Is Farm Management Skill Persistent?

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Abstract

Agricultural producers operate in a volatile environment, facing a number of sources of risk. A key question is whether farmers who are more highly skilled can better mitigate these risks and consistently earn higher returns than their lower skilled peers. In this article, farm management performance is analyzed based on yearly Illinois Farm Business Farm Management (FBFM) panel data across 6,760 farms from 1996 through 2011. Two out-of-sample measures of skill are used to analyze the ability of farm managers that consistently perform well over yearly and longer time horizons. Results suggest that the most skilled managers often generate better financial results. Furthermore, persistence tests show management skills are consistent and predictable.

Key words: skill, persistence, farm management, performance.
JEL Codes: Q12, Q13, M11

Agricultural producers operate in a volatile environment, facing a number of sources of risk. Due to the recent increase of commodity price volatility, U.S. farm income is projected to drop 14 percent to the lowest level (USDA, Economic Research Service)[1]. In addition, production agriculture has certainly not been immune to crises. The recent financial crisis has had a direct impact on the growth of farm income and farmland values (Paulson and Sherrick, 2009; Ellinger and Tirupattur, 2009). Furthermore, new farmers are in short supply, and this problem constitutes a threat to U.S. agriculture and the food supply (Gale, 2003; Hoppe et al., 2007). Some risks, such as commodity and input price volatility, can be more easily managed than others through financial instruments. However, certain supply-and-demand dynamics are truly driven by exogenous forces such as weather, disease, and macroeconomic conditions. It is implausible and impractical to provide a hedge against these types of risk. The above issues underscore the need for a long-run perspective on farm management skills, as managers whose financial performance was superior in one economic environment could experience difficulties in another.

A key question is whether farmers who are more highly skilled can better mitigate these risks and consistently earn higher returns than their lower skilled peers. While numerous studies have presumed that skill does lead to better performance and higher returns (Sonka et al., 1989; Plumley and Hornbaker, 1991; Mishra et al., 1999), the measurement of intrinsic skill has been conspicuously absent. The lack of attention in the literature to date is due in part to difficulties in developing suitable data series for farmers' financial performances in which measures of skill effects could likely be detected, and in controlling for non-operator influences, such as farm characteristics, in farm returns. Only Urcola et al. (2004) use corn yield data from McLean County, Illinois to test whether farming skills influence yields with a focus on short-term performance. Their results support the hypothesis that farmer skill influences yields. The prior research's sample however, is limited to only one county in Illinois, which does not consider different regions of the state.

[1]2014 Farm Sector Income Forecast (USDA, Economic Research Service) http://www.ers.usda.gov/topics/farm-economy/farm-sector-income-finances/2014-farm-sector-income-forecast.aspx#.VDyY9dKkohE

Since little formal research has addressed this issue in terms of skill persistence, this article explores that if there are farmers who outperform their peer group on a consistent basis. Persistence is the key feature in this study, because anyone could have large returns over short horizons only due to luck. A common approach to separate out luck from skill is to test for persistence. Persistent performance over time should be the real measure of whether or not management skills matter in agriculture. The testing approach for this research applies well known methods used in financial literature (Elton et al., 1987; Malkiel, 1995; Carhart, 1997; Aulerich et al., 2013) to see if some managers consistently outperform other managers.

Management skill persistence is well documented in the finance and marketing service literature with mixed results. For instance, Carhart (1997) finds persistence in mutual fund performance does not reflect superior stock-picking skill. Rather, common factors in stock returns and persistent differences in mutual fund expenses and transaction costs explain almost all of the predictability in mutual fund return. Grinblatt et al. (1995) find that momentum strategies generate better performance persistence. This is in contrast to Carhart (1997), who finds that transaction costs consume the gains from following a momentum strategy in stocks. These results are sensitive to model specification. Extensive literature also exists on investment performance in the mutual fund and hedge fund industries (Grinblatt and Titman, 1992; Kosowski et al., 2006). This literature focuses on the performance of an entire portfolio relative to market benchmarks. Although the results are not easily compared to this analysis, similar methods in measuring skill persistence can be used in the agricultural context. The research by Irwin et al. (2006) and Cunningham et al. (2007), suggest that pricing performance of advisory services is unpredictable.

