Linking Efficiency, Profitability, and Growth of Kansas Farms

by

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B.S., Kansas State University, 2015

A THESIS

submitted in partial fulfillment of the requirements for the degree

MASTER OF SCIENCE

Department of Agricultural Economics
College of Agriculture

KANSAS STATE UNIVERSITY
Manhattan, Kansas

2017

Approved by:

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Abstract

The main objective of this analysis was to examine the profitability and efficiency of Kansas farms in order to draw inferences among the profitability, efficiency, and growth of agricultural producers in Kansas. The time period analyzed was 2005 to 2015. Farms in the sample include a mix of 564 crop and/or livestock operations with 11 years of continuous data through the Kansas Farm Management Association data-bank.

Efficiency scores were calculated to determine how close each farm was to the production possibilities frontier, or their cost efficiency. Profitability measures, (operating profit margin and return on assets), were obtained for each farm. The profitability dynamics in 2014 and 2015 for these farms changed compared to previous years. Crop farms generated less profits in 2014 and 2015 compared to previous years, and relative profits from average fluctuated more for sampled farms in 2014 and 2015.

Farms were also categorized into risk classes. These classifications aim at distinguishing farms that are profitable or not, and their level of solvency, utilizing their net farm income from operations and their debt to asset ratio. Farms are migrating from the low risk classification, showing that Kansas farms are becoming less profitable, but are not transitioning to a higher risk solvency state. These farms will need to focus on utilizing their inputs more efficiently to keep their solvency levels in check.

After analyzing persistence in profitability, the results suggest that farms with higher return on assets tend to be more solvent, but farms with higher operating profit margin tend to be less solvent. The analysis also suggests that there might have been persistence in profits in the years prior to 2015. The analysis of relative positioning of farms in terms of return on assets suggests that during 2007-2011 some farms were able to consistently differentiate themselves by

generating either below or above normal profits. Some farms were able to become more profitable in 2012 and 2013, while others lagged behind supported by regression results that signaled divergence of profitability levels. The relative positioning analysis for operating profit margin indicates that farms had similar operating profit margins from 2010 through 2014, and divergence occurred in 2015 by farms that were able to differentiate themselves more through the average operating profit margin. Next the efficiencies of the farms were examined.

Analysis of the efficiency scores suggests that the cost efficiencies of Kansas farms are not explained by risk classification significantly, but the crop-labor percentage ratio significantly explains the cost efficiency of the farms. The relationship between cost efficiency and profitability measures proved to be the strongest out of the three performance measures due to their correlation. The final step in the analysis was to examine farm characteristics of the top performing farms.

Farms were ranked by profitability measurements and the efficiency measure. Variables of interest that were significantly different between the top 25 percent and the bottom 25 percent of farms include total farm assets, value of farm production, crop-labor percentage, crop acres, number of workers, and age of operators.

Table of Contents

List of Tables

Acknowledgements

I want to thank everyone that has helped support me, and helped me get where I am today. The first people being family, mainly my supportive parents Ronald and Stella O'Brien. I would also like to send my sincerest thank you to Dr. Elizabeth Yeager for the support and time she has put into my graduate education at Kansas State University and my work. Her patience with me through this journey has made a difference in my professional writing skills and insights into analyzing farm performance measure dynamics. Additionally, I want to thank everyone in the Agricultural Department that I talked with on a daily basis that made my day brighter; faculty, students and staff. Finally, I want to thank my wife, Bailey, for always understanding the stressful times we have had during our journey through each of our professional programs.

Chapter 1 - Introduction

1.1 Introduction

Agriculture is a cyclical industry with corn, soybeans and wheat commodity prices reaching their record high or second highest price spikes in the summer and fall of 2012. Live cattle prices also reached relatively high levels from fall of 2014 to the spring of 2015 seen through U.S. reported prices received from NASS (n.d.). Due to this cyclical nature, stakeholders need to continually evaluate firm performance. Profitability, efficiency, and growth represent three different economic dimensions of firm performance that are of interest. Understanding the dynamic links among these firm performance measures is important for managers, investors, and creditors to better understand the performance of farms at different stages, whether growing, at equilibrium, or decreasing in size.

