairy farms, as the three factors were negatively correlated with one another, and the results suggested that dairy management had the greatest payoff. The authors also concluded that the latent variable approach was a promising tool for disentangling management from other farm measures.

Empirical Procedure

Management is specified in this study using the latent variable approach, as in Ford and Shonkwiler, but specific data on farm-management actions are used rather than farm-efficiency measures. Exploratory factor analysis was used to examine the pattern of intercorrelation among responses to a set of management-action questions collected in a national survey of U.S. farm operations. Factor analysis is a statistical technique widely used in psychology and other social sciences and is regarded as a necessity in some branches of psychology where tests or questionnaires are often administered (Kline). The technique of exploratory factor analysis is appropriate when a number of variables are measured, and the number and nature of the underlying factors that are responsible for covariation in the data are to be identified. It is hypothesized that the management action variables collected in the survey are not each measuring unique approaches to management, but together are measuring a few underlying latent factors, or constructs, that characterize management approaches.

The goal of factor analysis is to explain the variance in the observed variables in terms of the underlying latent factors. The latent variables are believed to be various approaches to management that are unobserved but are influenced by the observed variables measuring management actions taken by farmers. This can be illustrated by the following regression equation:

$$(1) \qquad V_j = a_1F_{1j} + a_2F_{2j} + \cdots + a_qF_{qj} + \mu_j$$

where V_j is a vector of values for the observed jth variable (i.e., management action, $j = 1, \ldots, p$), a_k ($k = 1, \ldots, q$) is a vector of regression coefficients (or weights) for factor k, F_{kj} is a vector of estimated loadings of factor k on the jth variable, and the vector μ_j is similar to a residual, but known as the jth variable's unique factor (Hatcher).

Conducting a factor analysis involves a sequence of steps with somewhat subjective decisions made along the way. The first step is the initial extraction of the factors. The number of factors initially extracted will be equal to the number of variables being analyzed. A critical decision is determining the appropriate number of meaningful factors, q, that are worthy of being retained for rotation and interpretation. Options available for determining the meaningful number of factors include the scree test, proportion of variance explained, and the interpretability criterion (Hatcher). With the scree test, the eigenvalues associated with each factor are plotted and factors appearing before the break between large and small eigenvalues are assumed to be meaningful factors. The second option involves retaining a factor if it accounts for a certain (arbitrary) percentage of the variance in the data, such as those with at least 5 or 10%. Probably the most important criterion for solving the number-of-factors problem is the interpretability criterion: interpreting the substantive meaning of the retained factors and verifying that the interpretation is consistent with what is known about the constructs under investigation. A few rules to follow are (Hatcher): (1) do at least three variables have significant loadings on each retained factor? (2) Do variables loading on the same factor share a conceptual meaning? And (3) do variables loading on different factors measure different constructs?

Once the number of meaningful factors is determined, the second step is to rotate the factor loadings to a final solution. Rotation refers to a linear transformation of the factor loadings to simplify the factor structure and to achieve a more meaningful and interpretable solution. A criticism of factor analysis is that there are an infinite number of mathematically equivalent solutions resulting from factor rotation. However, the solution that meets the simple-structure criterion is generally regarded as the best solution (Kline). A rotated-factor pattern demonstrates simple structure when (1) most variables have high loadings on one factor and near-zero loadings on others and (2) each factor has high loadings for some variables and near-zero loadings for others.

The rotated-factor solution yields the rotated-factor pattern matrix, including standardized regression coefficients that indicate the loadings of the variables on the factors. The final step is to compute the factor scores from the final solution. Factor scores can be estimated by:

$$(2) \qquad F_k = b_1 V_{1k} + b_2 V_{2k} + \cdots + b_p V_{pk}$$

where F_k is a vector of estimated factor scores for the kth factor (i.e., management approach, $k = 1, \ldots, q$), b_j ($j = 1, \ldots, p$) is a vector of scoring coefficients for variable j used in creating estimated factor score k, and V_{jk} is a vector of standardized values for the observed jth variable (i.e., management action).[1] Factor scores indicate an estimate of each subject's standing on the underlying factor.

