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The Value and Feasibility of Farming Differently Than the Local Average

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ABSTRACT

The purpose of this research is to quantify the value of being different than the local average and feasibility of distinguishing particular parts of an operation from the local average. Kansas crop farms are broken down by their farm characteristics, production practices, and management performances. An ordinary least squares regression model is used to quantify the value of having different than average characteristics, practices, and management performances. The degree farms have distinguished particular parts of their operations from the average, and how consistently they distinguish their cost, yields, and prices from the average are also analyzed. Farms' relative size, workers per acre, planting intensity, machine costs, yields, and prices are all significantly related to farm relative performance. Farms' characteristics are generally more different from one another than their production practices and management performances, while over time farms' relative cost management performances are more consistent than their relative yield and price management performances.

INTRODUCTION

To remain viable operations, farms must manage employees, maintain equipment, complete field operations timely, market crops well, and stay in compliance with government programs. Additionally, a farm's viability is affected by how profitable it is compared to other operations. Crop production is a competitive industry in which farms compete directly with one another over scarce land resources and indirectly with one another through crop markets. More profitable farms can outbid less profitable farms for land, while they are also more capable of lasting through periods of unprofitability and producing crops at long-run equilibrium prices. On top of running a commercial business, to remain viable, it is important that farms distinguish their net income from other farms.

In his paper "What Is Strategy?" Michael Porter (1996) specifies two ways that businesses can outperform their rivals: operation efficiency and strategy. Superior performance by operation efficiency means executing the same activities more efficiently than their rivals and therefore earning a higher profit. In crop production this could equate to planting the same crops, using the same tillage practices, and applying similar inputs as other rival farms but doing it more efficiently and therefore earning a higher profit. Superior performance through strategy means performing different activities or performing similar activities in a different way than rivals. In crop production this could equate to planting different crops, using different tillage technology, or using different rates of an input (e.g., applying optimal rate of fertilizer) than rivals and as a result producing crops at a higher profit. This research implicitly analyzes the value of operating more efficiently, but the primary focus will be on strategy: how farms can outperform other farm operations by farming differently.

As an example, farms where the land is owned instead of rented may make valuable long-run investments (e.g., apply lime, do conservation work) on the land, while farms that use rented

land may choose not to make improvements due to the risk of losing the land in the future. Farms where the land is owned might achieve a higher level of performance than operations that rent land and, as a result, are able to make better decisions. Taking pest and weed control as another example, farms that use no tillage practices will typically have higher chemical costs, while farms that use traditional tillage practices will have higher fuel costs. If one method controls weeds at a lower aggregate cost (also including labor, repair, and depreciation expenses), farms that use one or the other will achieve a higher level of profitability. As a result of strategy, farms can outperform other operations through rippling effects of their strategic decisions or as a direct result of their different cost and revenue structures.

A number of studies have analyzed the sources of superior financial and economic performance in agriculture production. An adjusted net farm income has been used to measure the performance of dairy farms (Haden & Johnson, 1989) and crop operations (Sonka, Hornbaker, & Hudson, 1989; Mishra, El-Osta, & Johnson, 1999; Nivens, Kastens, & Dhuyvetter, 2002). Studies have also made it a point to measure farm performance over extended periods of time to account for the effect of uncontrollable weather events (Sonka et al., 1989; Gloy, Hyde, & LaDue, 2002; Nivens et al., 2002).

Previous studies have found that farm size is significantly and positively related to dairy and crop farm performance (Haden & Johnson, 1989; Gloy et al., 2002; Nivens et al., 2002). Mixed results have been reported regarding owning versus renting farmland and value of machinery investments per acre (Garcia, Sonka, & Yoo, 1982; Mishra et al., 1999; Ibendahl 2015).

Production practices and technology adoption have been found to be significantly related to farms success. Specifically, Mishra et al. (1999) found that diversification of crop mix resulted in higher returns to operator management in US crop production, and Nivens et al. (2002) found that Kansas crop farms that use their acres more intensively achieved higher than average net income. Nivens et al. (2002) found that the adoption of no-tillage technology was positive relative to net farm income in Kansas crop production, and Mishra et al. (1999) found that adopting an unproven technology after other operations had tried it resulted in a higher return to management in US crop production.

Additionally, operating expenses, crop yields and cow productivity, and product prices have consistently been found to be significantly related to farm success. More profitable farms have been found to have lower machinery costs per acre (Albright, 2002; Schnitkey, 2001) and lower input costs (Haden & Johnson, 1989; Mishra et al., 1999; Nivens et al., 2002; Sonka et al., 1989). Yields per acre and production per cow have been found to be positively related to farms' performance. The negative effect of input costs and the positive effect of production illustrates the trade-off between the cost of investing in more inputs and the value of producing more output. Farms that market their products at higher prices have achieved a higher level of performance (Haden & Johnson, 1989; Mishra et al., 1999; Sonka et al., 1989; Nivens et al., 2002). Nivens et al. (2002) also concluded that it was difficult for farms to market their crops at significantly higher than average prices.

Studies have also analyzed the variability of particular characteristics across farm operations. In a study of 179 Illinois crop farms, Sonka et al. (1989) found that the number of crops planted, soil productivity indices, and yields were similar in groups of top- and bottom-performing farms, while the operating expenses of farms were more variable in bottom-performing farms. In other words, more successful farms had similarly low costs, while other aspects of superior performers were just as variable as less successful farms. In a sample of 1,020 Kansas farms, Nivens et al. (2002) found that cost management performances varied significantly across farms, while yield and price management performances were similar.

Research has also looked at how consistently farms maintain their comparative performance across time (Yeager & Langemeier, 2009). Sonka et al. (1989) followed 128 crop farms over an eight-year period and found that only 17% of farms were ranked in the top-performing group for at least five of the eight years. Nivens (2002) found that 53% of 1,020 farms did not perform statistically different than average over a 10-year period. A study of New York dairy farms concluded that dairies were consistently more or less successful than other operations (Gloy et al., 2002).