This thesis will examine performance measures of Kansas farms and possible connections between the performance measures. Some elements have been recognized as impacting performance, such as financial constraints playing a role in profitability, efficiency, and growth of Kansas farms. This will provide new insight into the performance of Kansas farms, and provide emperical evidence of any such relationships between these specific performance measures. This study aims to aid farm managers, investors, credit providers, consultants, and researchers in determining what performance factors of farms need to be examined in this time of new market dynamics. Results will help farm managers determine what performance measures or characteristics need to be examined in times of lower profitbility levels to lower chances of default, and if different performance measures or farm characteristics need to be monitored in times of higher profitability to ensure profits are fully captured. An example of such an observation would be that producers that are of higher concentration in crops perform more cost efficiently in lower profitable years, so farms and managers should concentrate more on crop operations than livestock operations. Creditors will be able to include the proper performance measures based on market conditions in loan covenants set in place to minimize default risks. Finally, researchers will be able to utilize findings in future research over persistence in profits, farms efficiency studies, and other studies focused on performance of farms.

1.2 Objectives

The recent volatile prices in agriculture have many producers and lenders looking for additional ways to evaluate and monitor a farm's performance. The first objective of this study is to examine profitability persistence of farms. The second objective is to examine the relative efficiency levels of farms. The final objective is to expand previous work analyzing efficiency, profitability, and growth levels of Kansas farms, utilizing similar techniques to Bottazzi, Secchi and Tamagni (2008). The intent is to discover a link among efficiency, profitability, and growth in Kansas farms.

In order to analyze the profitability and efficiency of Kansas farms, the relative positioning of farms will be examined and compared across a simplified risk classification of farms related to their net farm income and ending debt to asset ratio. Simple auto-regressions, utilizing previous year values to try and explain current year values, will be performed on profitability levels to examine the effects of financial constraint levels through credit rating dummy variables. Several regressions aimed at finding determinates of efficiency will be conducted to explore the characteristics of more cost efficient farms.

1.3 Study Outline

The following chapters will be as follows. Chapter two will present a literature review over related topics that will examine work done within agriculture and relevant theoretical studies. Chapter three will demonstrate the empirical methodology employed. Chapter four reveals data used for the study and other variables to be analyzed. Chapter five will present the findings of this research. Finally, chapter six will discuss conclusions and future implications for Kansas farm stakeholders.

Chapter 2 - Literature Review

2.1 Introduction

In the past decade, U.S. agriculture has seen volatile commodity prices and tremendous demand factor changes such as growth in income in developing countries with higher income elasticities (Economic Research Service 2016). These changes have accelerated the productivity and growth of farms one year and strained their profitability the next year through world commodity surpluses (Bjerga and Wilson 2016). The link between productivity and profitability of firms has been inspected, and this chapter will examine studies conducted on the productivity and profitability of U.S. farms as well as the manufacturing and service industry.

This review will be broken down into five sections covering the financial characterization of farms, measures of conventional and agricultural productivity, profitability review, persistence in profitability, and the linkage and relationships between profitability, productivity, and growth.

2.2 Financial Characterization of Farms

The financial characteristics deliver a picture of the condition of farms that can be compared across time to determine trends and compare a group of farms against the average characteristics of a sample. The average Net Farm Income from Operations (NFIO) of Kansas farms in 2015 hit a low not seen since 1981 (Ibendahl 2016). Ibendahl (2016) split all Kansas Farm Management Association (KFMA) reporting farms into decile groups based on their NFIO, and displayed their NFIO distribution. Even though the average Kansas NFIO was positive, nearly 45 percent of KFMA farms had negative NFIO in 2015. The losses in 2015 were similar to that of 1981, where deciles six through ten had negative NFIO in 1981. In 2015, deciles seven through ten had negative NFIO, and the sixth decile averaged less than $1,000 NFIO. Due to the current financial condition of Kansas farms, financial performance measures need to be examined.

A simple method of accounting for the financial condition of a farm was conceived within the United States Department of Agriculture Economic Research Service after the 1980s farm debt crisis. It utilizes farm income and the debt to asset ratio to categorize farms into four financial position classifications. These include: favorable farms with positive farm income and a debt to asset ratio no more than 40 percent; marginal-income farms with negative farm income and a debt to asset ratio no more than 40 percent; marginal-solvency farms with positive farm income and a debt to asset ratio greater than 40 percent; and vulnerable farms with negative farm income and a debt to asset ratio greater than 40 percent (Hoppe and Banker 2010). This is a simple method of examining a farm's financial position based on their current period performance and their leverage position.