To characterize the farms in terms of the latent management approaches each estimated factor score (F_k) is regressed against farm and operator characteristics, specified by

$$(3) \qquad F_k = \mathbf{X}\beta + \varepsilon, \qquad (k = 1, \ldots, q),$$

where $\mathbf{X}$ is a matrix of farm and operator characteristics, including farm organizational and human capital variables, and ϵ is a random disturbance assumed to be normally distributed. The estimated coefficients (β) describe the impact that farm and operator characteristics have on each approach to management. Differences between the estimated coefficients of each factor regression provide an indication of which farms and farm operators are more or less likely to utilize each management approach.

Data and Model Specification

Data used in this study come from the U.S. Department of Agriculture, collected in the 2001 Agricultural Resource Management Survey (ARMS). Each farm in the ARMS sample represents a known number of farms with similar attributes (i.e., commodity specialty and size), so that weighting the data for each farm by the number of farms it represents provides a basis for calculating estimates for the target population. The annual ARMS data include detailed information about farm income and expenses, farm assets and debt, and farm and operator characteristics, as well as information about the farm household (U.S. Department of Agriculture, Economic Research Service 2005a).

In the 2001 ARMS, farmers were questioned about actions taken in the management of their farm businesses. The following 19 questions about management actions taken in 2001 were asked farmers in the ARMS[2]:

1. Did you lock in your price of inputs (forward purchase)?
2. Did you use farm-management services for advice on input or commodity markets?
3. Did you participate in buying clubs, alliances, etc. to purchase inputs?
4. Did you participate in collaborative marketing or networking to sell commodities?
5. Did you sell directly to consumers?
6. Did you use options or futures?
7. Did you use contract shipping to have

[1] The V_j in Equation (1) and the V_{jk} in Equation (2) both refer to the observed values for each management action. The difference between the two is that the values in Equation (2) have been standardized to a mean of zero and a variance of one.

[2] The questions are shown in the same way they were presented in the ARMS survey. Respondents were not given additional instructions about each of the questions. Their meaning was subject to interpretation by each respondent.

Table 1. Management Actions Used on U.S. Farms by Selected Farm Types, 2001

	Percent of Farms Using Action				
Management Action	Cash Grains	Cotton	Vegetables and Melons	Dairy	All Farms
1. Lock in input prices	39	19	8	33	14
2. Use farm-management service	17	24	3	18	8
3. Participate in buying clubs, alliances, etc.	4	9	5	4	3
4. Participate in collaborative marketing	5	23	6	13	4
5. Sell directly to consumers	16	10	80	12	25
6. Use options or futures	15	13	1	7	4
7. Use contract shipping	13	8	5	34	7
8. Use on-farm storage	58	12	19	81	39
9. Produce certified-organic crops	1	0	6	1	1
10. Differentiate livestock products	2	0	1	6	2
11. Reduce quantities of inputs used	33	49	9	27	16
12. Negotiate lower input prices	32	35	12	43	16
13. Change production practices	35	50	16	35	15
14. Change enterprise mix	10	9	5	6	5
15. Renegotiate rental agreements	11	19	6	5	5
16. Refinance existing farm loans	15	31	3	13	7
17. Expand the size of operation	18	33	9	23	11
18. Alter machinery complement	23	35	13	22	10
19. Adopt cost-saving technologies	26	38	11	30	13

Notes: Farm type is designated as the commodity, or group, that provided the largest share of production value in 2001. Use of a management action is reported for the farm operation, not necessarily for the commodity that defines the farm type.

your products hauled to the buyer or market?