While it is easily accepted that better farm management styles with higher revenue are distinct from those with poor performance, little effort has been made in the empirical literature to incorporate managerial skill persistence into analysis of farm performance. There are two purposes for investigating longer-run farm performance across a large pool of data: first, to find evidence of persistent managerial skill explained by readily observable data and proxies for managerial attributes; second, to ascertain if significant differences in performance can be documented for a large group of relatively homogeneous farms by considering performance over time.

This study expands the existing literature in farm management by controlling for survivor bias, and by documenting common-factor explanations for farm performance persistence. Section I presents models of performance measurement on the appropriate benchmark. Section II discusses the data set corrected for survivor bias. Section III documents and explains the one-year persistence in management skill and further examines and explains longer-term persistence. Section IV provides summary and conclusions.

1 Theoretical Model

1.1 Ratio of Performance Measurement

We define operator and land return as follows:

$$OpRet_{it}(\$/acre) = \frac{P \times Y_{it} - C_{it} + LC_{it}}{Acrtil_i} = \frac{Rev_{it} - C_{it} + LC_{it}}{Acrtil_i},$$

where $OpRet_{it}$ is operator and land return per acre ($/acre) on farm i for time period t, P is the output price, Y_{it} is the total yield; Rev_{it} is the total revenue (the sum of all operator's share of gross sales plus net change in inventory and capital accounts); C_{it} is the total cost (all expenses for items purchased, including interest paid, unpaid labor and the value of family labor, and annual depreciation); LC_{it} is the total land cost; $Acrtil_i$ is the farm size measured by tillable acre.

Management on the farm can be measured by the ability of the farmer to optimize the use of natural endowments and inputs to obtain an output. Therefore, the management dimension can be embodied by input expenditures. Farm managers have direct control of these expenses and finding which critical input to manage more effectively is of interest to understanding the persistence of performance. Consequently, input variables are used as determinant variables of persistence. Operator and land returns represent a return to both owning and operating the farmland (Schnitkey, 2010). The use of $OpRet_{it}$ as a sole accounting performance measure, however, is a dollar amount and does not accurately reflect use of inputs. Also, the form of farm business (family owned/enterprise) can cause problems for interpretation of this result. To take the heterogeneity of the costs of different farms into consideration, we use a ratio to measure the percentage return with respect to the total cost per acre:

$$Ratio_{it}(\%) = \frac{(Rev_{it} - C_{it} + LC_{it})/Acrtil_i}{C_{it}/Acrtil_i} \times 100 = \frac{OpRet_{it}(per\ acre)}{C_{it}(per\ acre)} \times 100.$$

This ratio of performance measure is used to evaluate the efficiency of managerial skill or to compare the efficiency of a number of different managers.

1.2 The "Hot Hand" Phenomenon

The key question in this research is whether some farmers are more skilled at making management decisions than others, and does this result in these highly skilled managers financially outperforming their lower skilled peers consistently? To conduct the persistence test, we apply the same procedure to returns using several models of performance proposed by past literature. These include the simple one-factor model of Jensen (1968), the three-factor model of Fama and French (1993), and the four-factor model of Carhart (1997). In the context of the present study, implementation of the multi-factor model approach involves two steps. The first step is to compute the average benchmark and then subtract the benchmark from each farm performance proxy. The second step is to apply the two-factor model to compute ordinary least square (OLS) estimated alphas (multivariate generalization of Jensen's alpha). The following theoretical model is derived from the conventional financial theory's existing framework.

$$Ratio_{it} = \alpha_i + \gamma Ratio_{jt} + \beta Z_{it} + \mu_{it}, \tag{1}$$

if $\gamma = 1$, then

$$Ratio_{it} - Ratio_{jt} = \alpha_i + \beta Z_{it} + \mu_{it}, \tag{2}$$

where

$Ratio_{it}$= the ratio of return to cost of farm i for time period t;
$Ratio_{jt}$= the ratio of return to cost of county j for time period t, which is normalized (assume $\gamma = 1$ held constant across time)[2];
α_i= the constant term;
Z_{it}= a vector of the farm characteristics, which contains soil productivity (Spr_{it}) and farm size ($Acrtil_{it}$)[3];
μ_{it}= the regression residual;
i, j, t= subscript indexes for farm, county, and year, respectively.