This research builds on the previous literature and analyzes the value and feasibility of farming differently than the local average. A sample of 453 Kansas crop farms is broken down by variables that are organized under farm characteristics, production practices, and management performance. The performance of farms is measured by an adjusted net farm income. More specifically, farms' variables are defined as the difference between a farm's net income and the local average and differences among farm characteristics, practices, management performances, and local averages. These are referred to as relative variables. The value of relative characteristics, practices, and management performance are quantified with a regression analysis. The degree that farms distinguish each characteristic, practice, and management performance from the average and how consistently farms achieve lower costs, higher yields, and high prices is also assessed. The purpose of this research is to provide information to farm managers and extension economists that help them in their strategic decision processes and educational efforts.

DATA

The 453 farms analyzed are members of the Kansas Farm Management Association (KFMA). All farms in the sample had to be members of the KFMA every year of the 2005–2014 period; at least 50% of their labor had to be allocated to crop production, and at least 50% of crop acres had to be planted to wheat, milo, corn, soybeans, or alfalfa. The KFMA splits Kansas into six regions, and there are farms from each region in the sample. The southeast region has the most farms in the sample, while western regions had the fewest (Figure 1).
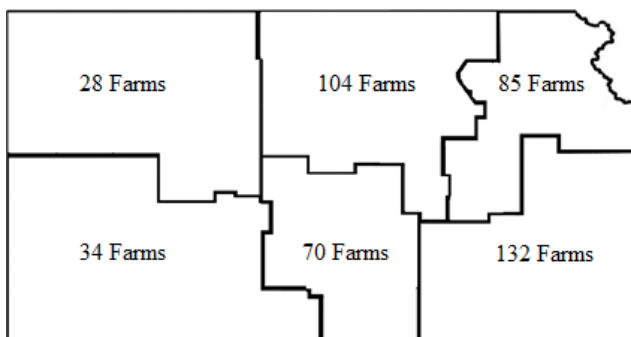

Figure 1. Sample distribution

The diverse sample includes large and small operations, farms that own and rent land, and farms with and without livestock. Table 1 shows the average farm size, workers per acre, and equipment investment per acre in the sample and the coefficient of variation, which is a normalized variability measure. Additionally, Table 1 includes summary information on yields and select explanatory variables described in the following section.

The size of farms ranged from 148 acres to 8,604 acres, and the average farm rents 68% of its cropland. However, there is considerable variation among farms, as there are farms in the sample that own all their land and equipment and farms that do not own any of either. The average number of owner-operators per 1,000 acres is 0.91, and the average number of workers is 0.97, as owner-operators make up the majority of labor. The average farm allocated 88.5% of labor to crop production, and on average 92% of crop acres were planted to wheat, milo, soybeans, corn, and alfalfa.

The 2005–2014 period included a number of widespread adverse weather events (late frosts and intense droughts), increasing and decreasing crop prices, and increasing input costs and land rents. The ethanol industry, tight global crop supplies, and a US drought pushed prices to historically high levels. Corn prices peaked in 2008 and 2013, and Kansas farmers shifted some acres out of wheat and milo and into corn and soybeans to take advantage. Crop inputs tracked crops prices higher, and average cash land rents increased steadily, but farm net incomes rose with crop prices. Average net income started at $10.60/acre in 2005 and peaked at $107.90/acre in 2013 (Figure 2). Farms invested their net income in land and machinery. The average amount of owned acres increased from 398 in 2005 to 513 in 2014, while equipment investment increased from $152/acre to $320/acre. Farms' net incomes ended close to where they started, at $3.43/acre, in 2014 as prices fell and cost remained high. After a 2007 spring freeze and during the 2012 and 2013 drought, farms received substantial income from insurance and federal disaster payments.

Other information used in the analysis is provided by the Kansas branch of the National Agricultural Statistics Service (NASS), the Farm Service Agency, and Kansas State University farm management guides. Market land rents and crop yield

Table 1. Summary statistics

	Average	Coefficient of Variation	Minimum	Maximum
Farm size (acres)	1,563	0.75	148	8,604
Share of rented acres (%)	67.6	0.39	0	100
Crop labor percentage (%)	88.5	0.15	50	100
Workers per 1,000 acres	0.97	0.63	0.28	9.7
Owner-operators per 1,000 acres	0.91	0.70	0.13	9.9
Share of main crop acres (%)	92.0	0.09	63	100
Specialization[1]	0.46	0.33	0.21	1
Planting intensity[1]	0.91	0.24	0	3
Tillage[1,2]	0.15	0.56	−0.39	1
Equipment investment ($/acre)	221	0.52	0	1,274
Machine cost ($/acre)	82	0.50	0	794
Input cost ($/acre)	200	0.45	40	1,690
Irrigated wheat yield (bu/acre)	50	0.41	0	124
Dryland wheat yield (bu/acre)	40	0.38	0	178
Irrigated corn yield (bu/acre)	174	0.22	0	270
Dryland corn yield (bu/acre)	95	0.45	0	236
Irrigated soybean yield (bu/acre)	51	0.25	0	132
Dryland soybean yield (bu/acre)	32	0.41	0	77
Government payments ($/acre)[2]	19.31	0.97	-45	376
Net crop income per acre ($/acre)	70	1.39	−1504	576