8. Did you use on-farm storage for your crops?
9. Did you produce certified-organic crops?
10. Did you engage in practices that could be used to differentiate your livestock products?
11. Did you take steps to reduce input costs by reducing quantities of inputs used?
12. Did you take steps to reduce input costs by negotiating lower input prices?
13. Did you take steps to reduce input costs by changing production practices?
14. Did you take steps to reduce input costs by changing enterprise mix?
15. Did you take steps to reduce overhead costs by renegotiating rental agreements?
16. Did you take steps to reduce overhead costs by refinancing existing farm loans?
17. Are you trying to expand the size of the operation to reduce per-unit production costs?
18. Are you trying to alter your machinery complement to contain costs?
19. Are you trying to adopt cost-saving technologies to contain costs?

Table 1 includes a summary of the management actions taken on different types of farms as reported in the ARMS. Type of farm is designated as the commodity that provided the largest share of production value in 2001. Many of the differences in management actions across farm types reflect differences in the marketing methods used for the primary commodity. For example, most vegetable farms reported selling directly to consumers, such as in farmers' markets or other local retail establishments. A relatively large share of dairy farms reported the use of contract shipping (milk) and on-farm storage (cattle feed).

Table 2. Variables Included in the Analysis of Approaches to Management on U.S. Cash Grain Farms, 2001

Variables	Definition	Mean	Standard Deviation
Operator and farm characteristics			
AGE	Age (years)	52.98	263.41
EDUC	Education (years of formal school)	13.21	37.04
OFFOCUP[a]	Off-farm occupation (proportion of farms)	0.30	8.21
PLANHOR[b]	Retired or plans to retire in 5 yr. (proportion of farms)	0.23	7.54
SPLAN[c]	Succession plan for farm (proportion of farms)	0.29	8.14
RISK[d]	Risk willingness (0–10 scale)	5.12	43.20
SIZE	Value of production ($1,000)	114.12	10,634.00
SPECIAL	Specialization (cash grain proportion of total value)	0.75	5.74
TENURE	Land tenure (owned proportion of total acreage)	0.47	7.36
LSTOCK	Livestock operation on farm (proportion of farms)	0.36	8.63
Region[e] (proportion of farms):			
HL	Heartland	0.51	8.98
NC	Northern Crescent	0.16	6.54
NP	Northern Great Plains	0.08	4.77
PG	Prairie Gateway	0.15	6.36
EU	Eastern Uplands	0.01	2.03
SS	Southern Seaboard	0.02	2.69
FR	Fruitful Rim	0.03	3.00
BR	Basin and Range	0.02	2.30
MP	Mississippi Portal	0.03	2.90

[a] Farms were asked to report their primary occupation as either farming, off-farm work (*OFFOCUP*), or retirement.
[b] Farmers reporting their major occupation as retirement were grouped with farmers that reported plans to retire from farming within the next 5 years to specify the planning horizon variable (*PLANHOR*).
[c] All farmers were asked if they had a succession plan (*SPLAN*) to pass on the farm business.
[d] Operator willingness to take risk (*RISK*) was reported by farmers on a scale where zero indicates farmers who avoid risk as much as possible and 10 indicates farmers who take as much risk as possible.
[e] The regions are defined using ERS farm resource regions (U.S. Department of Agriculture, Economic Research Service, 2005b).

Likewise, cotton farms more often participated in selling groups, such as those associated with the warehouse system. Other notable differences include the large share of cash-grain farms that reported forward purchasing inputs and storing grain on farm, and that a higher proportion of cotton farms were refinancing loans and using farm expansion to reduce costs than were other types of farms.

The analysis in this study was limited to the set of farms that reported the farm type as cash-grain (including oil seeds) production. Cash-grain farms are those where cash-grain production (e.g., corn, wheat, soybeans) provided the largest share of total farm production value in 2001. This included 1,149 farms in the ARMS sample, representing a population of about 370,000 farms across the nation. Because relatively few cash-grain farms reported using management actions 9 (produce certified-organic crops) and 10 (differentiate your livestock products), these were omitted from the analysis.