Featherstone and Langemeier (2015) employ an estimated credit scoring regression function for farms participating in the KFMA program to determine the credit quality of these Kansas farms. Essentially, the farms' ability to handle adverse conditions fell in 2015 through decreased credit ratings. This decrease in credit rating paired with a considerable decrease in the profitability of Kansas farms may cause their access to traditional credit to be diminished because interest rates are often dependent on credit ratings (Featherstone and Langemeier 2015). This analysis of farms' credit rating is a step closer to examining the true access to financing for a farm.

Bottazzi, Secchi and Tamagni (2008) examined a group of Italian business firms with more than one employee, due to self-employment dynamics, whose data were collected by Centrale dei Bilanci (CeBi). The top 3 percent of firms exhibiting extreme values were also removed because of suspicious instability of results when they were included. The sample were divided into manufacturing and service firms and put into different risk level classes based on the credit rating index supplied in the CeBi database. This index shows the position each firm is in with respect to their current financial conditions as well as forecasting future solvency. This risk rating serves as a proxy of firms' access to credit because it is taken into account by banks when issuing credit lines and is seen to be a reasonable measure of access to external financing (Bottazzi, Secchi and Tamagni 2008).

This section examines techniques of determining the financial position of farms, and access to external financing they have in order to classify farms based on these factors. A credit rating is summarized by Bottazzi, Secchi and Tamagni (2008) to be a reasonable relative measure of access to external financing due to banks utilizing risk ratings for loan approval. While Featherstone and Langemeier (2015) suggest risk ratings to be an effective generic control variable for the financial condition of the firm. This is in part due to the risk ratings taking into consideration the ability of farms to navigate adverse conditions. They also suggest that credit ratings have a large affect on effective interest rates. This research will utilize the risk rating categories outlined by the USDA.

Productivity levels are examined next in order to explore the connection between the access to credit as well as the financial condition of the farm and the productivity and efficiency of firms.

2.3 Significance in Productivity Levels

The efficient allocation of scarce resources is measured by productivity, which is expressed as the ratio of outputs to inputs. Basic productivity measures include labor productivity and capital productivity, which are simple ratios that measure the amount of product produced by one unit of the respective input. However, these partial productivity measures do not account for input factor trade-offs that are typical when making management decisions to increase productivity (Hannula 2002).

2.3.1 Productive Efficiency Methods

Most business processes utilize more than one input to produce an output, and can be measured by total factor productivity (TFP) (Caves, Christensen and Diewert 1982). Coelli et al. (2005) indicate that one can use a distance function index or price aggregation based index for measuring TFP at the individual company-level. One index based distance function is the Malmquist productivity index (MPI) that utilizes data envelopment analysis or regression methods to measure the distance each firm is from an unknown production possibilities frontier (Caves, Christensen and Diewert 1982). Price aggregation based indices include the Törnqvist productivity index or Fisher productivity index.

Caves, Christensen and Diewert (1982) explain MPI as either an output or input quantity productivity index, and the difference between the two are a factor reflecting the returns to scale of the production structure. This output or input index does not accurately measure changes in productivity in the presence of changes in returns to scale, but Bjurek (1996) suggests a generated Malmquist TFP (MTFP) is able to remedy that limitation and allow for variable returns to scale technologies. The generated MTFP is a traditional productivity index in the sense that it is a ratio between an output index and an input index i.e., as the ratio between the Malmquist output and input quantity indexes. MPI, and similarly MTFP, can be broken down to technical efficiency and allocative efficiency change; technical change relates to a change of the frontier that the business could perform their best, or that the business is expanding beyond its previous production capabilities, and the allocative change implies a change in outputs with the same inputs due to the business catching up to the most efficient productive practices (Färe, et al. 1994; Bjurek 1996).

Färe, Grosskopf and Lovell (1985) discuss differences between defined productivity and efficiency. Productivity is solely the ratio of output(s) to input(s), while efficiency is defined as a distance between a firm's quantity of input and output, and the quantity of input and output that defines the most efficient frontier of an industry. These measures cooperate together; efficiency provides a more accurate measure due to utilizing the most efficienct frontier, which expands upon productivity that is solely based on the ratio of outputs on inputs (Färe, Grosskopf and Lovell 1985).