[1] Descriptions of these calculations are provided in the "Explanatory Variables" section.
[2] Government payments are measured on an accrual basis, and the tillage variable is equal to a ratio of accrual chemical costs compared to accrual chemical, machine, and labor costs. There are farms in the sample with single years of negative government payments and of crop cost variables. The accrual accounts are calculated by the KFMA based on beginning, ending, and cash information and result in some negative accrual numbers. The majority of outliers in the sample have been removed.
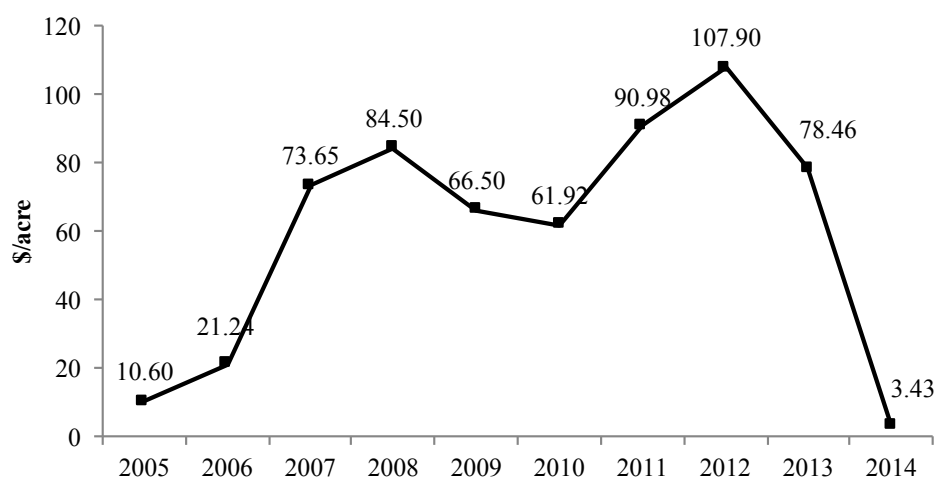
Figure 2. Average net income per acre

information were obtained from NASS, while price information was obtained from NASS and the Farm Service Agency. Expected crop input costs were based on projected crop budgets (i.e., farm management guides). Since 1974, the Department of Agricultural Economics at Kansas State University has annually published crop enterprise budgets in the Kansas farm management guides.

EXPLANATORY VARIABLES

For this study crop farms are broken down by their farm characteristics, production practices, and management performances. Table 2 lists the various categories and specific variables that fall under each. A farm's resources and how the farm accesses them are identified by their characteristics. Generally speaking, farm resources include land, equipment, and labor. Whether farms own or rent land is quantified by their share of rented

acres. The purpose of the equipment investment variable is to quantify a farm's decision to own its equipment and do its own fieldwork or hire custom operators. It also implicitly measures a farm's use of older or newer equipment and economies of size. The number of workers on the farm is measured by workers per 1,000 acres, where workers include owner-operators, family labor, and hired employees. Farm size is measured by acres of planted crops, and government payments are measured by payments per acre.

Farm production practices represent a farm's style of crop production. A Herfindahl index is used to measure how diversified farms' crop rotations are and whether they tend to plant small or wide ranges of crops. Planting intensity is calculated by dividing planted dryland acres by a farm's total owned and rented dryland acres. Use of traditional tillage practices versus no-till production is measured by a ratio of herbicide costs to

Table 2. Summary of relative explanatory variables by farm attribute

Variable	Mean[1]	Standard Deviation	Min	Max
Relative Farm Characteristics				
Size	0.00	71.99	−91.21	502.23
Share of rented acres	0.00	39.70	−100.00	81.77
Workers per Acre	0.00	58.94	−79.09	917.34
Overhead and equipment Investment	0.00	52.12	−100.00	562.82
Government payments	0.00	53.48	−74.73	785.07
Relative Farm Practices				
Specialization index	0.00	26.12	−44.25	112.93
Planting intensity	0.00	16.30	−82.95	46.06
Tillage index	0.00	42.82	−97.96	259.68
Risk	0.00	56.11	−76.33	785.61
Relative Management Performances				
Machine cost	0.00	37.49	−69.82	452.25
Crop input cost	0.00	30.99	−67.06	411.85
Yields	0.00	12.75	−51.70	89.96
Prices	0.00	7.47	−21.14	30.96
Relative Net Income				
Profit	0.00	37.23	−71.07	465.11

Note: There are 453 observations in the sample.

[1] Because each variable represents the difference from the average, the average variable is equal to zero by definition.

total chemical and machine costs. A higher ratio is assumed to be correlated with reduced or no-tillage production.

Farm management performance or focus represents how farm costs, yields, prices, and risk preferences deviate from the average. In a competitive industry where homogenous products are produced, it is in the best interest of farms to minimize their costs and maximize their yields. However, farms can deviate from the cost minimization and yield maximization industry average with their crop input decisions. Farms can choose to invest less than average in inputs and limit their yield potential or invest more than average in inputs and increase their yield potential. These strategies are quantified by the input cost and yield management variables. The machine cost variable measures how a farm's total equipment and custom hire cost compare to the average and therefore the value of cost minimization. A farm's focus on marketing is measured by how the prices it receives for crops compare to the prices received by other operations. There is also a risk variable that is measured by the variability of farms' relative net income over the 2005–2014 period. It is assumed that the variability of farm's relative net income is correlated with a farm's risk preference: more (less) variability quantifies a higher (lower) risk preference.

METHODOLOGY

The conceptual framework for this analysis can be shown as

$$Relative\ Net\ Farm\ Income =$$
$$Function \begin{pmatrix} Relative\ Characteristics, \\ Relative\ Practices, \\ Relative\ Management\ Performance \end{pmatrix}$$

Relative net farm income is defined as the difference between an operation's net income per acre and the average net income per acre of other farms in the same region. Relative characteristics, practices, and managment performance are the differences between an individual farm's attributes and the average attributes of others farms in the same region. All characteristics, practices, and management performances of farms are referred to as farm attributes.

A farm's relative net farm income$_i$ is equal to the average difference between a farm's adjusted net income per acre and a local average over a 10-year time period. Over time farms must maintain a positive net farm income to remain in business, but net income does not take into account the cost of operator and family labor and the opportunity cost of capital. To measure the economic performance of farms, studies have adjusted farms' net income by the opportunity cost of family labor as well as equipment and land assets (Sonka et al., 1989; Mishra et al., 1999; Nivens et al., 2002).

Net farm income is adjusted to account for an owner-operator salary, market rent for owned crop acres, and opportunity cost for equipment. Debt interest expenses are not included in the calculation of net income so that a farm's performance is not affect by its access to equity. The calculation of relative net farm income$_i$ is

$$(1) \qquad \overline{RNFI}_i = \frac{\sum_{t=1}^{10}(NFI_{irt} - \overline{NFI}_{rt})}{10},$$

where NFI_{irt} is the net income per acre of farm i in region r and year t and $\overline{NFI}_{rt}$ is the average net crop income of all farms in the KFMA region r. A farm's $\overline{RNFI}_i$ measures how its economic performance compares to the average performance of other farms that grow crops under similar environmental and economic conditions. The specific calculation of net farm income can be found in the appendix.