A summary of the data used as explanatory variables specified in the factor score regressions, including many of the farm structural and operator variables used as indicators of management in previous studies (Mishra and Morehart; Mishra, El-Osta, and Johnson; Purdy, Langemeier, and Featherstone), are shown in Table 2. Operator characteristics regressed against the factor scores include operator age (*AGE*), a quadratic term for operator age (*AGESQ*), operator education (*EDUC*), and whether or not the operator reported off-farm work as his/her primary occupation (*OFFOCUP*). In previous studies, these operator characteristics have been specified as proxies to represent management ability. In this study, these variables were specified to isolate the impact that differences in human capital, such as operator goals and formal training, have on the approach to farm management.

A variable was also added that characterizes farm operators with a short planning horizon, as indicated by whether or not the operator reported their major occupation as retired, or reported plans to retire within the next 5 years (*PLANHOR*). Farm operators with a short planning horizon for the business likely have different goals and are expected to manage differently than other farm operators. Likewise, the approach to management of farm operators with a succession plan for the business is expected to be different from those with no succession plan because they have a goal of maintaining a profitable business beyond their life span. The model was specified with a variable indicating whether or not the farmer reported having a succession plan (*SPLAN*). Operator tolerance for risk was also expected to influence the approach to management, as some approaches are inherently more risky than others. Operator willingness to accept risk was specified from the position on a scale-of-risk preferences (*RISK*), where 0 implies the avoidance of risk and 10 implies a willingness to take risk, as reported by farm operators.

Variables for farm size (*SIZE*), specialization (*SPECIAL*), land tenure (*TENURE*), and an indicator for the presence of a livestock operation (*LSTOCK*) were specified to reflect differences in farm organization. Farm size was measured by total farm value of production and was also specified with a quadratic term (*SIZESQ*). Farm specialization indicates what proportion of total farm value of production was generated by cash-grain production. Tenure is a measure of the proportion of total land owned. Operations with livestock operations may be managed differently than strictly crop farms because of the unique management and other resource requirements associated with livestock production. In addition, variables for geographic location (*HL, NC, NP, PG, EU, SS, FR, BR,* and *MP*), defined in Table 2, were also included in the model to account for the impact that differences in soil, climate, production practices, and pest pressures may have on the approach to farm management (U.S. Department of Agriculture, Economic Research Service 2005b).

Results of the Factor Analysis

The maximum likelihood method was used to extract the initial factors in the factor analysis. Analysis of the initial factors using the scree test and the proportion of variance accounted for by various factors suggested that the list of management actions could be described by three latent variables.[3] Eigenvalues for the weighted reduced correlation matrix (weighted with the ARMS survey weights) are shown in Table 3. The first factor accounted for about 70% of the variance, the second about 20%, and the third about 11%. No other subsequent factor accounted for more than 5% of the variance. Most important, the three factors were determined to be interpretable in a manner that is consistent with constructs that indicate approaches to farm management.

An oblique rotation with the promax method was used to transform the solution (Gorsuch). The rotated-factor pattern, shown in the form of standardized regression coefficients, is presented in Table 4. The factor pattern shows the characteristics of simple structure, as most variables have a high loading on one factor and much lower loadings on other factors. Likewise, each factor has high loadings for a few variables and lower loadings for the others. In interpreting the rotated-factor pattern, an item was said to load on a given factor if the factor loading was 0.40 or greater for that factor and was less than 0.40 for any other (criteria suggested by Hatcher).

Using these criteria for determining factor loading, responses to the following four questions:

[3] The scree plot of the eigenvalues is not shown due to space limitations.

Table 3. Eigenvalues of the Weighted Reduced Correlation Matrix from the Factor Analysis of Management Actions used on U.S. Cash Grain Farms, 2001

Factor	Eigenvalue	Proportion	Cumulative Proportion
1	7.0947	0.6956	0.6956
2	2.0096	0.1970	0.8926
3	1.0952	0.1074	1.0000
4	0.4500	0.0441	1.0441
5	0.3251	0.0319	1.0760
6	0.2734	0.0268	1.1028
7	0.1728	0.0169	1.1197
8	0.1344	0.0132	1.1329
9	0.0653	0.0064	1.1393
10	0.0034	0.0003	1.1396
11	−0.0295	−0.0029	1.1368
12	−0.1337	−0.0131	1.1237
13	−0.1816	−0.0178	1.1059
14	−0.2002	−0.0196	1.0862
15	−0.2522	−0.0247	1.0615
16	−0.2937	−0.0288	1.0327
17	−0.3335	−0.0327	1.0000

Notes: Factors can account for more than 100% of the common variance because the variance in observed variables accounted for by the common factors (i.e., prior communality estimates) is not perfectly accurate. Some factors may account for a negative percentage of the common variance (i.e., negative eigenvalues) because the analysis is constrained so that the cumulative proportion must equal 100% (Hatcher).