Coelli et al. (2005) discusses connections between cost efficiency (CE) and technical and allocative efficiencies. They state CE can be calculated if input price information is present, and is also less than or equal to technical efficiency due to all three efficiency measures being bound between zero and one. The calculation of CE is the product of technical and allocative efficiencies. Therefore, the calculation shows that a firm can only be cost efficient if and only if they are technically and allocative efficient. CE is an economic efficiency measure. With allocative efficiency accounting for proper decisions regarding input usage given input prices, and technical efficiency measuring a firm's success in producing maximum output from a given set of inputs (Coelli, et al. 2005), the CE is an appropriate measure of efficiency. The implication that CE is an appropriate efficiency measure puts CE on par with MPI and MTFP in term of determining whether a firm is fully efficient.

The Törnqvist productivity index utilizes observed prices and quantities over time to generate price or quantity indices but is a simple productivity calculation that presumes production is always efficient (Caves, Christensen and Diewert 1982). The MPI and MTFP aren't reliant on the assumption of technical and allocative efficiency like the Törnqvist index approach, and allows a breakdown of productivity growth into performance changes and technological change (Färe, et al. 1994). The slackness on the efficiency allows the analysis to consider that a farm is not performing at 100 percent technical or allocative efficiency.

The Fisher productivity index uses price and quantity observations over time to generate a measure of productivity. This measure is similar to the Törnqvist productivity index in the sense that it uses simple calculations and few assumptions are made about production technology. Unlike MTFP, the Fisher TFP index requires price data for inputs and outputs if there is not perfect allocative efficiency (Diewert 1992). Another drawback with the Fisher productivity index is a lack of coherent decomposition. It cannot be decomposed in many cases due to an assumption of constant returns to scale for decomposing technical change according to techniques prescribed by Kuosmanen and Sipiläinen (2009).

Bottazzi, Secchi and Tamagni (2008) examined efficiency of single input use through capital productivity and labor productivity, and a multi-factor description of productivity performance. This first technique of single input efficiency measures, capital and labor productivity, were examined across the credit rating classes and manufacturing and service firms. Productivity differentials were calculated and labor productivity and capital productivity densities were graphed for each sector and risk rating. These techniques aimed at visually exploring the difference between the labor and capital productivity amongst firms. Bottazzi, Secchi and Tamagni (2008) also utilized a Fligner-Policello test of stochastic equality in the 2002 results between the different risk ratings and found that with both the manufacturing and service industries the capital productivity of the middle risk class cannot be distinguished from the high risk class at the 10 percent confidence level. This comparison aims to show differences in productivity levels between firms in different risk classifications.

The multi-factor analysis Bottazzi, Secchi and Tamagni (2008) conducted was an examination of the output of each firm utilizing both capital (K) and labor (L). The first analysis is a simple ordinary least squares (OLS) regression determining parameters for K and L, that closely estimate outputs of firms. The high risk firms showed a higher proportion of lower levels of labor productivity in both sectors, but the same observation for capital productivity was only seen in the manufacturing sector. However, this parametric model doesn't consider firm specific effects that include financial conditions that can be represented by risk rating class or sectoral effects of a manufacturing or service firm.

2.3.2 Productivity and Efficiency in Agriculture

Agriculture has a unique production dynamic in the sense that some inputs and outputs are measured in units, and valued on a market basis with large fluctuations in prices. This industry depends on favorable weather conditions to produce optimal outputs of crops and livestock; unfavorable weather can cause significant stress on plants and livestock decreasing output yield. When examining individual farm-level TFP, aggregated inputs and outputs are required in order to get scalar values in the numerator and denominator. The following section will examine the use of productivity measures in agriculture.

Yeager and Langemeier (2011) utilized MPI to determine if productivity levels of 135 Kansas Farm Management Association (KFMA) farms had been converging or diverging over a 30-year period from 1979-2008. To determine the direction of growth, each farm's individual MPI was calculated. If the productivity levels were converging, the least productive farms would grow faster than the most productive farms essentially catching up in their productivity.

However, if they were diverging the most productive farms would have a higher productivity growth than lower productive farms and the productivity gap would widen. The findings of the study indicate that there was an average 0.5 percent annual productivity growth, where the top 45 farms' MPI suggested on average they grew 2.39 percent, and the lowest 45 farms' MPI showed an average decrease of 1.46 percent. Yeager and Langemeier (2011) suggest that examining farm productivity regularly is important to be able to benchmark an operation to find their relative position within the industry.