In this model, the county-level average measure ($Ratio_{jt}$) was selected to minimize the impact of geography and weather on returns. The use of a county average benchmark helps to control for systematic effects ($e.g.$, good v.s. bad weather, superior v.s. inferior growing conditions, or high v.s. low prices) that affect all farms within a country in one specific year. Therefore, excess return is a relative performance measure. It removes systemic effects on returns that might impact every farmer peer group in a given year.

($Ratio_{it} - Ratio_{jt}$) is the excess ratio; α_i is the ratio left unexplained by the benchmark model. Accounting for the variation in returns associated with Z_{it} (which contains Spr_{it} and $Acrtil_{it}$ then allows us to better focus on the effects of farm management, indicated by α_i or the constant term. An alpha greater than zero means a farm manager outperforms the expected performance (Jensen, 1968; Fama and French, 1993; Carhart, 1997; Kosowski et al., 2006). Managerial capacities (alpha) can then measure cost management or/and profit-making capacities at the farm level. Profitability is impacted by a number of factors, many of which are controlled to some extent by the management decisions of the farm operator.

However, natural endowments, such as soil quality and favorable weather conditions, may disguise the manager's actual capacities. Therefore, quantifying

[2]County j refers to the county which contains farm i, so that $Ratio_{jt}$ can be treated as a benchmark for farm i.

[3]The effects of location, weather, and precipitation on profitability are not taken into consideration similar to most research, because this analysis would control for these effects. The variability in temperature, and to a lesser extent in precipitation, are similar within a county. Also, these variables are not exactly linearly related to profitability so it is hard to predict the management skill in terms of functional form. Thus, we follow the method used by Sonka (1989) and control farm characteristics.

how much management and natural endowment ($e.g.$, soil productivity) matter respectively in persistence is of interest. In addition, some dimensions that are not directly related to the production process may be captured by a secondary effect, such as the size of the farm. However, the effect of farm size on profitability is an issue continually analyzed and debated by agricultural economists (Purdy et al., 1997; Garcia et al., 1982; Goodwin et al., 2002). We suggest there may be increasing returns to scale for grain farms, or a normalized measure of profitability (i.e. net farm income per acre) may be enhanced by expanding the scale of the operation. The above discussion motivates our choice of the variables in the farm characteristic vector. Therefore, in order to gain some insights, we employ a two-factor model to measure performance.

Several financial studies, such as Grinblatt and Titman (1992) and Malkiel (1995), present strong evidence in favor of a "hot hand" phenomenon, which is when mutual funds that achieved above-average returns continue to enjoy superior performance. In order to test if some farmers have persistent performance, we need to identify "α_{it}" for each of the farms over each time period. This means OLS estimated alphas (using the time series of returns for each farm i) can not accomplish our goal of testing for skill persistence.

To circumvent this problem, in *each year*, we estimate a cross-section regression:

$$Ratio_i - Ratio_j = \beta_1 Spr_i + \beta_2 Acrtil_i + \mu_i, \tag{3}$$

where μ_i is the residual of equation (3), and

$$\alpha_i \equiv Excess\ Ratio_i - E[Excess\ Ratio_i] = \mu_i, \tag{4}$$

where

$$Excess\ Ratio_i = Ratio_i - Ratio_j,$$

$$E[Excess\ Ratio_i] = \beta_1 Spr_i + \beta_2 Acrtil_i.$$

In this specification, alpha is represented by the residual of equation (3), which is the excess ratio left unexplained by the benchmark model in equation (4). An alpha greater than zero means a farm manager outperforms the benchmark. This procedure proposed by Carhart (1997) can allow for the possibility of examining every possible ordering of farm manager in a given year.

If some farmers have persistent performance, then it can be explained that they have consistently better skills than others. Farmers receiving above-average returns might be using a superior management skill, so finding performance persistence could help identify superior strategies. Two out-of-sample tests of persistence are used in the analysis to analyze the ability of farm managers that consistently perform well over yearly and longer time horizons, both of which have been widely applied in studies of market performance (Elton et al., 1987; Malkiel, 1995; Carhart, 1997; Irwin et al., 2006).