1. Did you lock in the price of inputs (forward purchase)?
2. Did you use farm-management services for advice on input or commodity markets?
6. Did you use options or futures?
12. Did you take steps to reduce input costs by negotiating lower input prices?

were found to load on the first factor. These questions refer to management actions for establishing input and output prices, and thus the factor was labeled as the price-negotiation approach to management.

Responses to the following three questions:

17. Are you trying to expand the size of your operation to reduce per-unit production costs?
18. Are you trying to alter your machinery complement to contain costs?
19. Are you trying to adopt cost-saving technologies to contain costs?

loaded on the second factor. These questions refer to management actions that involve investments to lower costs, and thus the factor was labeled as the long-term cost-control approach to management.

Responses to the following three questions:

11. Did you take steps to reduce input costs by reducing quantities of inputs used?
13. Did you take steps to reduce input costs by changing production practices?
14. Did you take steps to reduce input costs by changing enterprise mix?

were found to load on the third factor. These questions refer to management actions that involve adjusting input use to control costs, and thus the factor was labeled as the input-adjustment approach to management.

Factor scores were estimated for each of price-negotiation, long-term cost-control, and input-adjustment approaches to management. True standardized factor scores have a zero mean and variance of one. Estimated factor scores have a zero mean but a variance that equals the squared multiple correlation of the factor with the variables. The estimated factor scores were scaled by 100 for the regression analysis.

Results of the Factor Score Regressions

Results of the regressions with each of the three factor scores regressed against farm and operator characteristics are shown in Table 5. Farm and operator characteristics explained about 20–40% of the variation in the factor scores, with the R-squared ranging from .237 for the input-adjustment factor to .362 for the price-negotiation factor. Several explanatory variables, particularly operator characteristics, were statistically significant at the 1% level in each of the models. Regression coefficients in each equation were also tested for statistical

Table 4. Rotated Factor Pattern for Management Actions Used on U.S. Cash Grain Farms, 2001

		Standardized Regression Coefficients		
	Management Action	Factor 1	Factor 2	Factor 3
1.	Lock in input prices	73*	−5	−2
2.	Use farm-management service	54*	10	−7
3.	Participate in buying clubs, alliances, etc.	7	3	4
4.	Participate in collaborative marketing	20	21	−9
5.	Sell directly to consumers	−16	15	11
6.	Use options or futures	54*	2	3
7.	Use contract shipping	13	15	11
8.	Use on-farm storage	37	7	−2
11.	Reduce quantities of inputs used	12	−2	51*
12.	Negotiate lower input prices	49*	−8	26
13.	Change production practices	−8	9	70*
14.	Change enterprise mix	2	4	43*
15.	Renegotiate rental agreements	13	10	15
16.	Refinance existing farm loans	24	1	7
17.	Expand the size of operation	−1	76*	−4
18.	Alter machinery complement	3	68*	13
19.	Adopt cost-saving technologies	10	79*	5

Notes: Values have been multiplied by 100 and rounded to the nearest integer.
* Indicates variables that load on a given factor because the factor loading was 0.40 or greater for that factor, and less than 0.40 for any other factor. Management actions identified as 9 and 10 in Table 1 were not included in the analysis. Interfactor correlations between the estimated factors are: Factors 1, 2 = .32; factors 1, 3 = .33; factors 2, 3 = .48.

differences with those in the other equations.[4] Key results from these tests are discussed below.