Farms' relative characteristics, practices, and management performance are equal to the difference between their attributes and the local average over the 2005–2014 period. The calculation for relative characteristics and practices is

$$(2) \quad RATTRIBUTE_{irt} = \frac{ATTRIBUTE_{irt} - \overline{ATTRIBUTE}_{rt}}{\overline{ATTRIBUTE}_{rt}}$$

$$(3) \qquad \overline{RATTRIBUTE}_i = \frac{\sum_{t=1}^{10} RATTRIBUTE_{it}}{10},$$

where $ATTRIBUTE_{irt}$ is the observed value of farm i's size (share of rented land, workers per acre, equipment investment per acre, government payments per acre, crop specialization, plating intensity, tillage practices, and risk) and $\overline{ATTRIBUTE}_{rt}$ is the average characteristics and practices observed in farm i's KFMA region r in year t. The calculation of relative management performances is

(4)

$$RPERFORMANCE_{it}$$
$$= (MANAGEMENT_{irt} - \overline{MANAGEMENT_{rt}}),$$

(5) $\overline{RMANAGEMENT_i} = \frac{\sum_1^{10} RPERFORMANCE_{it}}{10},$

where $MANAGEMENT_{irt}$ is farm i's *MACHINE COST PERFORMANCE, INPUT COST PERFORMANCE, YIELD PERFORMANCE,* and *PRICE PERFORMANCE* and $\overline{MANAGEMENT_{rt}}$ is the average management performance in farm i's KFMA region r in year t. The calculation of the management performances account for the different sets of crops that each farm in the sample grows and their specific calculation can be found in the appendix. A farm's $\overline{RATTRIBUTE_i}$ and $\overline{RMANAGEMENT_i}$ measure the degree the farm's characteristics, practices, and management performances are similar or different from the local average over the 10-year period.

To quantify the value of farming differently than average, the relative net incomes of 453 Kansas crop farms are regressed on their relative characteristic, practice, and management performance values. The model is

(6)

$$\overline{RNFI_i} = \beta_0 + \beta_1 \overline{RSIZE_i} + \beta_2 \overline{RRENT_i}$$
$$+ \beta_3 \overline{RWORKER_i} + \beta_4 \overline{RINVESTMENT_i}$$
$$+ \beta_5 \overline{RGOVERNMENT_i}$$
$$+ \beta_6 \overline{RSPECIALIZATION_i}$$
$$+ \beta_7 \overline{RPLANT_i} + \beta_8 \overline{RTILLAGE_i}$$
$$+ \beta_9 \overline{RMACHINECOST_i}$$
$$+ \beta_{10} \overline{RINPUTCOST_i} + \beta_{11} \overline{RYIELD_i}$$
$$+ \beta_{12} \overline{RPRICE_i} + \beta_{13} \overline{RRISK_i} + e_i,$$

where $RNFI_i$ is the average difference between farm i's net income and the local average and explanatory variables are the percent difference from the individual farm's variable and the local average. Farms from all six KFMA regions are put into one regression. The regression analysis assumes that the effects of local differences (i.e., farm size, planting intensity, yield management, etc.) are consistent across Kansas's production regions. The ordinary least squares (OLS) regression model is estimated, and White errors are estimated to mitigate the possible problem of heteroscedasticity.

The variability of each *RATTRIBUTE* is used to assess the degree that farms have proven they can or cannot distinguish themselves from the local average. The variability of each relative attribute is measured by its standard deviation:

(7)

$$Std\ Dev\ (RATTRIBUTE_{ij})$$
$$= \sqrt{\frac{1}{(i-1)} \sum_{i=1}^{453} (RATTRIBUTE_{ij} - \overline{RATTRIBUTE_j})^2},$$

where $RATTRIBUTE_{ij}$ is farm i's 10-year average relative characteristic, practice, or management performance j and $\overline{RATTRIBUTE_J}$ is the average relative j attribute of all farms. The standard deviation of each *RATTRIBUTE* measures how similar or different farms are within each KFMA region in regard to attribute j. The more (or less) farms have distinguished themselves from local average, the more (or less) they have proven that they are capable of distinguishing their attributes from the average.

Statistical hypothesis testing is used to analyze how consistently farms maintained their relative cost, yield, and price management performances and their relative net income over the 2005–2014 period. If a farm's average relative management performance, or average relative net income, is statistically different than zero at the 0.10 significance level, it is determined that the farm consistently distinguished its performance, or net income, from the average over the period. By definition, if a farm's relative performance or relative net income is equal to zero, then the farm's performance or net income is not different than average. For each performance, the number of farms that do and do not consistently distinguish their performance from the average is tabulated, totaled, and expressed as share of all farms. The more farms that consistently distinguish a performance from the average, the more feasible it is assumed to be for farms to distinguish across time. The number of farms that distinguish their net income from the average are also expressed as share of all farms.

RESULTS

The variability of relative attributes explained 45% of the variability of farms' relative net

Table 3. Regression results

Variable	Estimate	Std. Dev.	T-Statistic	P-Value
Intercept	0.000	2.016	0.00	1.000
Farm Characteristics				
Planted crop acres	0.108**	0.032	3.38	0.001
Rent	0.030	0.063	0.48	0.633
Workers per acre	−0.554**	0.064	−8.66	<0.001
Equipment investment per acres	0.035	0.072	0.49	0.623
Government payments	0.212**	0.065	3.24	0.001
Farm Practices				
Specialization index	−0.081	0.081	−1.00	0.319
Planting intensity	0.513**	0.176	2.92	0.004
Tillage index	−0.115	0.069	−1.65	0.100
Management Performances				
Machine costs	−0.394**	0.121	−3.27	0.001
Input costs	0.138	0.126	1.10	0.273
Yields	0.915**	0.211	4.33	<0.001
Prices	0.692**	0.307	2.25	0.025
Risk	0.002	0.061	0.03	0.978
R-square	0.46			
Adjusted R-squared	0.45			

* Indicates significance at the 0.10 level.
** Indicates significance at the 0.05 level.

incomes per acre (Table 3). Farm size, workers per acre, government payments, planting intensity, and machine cost management, yield management, and price management were significant at the 0.05 level. The interpretation of each coefficients is what the $/acre higher than average net income is expected to be for being 1% different than the local average (with regard to each particular variable), holding all other variables equal to average. A farm that was 1% larger than the local average achieved a $0.11/acre higher than average net income per acre, holding all other variables equal to their averages.