1.3 Spearman Ranking Test

The first test is the Spearman ranking test, which is a paired correlation analysis across adjoining periods[4]. Persistence simply means that the actual statistic is correlated from one period to the next throughout the sample periods. For instance, if financial performance of farm i statistically outperformed the benchmark in 2011, it would be correlated highly with the good performance in 2012. Therefore, for a single farm manager, whether alpha rankings in consecutive periods are positively correlated would be a measure of persistence which means the statistic is indicative of skill. We also perform the Spearman nonparametric test on the rank ordering of performance measure because it has some statistical advantages, i.e. it does not assume a linear relationship between variables. Correlations are calculated using pairwise deletion of observations with missing values due to an unbalanced data set. We use casewise deletion, where observations are ignored if any of the variables are missing. Here, the null hypothesis is that the performance measure is randomly ordered.

1.4 Winner and Loser Ranking Test

Mirroring the previous discussion, the second test is a winner and loser ranking test that assesses, in a nonparametric context, whether managers in the top half of

[4]Spearman (1904) rank correlation is calculated as Pearson's correlation coefficient computed on the ranks and average ranks (Conover, 1980). The significance is calculated using the approximation: $p = 2 \times ttail(n-2, |\hat{\rho}|\sqrt{(n-2)}/\sqrt{(1-\rho^2)})$.

the alphas distribution in a time period continue in the top half of the distribution in the next period. Farms with high past alphas demonstrate relatively higher alphas and expected returns in subsequent periods. The null hypothesis is the past ranking of a farm manager does not help predict the manager's future ranking.

This test is based on placing farm managers into winner and loser categories across adjacent pairs of years. The first step in this test procedure is to form the sample of all farm managers that are present in the pair of years. The second step is to rank each farm manager in the first year of the pair ($e.g.$, $t = 1996$) based on alpha estimates from equation (2). Then, the managers are sorted in descending rank order. The third step is to form two groups of mangers in $year_t$: a winner is defined as a manager's alpha ranking that has achieved above the median; a loser is defined as a manager's alpha ranking that has achieved below the median. The fourth step is to rank each farm manager in the subsequent $year_{t+1}$ of the pair ($e.g.$, 1997) based on alpha estimates and once again form winner and loser groups of farm managers. The fifth step is to compute the following category counts for the farm managers in the pair of years: $winner_t - winner_{t+1}$, $winner_t - loser_{t+1}$, $loser_t - winner_{t+1}$, $loser_t - loser_{t+1}$. The sixth step is to construct a 2×2 contingency table formed on the basis of winner and loser counts. The appropriate statistical test in this case is Fisher's exact test, a nonparametric test that is robust to outliers because both row and column totals are predetermined in the contingency table. The null hypothesis is that the relative proportions of $year_t$ are independent of $year_{t+1}$. With large samples, a Pearson's chi-squared test can also be used.

We also calculate the percentage of winners in the initial year that remain in the upper 50% in the subsequent year. If these conditional probabilities are higher than what would result from flipping a coin (randomness), they can provide predictability. The disadvantage of this repeat winners and losers approach is that it has low power to reject the null hypothesis of no performance persistence (Cunningham III et al., 2007). A fuller description of the variables involved follows.

2 Data

This research requires a panel of individual and detailed farm-level data. The lack of literature is a direct result of lack of suitable data. The data set contains continuous observations for a sample of 6,760 farms in the state of Illinois over 16 years, from 1996 to 2011, collected from the Illinois Farm Business Farm Management (FBFM) survey. The FBFM records include a variety of financial and agronomic characteristics for each cooperating farm operation. The most relevant empirical study addressing individual farm managerial skill is Urcola et al. (2004), which also uses data from the FBFM. FBFM data prior to 1996 is summarized in a different manner (Urcola et al., 2004). Due to the data change, we focus on the time period from 1996 to 2011 for this analysis. This study extends beyond the 7-year horizon used by Urcola et al. (2004). Instead, we test for persistence using a 16-year horizon. Also, the prior research's sample is limited to only one county in Illinois, but does not consider different regions of the state. Finally, other prior studies have focused on in-sample estimates of the correlation in performance measure rather than out-of-sample estimates that are the standard in investment studies (e.g. Malkiel, 1995). An out-of-sample measure is a more stringent test of the persistence of profit in farm management.