Operator age was statistically significant in each of the factor score regressions, but signs on the estimated coefficients varied among the factor scores. Age was positively associated with factor 1, but negatively associated with factors 2 and 3. This means that older operators were more likely to use practices associated with the price-negotiation approach, possibly because of the greater number of contacts that more experienced operators had with input sellers and commodity buyers. In contrast, the negative coefficients on factors 2 and 3 mean that the use of management practices associated with the long-term cost-control and input-adjustment approaches was less for older farm operators. Younger farmers are more likely to make long-term investments to reduce costs and are likely more willing to modify practices and the enterprise mix because of the longer time they plan to be in business. These findings are illustrated in Table 6, with data showing that most management actions associated with the price-negotiation approach were more often used by farm operators between 35 and 65 years of age, while farmers less than 35 years of age used practices associated with the long-term cost-control and input-adjustment approaches much more often than did older farmers.

The positive impact of age on use of the price-negotiation approach decreased over time, as indicated by the negative coefficient on the quadratic term for age (Table 5). When farm operators had a shortened planning horizon, at or near retirement, they were less likely to use practices associated with the price-negotiation approach. The negative impact of age on use of the long-term cost-control approach increased over time, as indicated by the positive coefficient on the quadratic term for age. Use of long-term cost-control

[4] Statistical differences between estimated coefficients in each of the regressions were tested with an F-statistic computed using seemingly unrelated regression on each pair of equations.

Table 5. Regression Estimates for the Factor Scores of Management Approaches Used on U.S. Cash Grain Farms, 2001

	Factor 1		Factor 2		Factor 3	
Variables	Estimate	Std. Error	Estimate	Std. Error	Estimate	Std. Error
INTERCEPT	−13.944**	1.659	2.071	1.886	1.276	1.755
AGE	0.400**	0.053	−0.225**	0.060	−0.183**	0.056
AGESQ	−4.1E-3**	5.1E-4	1.2E-3*	5.8E-4	9.4E-4	5.4E-4
EDUC	0.316**	0.063	0.293**	0.071	0.210**	0.066
OFFOCUP	−2.952**	0.280	−1.548**	0.318	−1.190**	0.296
PLANHOR	−1.215**	0.304	−1.725**	0.346	−0.314	0.322
SPLAN	1.258**	0.259	1.773**	0.294	1.303**	0.274
RISK	−0.026	0.053	0.144*	0.060	0.157**	0.056
SIZE	2.6E-3**	4.4E-4	1.1E-3*	5.0E-4	9.4E-4*	4.6E-4
SIZESQ	−3.3E-8**	6.5E-9	−1.3E-8	7.4E-9	−1.1E-8	6.9E-9
SPECIAL	1.763**	0.441	0.939	0.502	1.016*	0.467
TENURE	1.718**	0.369	0.181	0.419	0.767	0.390
LSTOCK	0.363	0.265	1.831**	0.301	1.288**	0.281
NC	−1.153**	0.382	0.922*	0.434	0.340	0.404
NP	−0.362	0.456	0.370	0.518	0.883	0.482
PG	−1.984**	0.354	0.965*	0.402	1.120**	0.374
EU	−2.187*	1.036	−0.432	1.177	−1.006	1.096
SS	−1.204	0.781	−0.219	0.887	1.110	0.826
FR	−3.834**	0.708	−0.655	0.804	−0.508	0.749
BR	−1.757	0.953	1.801	1.083	4.322**	1.008
MP	−2.154**	0.723	0.242	0.822	1.005	0.765
R^2	0.362		0.275		0.237	
Sample size	1,149		1,149		1,149	

Notes: Factor 1 represents the price-negotiation approach to management. Factor 2 represents the long-term cost-control approach to management. Factor 3 represents the input-adjustment approach to management. Factor scores were scaled by 100. *AGESQ* is a quadratic term for *AGE*, and *SIZESQ* is a quadratic term for *SIZE*. *HL* (Heartland) was the deleted region variable in the estimation. '*' indicates significant at 5%. '**' indicates significant at 1%.