Previous studies found that the main source of TFP in Kansas farms is due to technical change, and not efficiency change (Mugera, Langemeier, and Featherstone 2012a; Mugera, Langemeier, and Featherstone 2012b). These studies examined Kansas farms whose data came from the Kansas Farm Management Association (KFMA), and focused on labor productivity growth, and its convergence in the Kansas farm sector.

Mugera, Langemeier, and Ojede (2016) worked to connect the effect that productivity had on profitability, which will be discussed in a later section. In their findings, they also find that the gains seen in TFP of Kansas farms are attributable to technical change and have remained constant after 2000. This technical change was seen to be the main driver in productivity changes and profitability changes in the sampled Kansas farms.

Yeager and Langemeier (2016) utilize economic or cost efficiency (CE) that focuses on the efficient use of inputs measuring distances farms are from the production possibility frontier. This CE measure is the product of technical efficiency which measures whether the farm is producing on the production possibility frontier, and allocative efficiency which measures whether the optimal mix of inputs is used. Agriculture producers are assumed to be cost minimizers, which allows CE to be an effective manner for measuring productivity for farms due to the availability of input prices. The CE is made up of the minimum input cost under variable returns to scale divided by the observed input cost of the farm (Coelli, et al. 2005; Yeager and Langemeier 2016).

These efficiency measures focus on the efficient use of inputs to measure the ability of a firm to generate the outputs. Techniques include examining the efficient production of outputs with a given input, and the fewest inputs given the output such as CE.

2.4 Coinciding Profitability

Single business owners or partnerships are incentivized to be profitable to generate income for themselves at their current size or to grow their operations for larger potential future earnings. By having adequate earnings to assets or investment, stakeholders of the business can benchmark their earnings to determine if they are earning more than the opportunity cost of not putting money elsewhere. Opportunity cost for farms is explained by Hofstrand (2008) as being the alternative income that could have been generated in an alternative investment other than the current investment. Being profitable not only benefits the owner of the business, but it also allows for flexibility to use retained earnings as an investment to increase the scope of an operation for more earning potential in the future.

Traditional accounting methods in agriculture are different from many other industries such as manufacturing or service industries. Many farm businesses have historically not utilized general accepted accounting principles (GAAP) in maintaining their financial records (FFSC 2015). These practices are only one small factor in new financial reporting standards. The farm crisis in the 1980s led to the realization that agricultural producers, lenders, farm financial advisors or other interested parties couldn't be confident in the system used for financial reporting at the time, and comparative analyses couldn't be performed between farming operations within the same industry. In response to this, the Farm Financial Standards Council (FFSC) was commissioned to develop financial guidelines to be used by agricultural producers. These guidelines aid producers in reporting finances in a technically sound manner, create standardized definitions and methods to derive financial measures to determine financial position, and provide guidelines for benchmarking when using aggregate financial statement data (FFSC 2015).

The level of profit a farm generates from land, labor, capital, and management use, can be extrapolated from the following financial ratios described in FFSC (2015) and previous literature. Net Farm Income from Operations (NFIO) is the leftover farm revenue after accounting for farm expenses paid with those revenues taken on a before-tax basis, with depreciation included as a non-cash expense. Operating Profit Margin ratio (OPMR) measures profitability as the return per dollar of value of farm production. Rate of Return on Farm Assets (ROA) is, in its essence, an overall picture of the profitability of a business. ROA links the level of operating profit to the assets utilized to generate those profits. Finally, measuring the Rate of Return on Farm Equity (ROE) provides insight on how well the equity in the farm is being utilized (Langemeier 2011).

The total economic activity of a production process, input expenses, and marketing conditions occurring over a selected time period are all captured within NFIO (Schnepf 2013). The level of NFIO is utilized by the Farm Income Team (2016) in the United States Department of Agriculture Economic Research Service as a measure of profitability in the farm sector.

The previously mentioned ratios have a role in benchmarking farms as described by FFSC (2015). OPMR is essentially the operating efficiency of the farm. It can be used as a measure between different sized farms to compare their profitability, and determine if a farm is at a high risk level by setting a critical zone limit at 10 percent OPMR (Hoppe and Macdonald 2016).