Farm size and other size-related factors are related to superior performance. Farms with 1% fewer workers per acre than average achieved a $0.55/acre higher than average net income. Operators made up 94% of workers per acre, and each operator was charged an average salary of $49,875, adjusted by the share of time they allocated to crop production. The significant effect of workers per acre is therefore primarily explained by the number of operators per acre on a farm. Machine costs are also significant, and a 1% change in machine cost has three times the effect of a 1% change in input costs. Fewer workers per acre and lower machine costs per acre are correlated with farm size, suggesting that they are sources of economies of size. The significance of farm size by itself suggests that larger farms might also benefit from input discounts and bargain power with grain buyers.

The insignificance of the share of rented acres suggests that the profitability of a farm's crop input decisions are generally not affected by whether a farm rents or owns more of its acres. The significant positive impact of government payments is surprising, given that payments make up a small portion of farm income, but may be explained by Kansas's late spring frost in 2007 and

drought in 2012 and 2013. Farms that qualified for disaster payments may have achieved higher than average net incomes as a result. Farms that used their acres more intensively than average achieved higher than average net incomes. This would include farms that used less fallow periods in their crop rotation in western Kansas and farms that planted double crop soybeans in eastern Kansas. Contrary to previous findings by Nivens et al. (2002) and common agreement in the industry, the use of no-tillage practices was negatively related to farms' performance. Given how the tillage variable is calculated, farms' varying uses of main brand and generic chemicals may be affecting the measurement of farms' tillage practices and therefore the relationship between no-tillage practices and profitability.

While lower machine costs were significantly related to higher net incomes, farms' expenditures on crop inputs were positively but insignificantly related to farms' performance. Farm's machine costs may determine the differences in farms' performance more so than their input decisions. Higher input costs are correlated to higher yields, which are significantly related to farm performance. The positive coefficient on marketing performance suggests that spending more time or investing more resources marketing crops may not detract from the performance of other areas of the farm business.

The standard deviations of relative attributes are shown in Figure 3. The variability of farm size, share of rented acres, and equipment investments per acre may be explained by farms' different preferences and circumstances. Taking farm size as an example, the variability of size may reflect the different goals of managers but also the amount of time it takes for smaller growth-focused operations to achieve their desired size. On the other hand, the variability of farm production practices, which can change in the short run, suggests that farms agree or disagree on a clear best practice. The lack of variability in crop specialization and planting intensities suggests that there is consensus on which crops to grow and how intensively to use acres. The variability of the tillage variable suggests that there is not consensus on a best tillage practice.

Crop machine and inputs costs vary more across operations than yield and price management performance. Uncontrollable pest and weather events might prevent farms from distinguishing their yield performances regardless of their input decisions. The difficulty of beating the market might prevent farms from marketing their crops at considerably higher than average prices over time, regardless of how much time they invest analyzing markets. Each farm's risk variable measures how much its relative performance varied through the 10-year period, and the results show that this was considerably different across farms.

The standard deviation analysis is combined with the value analysis to quantify the value of
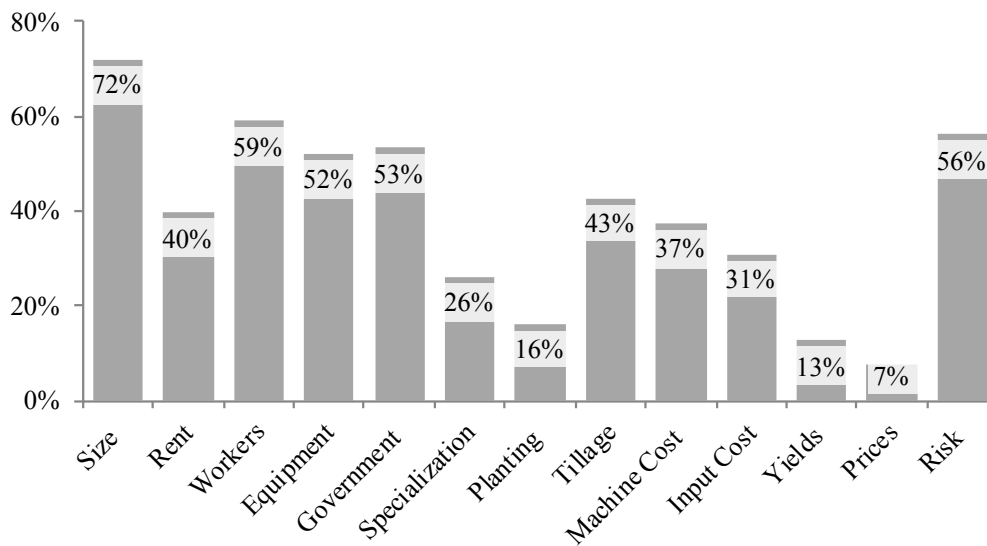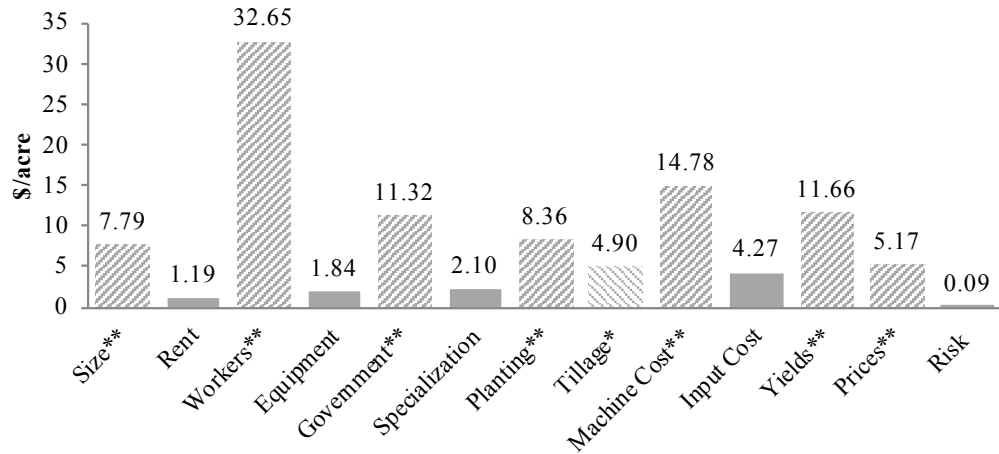