In this research, we restrict the analysis to corn and soybean farmers, who are defined as having 95% or more of gross revenue coming from crop revenue and less than 5% of farm receipts coming from livestock sales. Within Illinois, acreage of farms enrolled in FBFM account for approximately 25% of the acres in corn and soybean production. To be selected from a large pool of FBFM cooperator data, each farm record had to have been certified usable by the FBFM field staff representative with 180 or more tillable acres.

In this study, operator and farmland returns are computed to represent average returns to Illinois farmland[5]. Operator and farmland returns equal gross revenue minus non-land costs, and represent a return to both owning and operating the farmland[6].

[5]For comparison and validation, we use management return (subtracting total land costs from operator and farmland returns yields the return to management) to test persistence. The results derived from these two measurements are very similar.

[6]The return to farmland varies depending on whether the farmland is owned, share rented,

For each of the farms, the farm ID combined with county ID results in a unique farm identification marker and is used to isolate management return ($/acre) on each farm. Ninety-eight counties in total are investigated. All FBFM expenses were adjusted for prepaid expenses, accounts payable and cash settlements. The enterprise analysis reports all the costs related to each farm for a given year. Total costs can be further broken down into three categories: 1) direct costs include fertilizer, seed, pesticides, drying, and storage; 2) power costs include machinery repairs, equipment depreciation, machine hire and lease, and fuel; 3) overhead costs include land, hired labor, building repairs and deprecation, insurance, and interest. In the dataset, revenues include crop revenue, livestock revenue, custom revenue and other revenue. Total gross revenue after the total cost is the management return[7].

FBFM reports a soil productivity ratio (SPR) based on maps of soil types for each Illinois farm, following Fehrenbacher et al. (1978). The SPR is an average of yield potential on a farm weighted by the soil types within the farm. The SPR ranges from 40 to 100, with 100 being the most productive soil quality, and was calculated at the farm level based on soil structure and quality as well as suitable crops. It directly embodies the potential productivity of the soil for main crops like soybean and corn. Therefore, the expected effect on returns should be positive as better soil should not need more use of chemicals to compensate for deficiencies.

Total tillable acres for each farm are the indicators of farm size. While Purdy et al. (1997) show that larger farms outperformed smaller farms in Kansas, Garcia et al. (1982) do not find any significant relationship between size and success. In this research, it is hypothesized that persistent high-return farms produce more

or cash rented. If farmland is cash rented, subtracting the cash rent from operator and farmland returns yields the return to farming while the cash rent represents the return to the land ownership.

[7]The costs and returns are matched up to the same crop/calendar year. But we also noticed they may not be matched up to the same production/marketing year. For instance, corn that is harvested in October of one year may not be sold until the following calendar year or longer. This says that returns may have various components which could include the returns to storage. Similarly, inputs for the next production cycle which begins with planting in May may be purchased immediately after the last harvest (between October and December) rather than in the year that it is going to be used. Since the FBFM data account for the accrual management return within calendar year by recording both old crop and new crop, which means marketing/production year returns are adjusted for each year on an accrual basis, for the simplicity of this model, we assume that there are no storage costs for crops.

acres than other farms.

It is possible that farmers with low skills are naturally eliminated from our database as their farms go out of business. This might create substantial survivorship bias, leaving only highly skilled farmers who are able to maintain high returns through time. Survivorship bias would likely cause an overstatement of returns obtained by farmers, a consequence of tracking only farms that remain in business at the end of sample period. Thus, survivorship bias is an important issue in mutual fund research (Brown et al., 1992; Malkiel, 1995; Carhart, 1997; Carpenter and Lynch, 1999) since it is typical of mutual fund and hedge funds databases. However, our sample is, to our knowledge, the largest and most complete survivorship-bias-free farm database currently available. We find that the comparison of mean returns of farmers present in all years and the whole group of farmers imply that survivorship bias effects have no great differences in returns[8]. The sample is stable with an average attrition rate of 18.1% and an average entry rate of 20.6%. According to a private conversation with FBFM specialist Bradley Zwilling, if farms are FBFM cooperators, they are always in the data set, just not always certified useable. So common reasons for the ”attrition rate” would be that their farm has a critical error in the data and it is not certified useable. For instance, this could be due to not turning in their data, not have completing their records, etc. Urcola et al. (2004) use a similar database obtained from FBFM to study the effect of farmer skills on yields. The sample in their study is stable with an average attrition rate of 6.9% and an average entry rate of 5.8%. In addition, the comparison of mean yields of farmers present in all years and the whole group of farmers imply that survivorship bias effects can be considered negligible.