Table 6. Management Actions Used on U.S. Cash Grain Farms by Operator Age, 2001

	Percent of Farms Using Action			
Management Actions in Each Approach	Less than 35 Years	35–49 Years	50–65 Years	65 Years or More
Price-negotiation approach				
1. Lock in input prices	28	51	42	28
2. Use farm-management service	17	23	19	7
6. Use options or futures	9	22	16	10
12. Negotiate lower input prices	36	39	32	21
Long-term cost-control approach				
17. Expand the size of operation	49	20	15	3
18. Alter machinery complement	62	26	19	5
19. Adopt cost-saving technologies	52	30	26	7
Input-adjustment approach				
11. Reduce quantities of inputs used	53	36	33	21
13. Change production practices	72	38	29	21
14. Change enterprise mix	17	15	7	8

practices was much less among operators at or near retirement, for obvious reasons. However, a shortened planning horizon was not statistically significant in the model for the input-adjustment approach. This approach may be used by some operators at or near retirement as part of the process of transitioning from farming.

The planning horizon for the farm business is extended regardless of operator age if there is a plan for the succeeding generation to continue the business. The presence of a succession plan was statistically significant and positively associated with the use of each management approach. This suggests that, regardless of the approach, farm operators indicate that more management actions are taken when there is a plan to perpetuate the business beyond the current generation. It is possible that the farm business goals of the next generation are influencing current management decisions on farms with a succession plan.

Variables for operator education and a primary occupation off farm were statistically significant in each of the factor score regressions. Operator education was positively associated with each of the factor scores, meaning that more educated farm operators were more likely to use the practices that were part of the price-negotiation, long-term cost-control, and input-adjustment approaches to management. Operators with more education are likely more capable of utilizing the practices associated with each management approach. In contrast, farm operators whose primary occupation was off farm tended to score lower on each of the factor scores than other farm operators. Operators spending the majority of their time working off farm likely have less time and fewer incentives to take on a greater farm-management role.

Operator willingness to take risks was positively related to the long-term cost-control and input-adjustment factors, but not statistically significant in the price-negotiation factor regression. These findings indicate that farm operators willing to take more risks are more likely to use the long-term cost-control and input-adjustment approaches to management. Significant production risks are inherent in the management practices comprising these approaches, such as farm expansion and shifting farm enterprises. In contrast, the price-negotiation approach involves practices that attempt to reduce market risks by securing input and output prices.

Variables for size of operation were statistically significant in each of the factor regressions. Larger farms were more likely to utilize each of the management approaches, and the positive relationship with each of the management approaches may be indicative of greater managerial requirements on larger farms regardless of the management approach. However, the magnitude of the size effect was statistically greater for the price-negotiation approach than for the other approaches. This may result from larger farms having more opportunities to obtain economies of size from purchasing inputs and marketing products in larger volumes.

The presence of a livestock operation on these cash-grain farms had a statistically significant and positive impact on the long-term cost-control and input-adjustment factors, but not the price-negotiation factor. Farm operations with livestock are more likely to pursue the advantages of farm expansion and technology adoption to reduce costs because economies of size may be more readily available in livestock production than in cash-grain production. Variables for farm specialization and land tenure were statistically significant in the factor regression for the price-negotiation approach. Greater specialization in cash-grain production and greater land ownership implies a higher level of commitment to this type of operation and may mean that more managerial effort is put into securing input and output prices for cash-grain commodities.

Estimated coefficients on the region variables indicate the difference that being in a region outside of the Heartland (the control group) had on the factor score for each management approach. More regional variables were statistically significant in the equation for the price-negotiation approach to management than in the other equations. In this factor regression, all significant regional variables had a negative sign, meaning that farm operators in these regions were less likely to use this approach to management than were operators of farms in the Heartland. Because substantial corn and soybean production in the Heartland make it the leading cash-grain region, farmers in the Heartland may have more opportunities to utilize price-negotiation practices because more vendors may offer these services (e.g., input buying programs or farm-management services). Location in the prairie Gateway was associated with higher scores for the long-term cost-control and input-adjustment factors relative to location in the Heartland. Irrigation requirements on cash-grain farms in this region mean that farm expansion and choice of practices are important strategies to reduce costs by spreading these additional investments over more acreage.