Figure 3. **Variability results**

Figure 4. Top third analysis
Note: Significance indicated by column patterns and asterisks. ** significant at the 5% level and * significant at the 10% level.
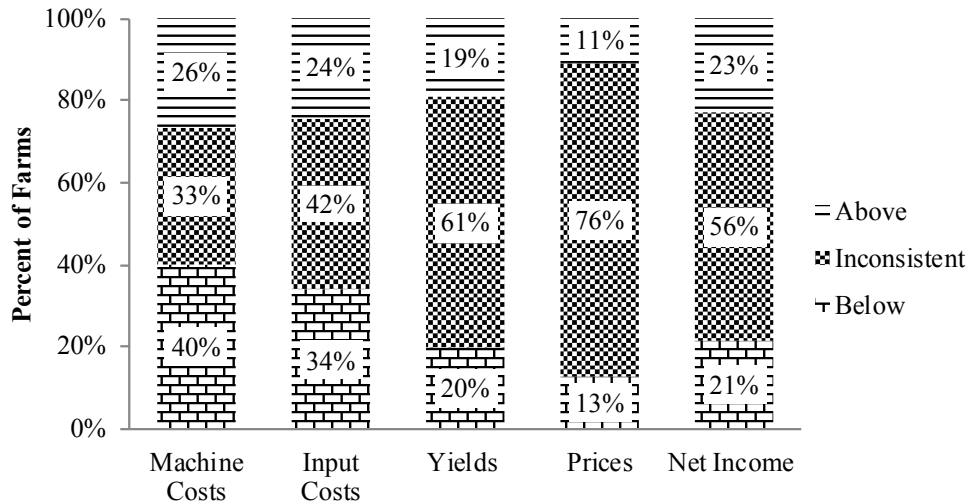

Figure 5. Consistency results

being a top-performing farmer for any one attribute. Figure 4 shows the value of being in the middle of the top third for each relative attribute. Taking farms planting intensity as an example and holding other attributes at their means, farms in the top third of all farms for planting intensity made $8.36/acre higher net income on average. The top third analysis takes into account the marginal value of being different than average and the degree that farms have shown that they can be different from other farms in their region.

The value of being one of the largest farms may be larger than $7.79/acre. Farm size is correlated with fewer workers per acre and lower machinery costs per acre. A farm in the top third for the three variables would achieve a $55.22/acre higher average net income, holding all other variables equal to average. The value of being in the top third for government payments may be explained by the Kansas frosts in 2007 and the drought in 2012 and 2013. The value of being a top machine cost and yield manager supports the importance of lower costs and good yields in crop production. Top price managers achieved a $5.17/acre income, and this was notably less than the value of being a top machine cost and yield manager.

The consistency results reveal that there is significant variability in farms' relative management performances and net income over time (Figure 5). Of the 453 farms, 42% had inconsistent relative

input costs, 61% had inconsistent relative yields, and 76% had inconsistent relative crop prices. Given the larger shares of farms with consistently higher or lower than average cost performances, farms might have the most control of their relative costs and more specifically their relative machine costs. The unique pest problems and weather events that farms face may prevent them from consistently achieving higher than average yields. The results also support the theory that it is difficult to consistently beat the market, as very few farms (24%) had consistently higher or lower prices than the average. The variability of farms' relative management performances explains the variability of farms' relative net incomes per acre. Only 23% of farms maintained consistently higher than average net incomes per acre over the 2005–2014 period.

Despite the variability in farms' performances, the econometric analysis showed that farms with superior average management performances did achieve higher than average net incomes per acre. The two results suggest that while farms might not outperform the average in costs, yields, and prices each year, farms can still benefit from a superior average performance over time. In other words, farms might not achieve higher than average yields each year, but farms that achieve a higher than average yield over a 10-year period can achieve a higher than average net income. The same theory can be applied to characteristics and practices. Larger than average farms or farms that use their acres more intensely might not benefit from economies of size or high revenues each year, but over time they can achieve a higher than average level of performance.

CONCLUSION

This research analyzed the value and feasibility of farming differently than the local average. A sample of 453 Kansas farms from the KFMA was analyzed over the 2005–2014 period. Farms were broken down by their characteristics, practices, and management performance or focus. The relative net income of farms is regressed over their relative characteristics, practices, and management performances to assess the value of farming differently than average. The degree that farms are capable of distinguishing their operations from the average is assessed through a standard deviation analysis, while statistical hypothesis testing is used to evaluate how consistently farms distinguish their management performance and their net farm income from the local average.

The econometric results suggest that the way farms access resources, produce crops, and manage their operations has a significant impact on how their farm performs relative to other operations. The OLS model explained 45% of the variability in farms' relative net income, and a number of relative attributes are statistically significant. Farms that were larger and used their acres more intensely as well as achieved higher yields had net income that was higher than the local average. The share of total income variability explained by the model is consistent with previous research on farm performance. The large share of variability not explained could be the result of differences in soil resources, inches of precipitation received, management quality, and luck (i.e., randomness).