As a check on the representativeness of the sample, a number of previous studies compare the financial characteristics of farm management association members to a random sample of farms (Mueller, 1954; Olson and Tvedt, 1987; Gustafson et al., 1990; Andersson and Olson, 1996; Kuethe et al., 2014). The earliest published study by Mueller (1954) find that, compared to a random sample, managerial ability is not greatly different on farms in the FBFM service and record-keeping farms given equal basic resources, particularly farm size and soil quality.

[8]The comparison results are available by the authors upon request.

Table 1: Descriptive Statistics

Variable	Definition	Mean	Std. Dev.
N	Observations	50,623	–
$C_i(\$/acre)$	Total Cost	511.11	1,133.66
$Ret_i(\$/acre)$	Management Return	37.86	126.52
$LC_i(\$/acre)$	Land Cost	131.70	399.13
$OpRet_i(\$/acre)$	Operator and Land Return	169.56	420.01
$Ratio_i(\%)$	$\frac{Ret_{it}}{C_{it}}$ per Farm	35.00	26.23
$Ratio_j(\%)$	$\frac{Ret_{it}}{C_{it}}$ per County	33.71	7.68
$ExcessRatio_i(\%)$	$Ratio_{it} - Ratio_{jt}$	1.30	25.36
$AcrTil_i(acre)$	Farm Size	933.18	711.16
Spr_i	Soil Productivity	79.68	13.50

Table 1 reports descriptive statistics of the farm data. Our sample includes a total of 6,760 diversified farms over 16 years. The data set was cleaned by omitting the outliers. We used a simple rule of thumb, z = 3 guideline (i.e. data points three or more standard deviations from the mean of Ret_i), as an initial screening tool, and depending on the results of that screening, examined the data more closely and modified the outlier detection strategy accordingly. The sample includes 50,623 total observations with per acre average return of \$37.86 and average expenses of \$511.11. Total land costs include interest charge on land, taxes, cash rent and leasing cost. Farms in this report have per acre average land costs of \$131.7 and per acre average operator and land return of \$169.56. In addition, the excess ratio in the sample is 1.30%. Also, over the full sample, average farm size is 933.18 acres and the average soil productivity index value is 79.68.

3 Results

3.1 One-year Persistence Test

The Spearman rank correlations for alphas are shown in table 2. Table 2 shows the p-values for the null hypothesis that the past ranking of a farm manager's alpha does not predict the manager's future ranking ($H_0 : \rho = 0$ versus $H_a : \rho > 0$). Rank correlations are all significant and positive between adjacent years. In this

Table 2: Spearman Rank Correlations

Year	N	Spearman's ρ	p-Value
96-97	2637	0.368	0.000
97-98	2448	0.399	0.000
98-99	2477	0.465	0.000
99-00	2641	0.450	0.000
00-01	2649	0.521	0.000
01-02	2709	0.465	0.000
02-03	2630	0.427	0.000
03-04	2674	0.474	0.000
04-05	2615	0.508	0.000
05-06	2507	0.432	0.000
06-07	2498	0.523	0.000
07-08	2508	0.480	0.000
08-09	2385	0.317	0.000
09-10	2283	0.354	0.000
10-11	2325	0.436	0.000
$Average$	2532	0.441	–

H_0: α_t and α_{t+1} are independent.

case, random rank-ordering is rejected. Rank correlations for alphas vary between the adjacent years and have an overall average of 0.441. Thus, results indicate that, even after controlling for soil productivity and farm size, some farmers still have consistently better skill than other farmers. However, since the Spearman test treats the ordering of winner and loser categories equally, it lacks power against the hypothesis of predictability in performance.