Conclusions

Exploratory factor analysis was used to identify approaches to management based on a list of management questions posed to a sample of U.S. cash-grain farmers in 2001. Three approaches were identified by the factor analysis: price negotiation, long-term cost control, and input adjustment. These management approaches are unique and different strategies for managing the farm business. Price negotiation is a proactive strategy, where farmers take measures to reduce the price risk inherent in production agriculture by locking input and output prices. In contrast, input adjustment is more of a reactive strategy, where farmers observe the situation and adjust the input or product mix in response to price and production conditions or possibly to changing goals for the farm business. Long-term cost control involves land and capital investments in order to lower per-unit costs of production.

Results of the factor regressions suggest that the factor analysis was successful at distinguishing the price-negotiation approach to management from other approaches used by farm operators. The factor scores for the price-negotiation approach were not highly correlated with the other factor scores, and the relationship between the price-negotiation factor scores and farm characteristics was much different than that for the other factor scores. Factor scores for the long-term cost-control and input-adjustment approaches were more highly correlated, and their relationship with farm characteristics was similar. These results are not surprising because the first unique factor of a factor analysis explains the most variation in the data, while the following unique factors explain progressively less.

Results of the factor regressions provide a profile of cash-grain producers likely to use each management approach that is closely related to stage of life of the operator and the farm business, as operator age was found to be best at distinguishing among the farm-management approaches. Farm operators using the price-negotiation approach are generally older, well-educated, risk-adverse, and full-time farmers who operate the largest and most specialized farms. These appear to be firmly established producers managing input and output markets to maintain farm profitability for the current and next generation. In contrast, farm operators using the long-term cost-control approach are generally younger, well-educated, risk takers who operate large but diversified operations that more often include livestock operations. These producers appear to be investing to grow the farm business for the current and next generation. Farm operators using the input-adjustment approach have many of the same characteristics as those using the long-term cost-control approach, except that a short planning horizon did not influence use of this approach. The input-adjustment approach likely appeals to both younger farmers wanting to try alternative, potentially more profitable farm enterprises and practices and older farmers at or near retirement who are transitioning out of farming.

Results of this study indicate how difficult it is to characterize the level of farm management by basic farm-operator characteristics. For example, this study finds operator age to be more indicative of operator stage of life and the management approach most associated with each stage rather than managerial experience. Similarly, willingness to accept risk, the business planning horizon, land tenure, the presence of a livestock operation, and farm location all have a unique impact on the approach taken to farm management. Findings of this study suggest that operator education, primary occupation, and the presence of a succession plan may be the best general indicators of the management input used in the farm business in that they each have a significant and consistent relationship with each of the management approaches.

Findings of this study also offer insight into the factors that influence farmer behavior, likely farm-program preferences, and the potential response to changes in farm policy. For example, as the average age of farm operators continues upward, the demand for risk-management tools and insight can be expected to grow. Based on their approach to management, older and established cash-grain producers would likely seek alternative means of managing risk in response to changes from traditional commodity programs. In contrast, the fewer young farm operators benefit from access to credit and information that supports cost-control efforts, such as expanding farm size and adopting new practices and technologies. These farmers may seek opportunities from farm programs, such as credit, research, and educational support, in order to grow the farm business and reduce costs. The ability of policy mechanisms to affect management behavior on many farms, however, will likely diminish as off-farm income continues to become an increasing share of total household income on more farms and the impact of the farm-management input on total household income lessens.

Finally, this study illustrates a method for defining and characterizing approaches to farm management. Detailed information about actions taken by farm business managers combined with an analysis of variable correlation and latent factors, such as factor analysis, appears promising as a technique for developing unique and meaningful measures of management. Results of this technique may be useful for disentangling the effect of management from other sources of variation in farm business performance. The down side is the significant data requirement necessary to measure these latent variables.

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