Farms might be more capable of distinguishing their characteristics from the average than from their practices and management performances. Farms size, share of rented acres, and equipment investment per acres varied significantly across farms in each KFMA region. On the other hand, a farm's crop specialization, planting intensity, and yield and price management performance were similar within each KFMA region. The consistency results also suggest that farms cannot expect to distinguish their management performances and net income from the average every year. However, the econometric results suggest that farms that achieve superior management performances on average do achieve higher than average net incomes over time.

Further research in this area could incorporate additional information and valuing of relative characteristics, practices, and management performance over multiple 10-year periods. Individual farm soil quality and rainfall data could be included to account for the share of farms' relative performance determined by the quality of their resources and by weather events; however, these data would be costly to obtain. The incorporation of production environment data might improve the explanatory power and accuracy of the econometric model. Looking at 10-year time periods incrementally year by year, it could be observed whether the value of relative attributes has changed or remained constant across time.

Production technology, the agribusiness industry, and crop markets have changed and continue to change. Therefore, an analysis across time could identify what parts of the farm are becoming more and less important in determining farms' comparative performances.

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APPENDIX

Adjusted Net Farm Income

An adjusted net income measurement is used to measure the general economic performance of farms. Net income is a widely used measure of farm success but does not account for the cost of owner-operator labor and management or the opportunity cost of owning land and equipment. It is also affected by a farm's access to capital through interest expense. Therefore, the adjusted net income includes a salary charge for each owner-operator as well as a market rent for owned crop acres and does not include an interest expense on debt. An owner-operator salary is determined annually by the KFMA. It was \$27,000 in 2005 and increased to \$68,400 in 2014. Farms with livestock operations are credited income for crops fed to livestock to treat their performance as if they sold their crops. The following equations show how income and expenses are defined:

$$(A1) \qquad Income_{it} = \frac{(Crop\ Income_{it} - Crop\ Expenses_{it})}{Planted\ Acres_{it}},$$

$$(A2)\quad Income = Crop\ Sales_{it} + Governement\ Payments_{it} + Insurance\ Payments_{it} + Feedincome_{it},$$

$$(A3)\quad Crop\ Expenses_{it} = Crop\ Inputs\_it + Crop\ Labor\ Expenses\_irt + Machine\ Expenses\_it + Cash\ Rent\_it + Own\ Land\ Rent\_it.$$

The adjusted net farm income is divided by planted acres so that the economic performance of different-size operations can be compared to one another.

Management Variables

Farms in the sample plant different amounts and shares of wheat, milo, corn, soybeans, and alfalfa and other crops. The costs, yields, and value of farms' crops cannot be compared outright to determine their cost, yield, and marketing performances. If this were done, differences would reflect differences in farms' crop mixes, not necessarily differences in management performances. To get around this issue, expected costs, yields, and crop values are created for each individual farm and their specific crop mix. Farms' observed costs,

yields, and prices are compared to these expectations to determine each individual farm's management performances.

Cost

A farm's cost management performance is equal to the percent difference between a farm's actual costs per acre and its expected costs per acre. Farms that plant different crops have fundamentally different costs. When determining whether a farm that plants corn has higher or lower than average costs, the farm's per acre costs cannot be directly compared to the per acre costs of a farm that plants wheat. An intermediate step is needed before these farms' cost performances can be compared. The actual cost of farms is given by

$$(A4) \qquad ACTUAL\ COST_{irt} = \frac{CROP\ COST_{irt}}{PLA_{irt}},$$

where $CROP\ COST_{irt}$ is farm i's total crop labor, inputs, fuel, repairs, and depreciation costs measured on an accrual basis in year t and PLA_{irt} farm i's total planted crop acres. The $ACTUAL\ COST_{irt}$ measures farm i's crop costs per acre for all crops: main crops (wheat, milo, soybeans, corn, and alfalfa) and other crops. The expected cost of each farm is calculated with cost information report in the Kansas farm management guides. The calculation is

(A5)

$$EXPECTED\ COST_{irt} = \frac{\sum_{k}^{5}(CROP\ BUDGET_{ikrt} \times ACRES_{ikrt})}{MCA_{irt}},$$

where the $CROP\ BUDGET_{ikrt}$ includes per acre labor, input, fuel, and machinery costs for main crop k in region r and year t on farm i and $ACRES_{ikt}$ is the acres of crop k planted in region r and year t on farm i. Crop budgets are published by the Department of Agricultural Economics at the end of the year prior to the planting year and are projected crop input costs for each main crop k in region r. The MCA_{ikrt} is the total acres of main crops (wheat, milo, soybeans, corn, and alfalfa) planted on farm i in year t.

A farm's cost management performance, $COSTP_{irt}$, is equal to the percent difference between their actual costs and expected costs. The calculation is

(A6) $COSTP_{irt} = \frac{(ACTUAL\,COST_{irt} - EXPECTED\,COST_{irt})}{EXPECTED\,COST_{irt}} \times 100,$

where $COSTP_{irt}$ measures how farms' actual costs per acre for all crops compare to their expected costs per acre for main crops. The indirect comparison between farms' total crop costs per acre and expected main crop cost per acre is necessary due the cost information available. Each farm's crop expenses were not available at the individual crop level, while only crop budgets for main crops were widely available for all of the KFMA regions. For the sample of farms the average share of main crop acres is 92%, so it assumed that the indirect comparison accurately measures whether a farm had lower or higher than expected costs.

The final variable used in the econometric model, standard deviation analysis, and consistency analysis is equal to the average difference between a farm i's cost management performance, $COSTP_{irt}$, and the region average cost management performance, $\overline{COSTP_{rt}}$. The calculation is

(A7) $\overline{RCOSTP_i} = \frac{\sum_{t=1}^{10}(COSTP_{irt} - \overline{Cost\,Performance_{rt}})}{10},$

where $\overline{RCOSTP_i}$ measures how farm i's cost management performance compared to the region average over the 2005–2014 period.