Table 3 shows the number of winners and losers conditional on the previous year's performance based on alpha ranking. On average, the percentage of repeated winners is 65.5% (the conditional probabilities are higher than 25%, i.e. what would result from flipping a coin).

Results show the p-values for the Fisher's exact tests of the null hypothesis that the past ranking of a manager's skill does not predict the manager's future ranking. The null hypothesis that a winner and loser are randomly determined is rejected in all years. These results are consistent with the conclusions of the correlation analysis shown in the previous section and support the hypothesis that a farm manager's skill influences financial performance and persists.

Table 3: Contingency Table

		$Year_{t+1}$		Percentage of Repeated Winners (%)	p-Value for Fisher's Exact Test	p-Value for Pearson's χ^2 Test
$Year_t$		W	L			
1996	W	828	498			
	L	494	825	0.624	0.000	0.000
1997	W	787	441			
	L	438	784	0.641	0.000	0.000
1998	W	824	415			
	L	414	824	0.665	0.000	0.000
1999	W	870	454			
	L	452	868	0.657	0.000	0.000
2000	W	904	422			
	L	422	904	0.682	0.000	0.000
2001	W	908	470			
	L	458	896	0.659	0.000	0.000
2002	W	838	478			
	L	477	838	0.637	0.000	0.000
2003	W	897	444			
	L	441	894	0.669	0.000	0.000
2004	W	887	423			
	L	421	886	0.677	0.000	0.000
2005	W	815	438			
	L	438	816	0.650	0.000	0.000
2006	W	859	392			
	L	391	859	0.687	0.000	0.000
2007	W	848	411			
	L	407	845	0.674	0.000	0.000
2008	W	739	456			
	L	454	738	0.618	0.000	0.000
2009	W	715	428			
	L	427	715	0.626	0.000	0.000
2010	W	767	396			
	L	396	767	0.660	0.000	0.000
			Average	0.655		

1. H_0: the relative proportions of $Year_t$ are independent of $Year_{t+1}$.
2. Fisher's exact test is a statistical significance test used in the analysis of contingency tables. With large samples, a Pearson's chi-squared test can be used.

Table 4: Spearman Rank Correlations

$Year_t$	$Year_{t+1}$	N	Spearman's ρ	p-Value
1996-1997	1998-1999	1716	0.474	0.000
2000-2001	2002-2003	1869	0.585	0.000
2004-2005	2006-2007	1917	0.507	0.000
2008-2009	2010-2011	1800	0.520	0.000
1996-1999	2000-2003	1009	0.616	0.000
2000-2003	2004-2007	1172	0.696	0.000
2004-2007	2008-2011	1243	0.663	0.000
	Average	1532	0.580	–

H_0: α_t and α_{t+1} are independent.

3.2 Long-term Persistence Test

The predictability results presented so far are based on one-year comparisons. It is possible for performance to be unpredictable over longer time horizons, but predictable over shorter horizons. To reduce the noise in past performance rankings, we repeat our earlier analysis and assess longer-term predictability. The sample is again limited to all 16 crop-years of the Spearman ranking test. The correlations are the rank correlations between a producer's average alpha in a two-year/four-year period and alpha in a subsequent two-year/four-year period (Cunningham III et al., 2007). Alpha rankings are averaged for each of the farm managers during the initial two/four years (e.g., $1996-1997$ or $1996-1999$) and the subsequent two/four years (e.g., $1998-1999$ or $2000-2003$). Tests of predictability are then applied to the two sets of long-term averages.

Results are similar for a longer-term period. Table 4 shows skill persistence in the long-term period in terms of positive rank correlation in two consecutive four-year periods. Table 5 shows the percentage of managers whose alpha ranked in the top 50% in two consecutive four-year periods. All the percentages of repeated winners in longer-term tests are higher than in the one-year tests. The Fisher's exact tests and Pearson's chi-squared tests results reject the null hypothesis that alpha ranking is by chance. Therefore, table 4 and table 5 suggest strong skill persistence in the long run.