Yield

The yield management performance of each crop farm i is quantified by comparing a farm's main crop yields (wheat, milo, soybeans, corn, and alfalfa) to the average respective yields of all farms in the farm's KFMA region. The crop production per acre for each crop is different than the others, so the yields of each crop must be compared individually to one another. The yield for each crop is calculated as

(A8) $YLD_{ikrt} = \frac{PRODUCTION_{ikrt}}{ACRES_{ikrt}},$

where YLD_{ikrt} is production per acre of crop k for farm i in region r and year t. A yield is calculated separately for irrigated and nonirrigated wheat, milo, soybean, corn, and alfalfa.

Each year weather conditions are unique to the different counties in each KFMA region. It would be inappropriate to compare each farm's yields directly to the region average, because each

farm's maximum yield potential will be different as a result of the different weather conditions that farms face. For each farm i, its region r's average yield is adjusted by a ratio of the farm's county c yield compared to the average county yield in the farm's KFMA region r:

(A9) $ADJ\,AVERAGE_{ikcrt} = \overline{YLD_{krt}} \times \frac{CYLD_{kcrt}}{\overline{CYLD_{krt}}},$

where $\overline{YLD_{ikrt}}$ is the average yield for crop k of all farms in region r during year t. The $CYLD_{kcrt}$ is the average yield reported by NASS in county c and $\overline{CYLD_{krt}}$ is the average NASS yield calculated for all counties in region r. The KFMA region average yield is adjusted up (down) if average NASS yield in county c is higher (lower) than the average NASS yield of all counties in region r. It is recognized that individual farms within a county may experience different weather conditions than other farms in their county in any year. This adjustment is made on best efforts basis to try to account for the unique weather conditions that farms face.

For each farm i the yield of each crop k is compared to the respective adjusted region average

(A10)
$CROP\,YIELD_{ikrt}$
$= \frac{YLD_{ikrt} - ADJUSTED\,AVERAGE_{ikrt}}{ADJUSTED\,AVERAGE_{ikrt}} \times 100,$

where $CROP\,YIELD_{ikrt}$ measures the yield performance of each crop k on farm i. The overall yield performance of farm i, $YIELD_{irt}$, is calculated as

(A11) $YIELD_{irt} = \frac{\sum_{k=1}^{10}(CROP\,YIELD_{ikrt} \times ACRES_{ikrt})}{MCA_{ikrt}},$

where $YIELD_{irt}$ is the weighted yield performance of the farm i. $ACRES_{ikrt}$ is the number of acres planted to crop k in year t, and MCA_{ikrt} is the total acres of main crops. The relative yields of each main crop k are weighted by the number of acres planted to them. The more acres planted to a crop k, the larger the effect that a particular crop's yield performance has on the farm over yield management performance.

The final $RYIELD_i$ variable used in the econometric, standard deviation, and consistency sections measures the difference between a farm's yield management performance and the average performance in the region. The calculation is

(A12) $\overline{RYIELD_i} = \frac{\sum_{t=1}^{10}(YIELD_{irt} - \overline{YIELD_{rt}})}{10},$

where $\overline{RYIELD}_i$ is the average difference between a farm's overall yield management performance and the average yield management performance in their region over the 2005–2014 period.

Price

The value of crops produced per acre is used to measure the marketing performance of crop farms. The specific prices that farm sell their crops at each year are not available in the KFMA data base, but the market value and quantities of all crops sold and produced each year are available. The value of farms' production per acre cannot be compared directly to one another. An intermediate step is required to account for the different crops that farms grow and the differences in basis between different counties. In each year the price management of farms is estimated by comparing the actual dollar per acre value of farms' crop production to what the dollar per acre value of their crop production would be if they sold their crops at the average price received for crops in their county.

The gross value of crops produced on farm i in year t is recorded by the KFMA. The actual value of crops produced is

(A13) $ACTUAL\,VALUE_{ikcrt} = \frac{GROSS\,VALUE_{ikcrt}}{PLANTED\,ACRES_{ikcrt}},$

where $GROSS\,VALUE_{ikcrt}$ is the total value of all crops produced on farm i located in county c in region r during year t and $PLANTED\,ACRES$ is the total acres of crops planted on farm i in year t. The total value of crops and planted acres includes main crops and nonmain crops. The expected per acre value of a farm's crops is

(A14)

$EXPECTED\,VALUE_{ikrt} = \frac{\sum_{k}^{5}(PRODUCTION_{ikcrt}\times PRICES_{kcrt})}{MCA_{ikcrt}},$

where $PRODUCTION_{ikcrt}$ are the bushels of each main crop k produced on farm i located in county

c in region r during year t and where $PRICES_{kcrt}$ is the estimated average price received for crop k in county c and year t. The county average price for each main crop k in each county c and year t was estimated using NASS prices at the crop reporting district level and Farm Service Agency county-level loan rate data. The MCA_{ikcrt} is the total acres of main crops so that the $EXPECTED\,VALUE_{ikcrt}$ measures the per acre value of farm i's main crop production if all of farm i's main crops were sold at the estimated county c average price in year t.

The price management performance of each farm i, $PRICE_{irt}$, is equal to the percent difference between farm i's actual value of crops per acre and the expected value of main crops per acre. The calculation is

(A15)

$PRICE_{irt} = \frac{(ACTUAL\,VALUE_{irt} - EXPECTED\,VALUE_{irt})}{EXPECTED\,VALUE_{irt}} \times 100,$

where $PRICE_{irt}$ measures the degree that farm i marketed its crops at higher than county average prices. Similar to the calculation of $COST_{irt}$, the value of all farm i's crops per acre are compared to the expected value of farm i's main crops per acre. This procedure is due to the lack of data on nonmain crop county average prices. Because the sample's average share of main crops is 92%, this assumption is not expected to have a significant effect on the results.

The calculation of the final relative price management variable used in the econometric, standard deviation and consistency analysis is

(A16) $\overline{RPRICE}_i = \frac{\sum_{t=1}^{10}(PRICE_{irt} - \overline{PRICE}_{rt})}{10}$

where is the average price performance, $PRICE_{irt}$, of all farms in region r during year t. A farm's $\overline{RPRICE}_i$ measures how the farm's management performance compared to the average management performance in its KFMA region over the 2005–2014 period.