Table 5: Contingency Table

		$Year_{t+1}$		Percentage of Repeated Winners(%)	p-Value for Fisher's Exact Test	p-Value for Pearson's χ^2 Test
$Year_t$		W	L			
		98-99				
96-97	W	560	301			
	L	297	563	0.650	0.000	0.000
		02-03				
00-01	W	666	274			
	L	269	671	0.709	0.000	0.000
		06-07				
04-05	W	641	319			
	L	318	641	0.668	0.000	0.000
		10-11				
08-09	W	612	289			
	L	289	611	0.679	0.000	0.000
		00-03				
96-99	W	363	145			
	L	143	361	0.715	0.000	0.000
		04-07				
00-03	W	444	146			
	L	142	448	0.753	0.000	0.000
		08-11				
04-07	W	456	116			
	L	165	456	0.733	0.000	0.000

1. H_0: the relative proportions of $Year_t$ are independent of $Year_{t+1}$.
2. Fisher's exact test is a statistical significance test used in the analysis of contingency tables. With large samples, a Pearson's chi-squared test can be used.

4 Summary and Conclusions

Using individual farm-level data from FBFM from 1996 to 2011, this study investigates whether managerial skill persists in farm performance. The extent to which the skills used by farm managers are either efficient or not was measured by a two-factor model that includes a benchmark. The benchmark emphasis makes the model applicable to many farm types that differ in geographic location, tenure, and other structural characteristics. Given the evidence documented here, persistent profit-making capacity is an indication of skill. In addition, farm managers appear to benefit from natural endowment (i.e., soil productivity and farm size). Based on previous research (e.g., Malkiel, 1995; Urcola et al., 2004; Irwin et al., 2006), two basic out-of-sample persistence tests - a Spearman ranking test and a winner and loser ranking test - are examined to determine whether farm managerial skill consistently performs well.

Overall results provide compelling evidence that the superior alphas of star managers survive and are not an artifact of luck. While it is difficult for farm managers to always profit, persistence emerges from the Illinois crop market in terms of the rank correlations of alpha. The strongest evidence for persistence exists with Spearman's ρ reaching 0.70 for four adjacent years. The findings identify significant persistence in ranking; managers in the top 50% of the profits distribution in t tend to stay in upper half in $t + 1$. On average, 65.5% of winners are also winners in $t + 1$. In addition, for both short and long horizons, the Fisher's exact test and Pearson's chi-squared test results appeared to be significant. Thus, our findings using an arguably more rigorous measure - out-of-sample persistence in profit-making skill - are consistent with the hypothesis that skill does exist. With regards to the work by Urcola et al. (2004), our findings are consistent with the structure and implication of their models. This evidence, while not extensive in magnitude, may provide support for behavioral theories.

We are also aware of the limitations of this study. A complete comparison of the estimation procedures employed in this study would include a top and bottom performance deciles test that takes into account the magnitude of skill differentials between top and bottom groups. The findings can be further applied to indicate whether management skills are on the cost side, the revenue side, or both. The analysis in this study could also be extended to investigate the characteristics of the most skilled farm managers and their management styles in the performance evaluation. However, more performance profiles and observations per farm manager are needed for this type of analysis.

Applications of persistence tests in skill represent an interesting picture for future studies. The next step in this research should examine how this management skill persistence relates to farm growth, since farms' financial successes depend on management returns. It could be the case that historical expertise may convey important information about optimal production practices in the long run. Thus, it would be valuable to focus on ”alpha” as a measure to explicitly capture predictable efficient management skill. The approach implemented in this article provides a framework for more general evaluation of farm management for agencies such as farmers, investors, educators, and policymakers. Lenders and investors will be interested in the degree to which skill influences farm profitability. Funding issues for major lenders and the emerging regulatory design arise from commodity and farm-related credit market activity during the recent financial crisis (Paulson and Sherrick, 2009; Ellinger and Tirupattur, 2009). Thus, potential farm management efficiency needs to be recognized in risk management activities. For future research, the effectiveness of education and training for superior farm management practices could be investigated to identify the types of training most effective to improve profitability. Ultimately, studying farm management skill persistence will help with the challenging task of prediction, and better predictions lead to greater farm performance.

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