Calculated ROA is a profitability measure relating operating profit to assets, signaling whether there is a profitable return in relation to the assets of the whole farm. Wolf (2010) utilizes the ROA of dairy farms as a base for farm profitability to determine if another measure accurately serves as a profitability proxy. Scott, Scott and Cacho (2013) examine whole-farm operations in Australia to see if different livestock management systems had an effect on the ROA, or profit, of each farm. The main reason for utilizing ROA as their profitability measure was due to it being a whole-farm rate of return. This ROA incorporates earnings distributed to equity and debt holders, showing the profitability over all business assets.

Determining if the investment in a farm is worth continuing is the purpose of ROE. Looking at trends over time, owners can see if their investment into the farm could have been utilized somewhere else to get the same or better return. In essence, if the farm is leveraged then in the long-run ROE should be higher than ROA. This is due to the relationship between the ratios, where ROE is solely the return over the amount of owner’s equity, while ROA is the return over the amount of owner’s equity plus any liabilities within the farm. The intuition behind ROE being larger than ROA is that a business should be earning more from its own equity in the farm than what you are earning for the debt holders, and the operation should also earn more on the debt itself used to buy assets than what the business is paying the creditor for the debt. If ROE is not higher, then it signals that the manager is not utilizing debt leverage to the farm’s advantage. ROE needs to be examined alongside other ratios to avoid any skewedness of ROE due to varying structural farm characteristics (FFSC 2015).

Bottazzi, Secchi and Tamagni (2008) examined the empirical distribution of the profitability of Italian firms through profitability measures that would solely align with the operations of the business and weren't dependent on financial or taxation policies. These measures include return on sales ratio for operational profitability and return on investment to take into account capital of the business. Bottazzi, Secchi and Tamagni (2008) also investigated the autoregressive structure of the relative positioning of both profitability measures. This provides insight on the convergence of each industry separated between each risk class. The results showed that convergence was present in high-risk firms to move toward the sectoral average common to all other risk groups (Bottazzi, Secchi and Tamagni 2008). An explanation provided is that some higher risk firms can perform remarkably well and drive the average profitability of the risk class up over time. A consideration of profitability measures typical of the agricultural sector discussed previously is important, along with techniques employed by Bottazzi, Secchi and Tamagni (2008), to accurately measure and compare farms.

2.5 Persistence in Profits

Previous work in other industries examined the degree of persistence in profitability of firms over the long run. These studies determined if there was persistence in the profitability levels, but not the determinants of the persistence in profitability in the long-run. Consistent profitability in farms can be determined by weather, management decisions, farm size, and farm type. All of these factors combine to create the resulting profitability levels. Ibendahl (2013) showed that management decisions might contribute to one third of the variance in the net farm income of 626 Kansas farms from 1997 through 2011. However, the study didn't examine farm size or farm type, both of which may contribute to part of the one third explanation of the variance in net income the author found management decisions had.

Herbel and Langemeier (2012) examined the persistence in financial performance in 1,031 KFMA reporting farms from 2007 to 2011. The study examined OPMR as the profitability measure as well as other measured characteristics of the farms broken into ranked OPMR quartiles. Five-year average data showed a significant difference in financial performance between the top and bottom quartiles. They noted that 47.6 percent of farms were never in the bottom OPMR category, while approximately 21.5 percent of farms in the bottom OPMR category were there for three or more years. In essence, the study stressed the importance of utilizing several years of data to benchmark the financial performance of farms, and suggested that it is possible that farms can have a sustained competitive advantage (Herbel and Langemeier 2012).

Griffin, Ibendahl, and Stabel (2016) studied the probability of 425 farms switching between profit quintiles from 1994 to 2013. The percentage of farms that stayed in the same profit quintile or switched to another were calculated each year, and these calculations were used in the probability calculation that a farm would stay in the same profitability quintile or change to a different one. This was done on a Kansas wide calculation and a regional calculation based on the six regions of the KFMA Association. The study indicated that farms tend to remain in their profitability category which advocates that management skill or farmland quality may both control profitability more than random factors. Another noted observation over the different profitability categories is that the highest and lowest categories have a higher probability of switching quintiles than the middle three categories. This shows that farms likely cannot hold onto the highest profit levels consistently, and the lowest performing farms rebound and are more likely to recover than middle farms in order to improve their profitability (Griffin, Ibendahl and Stabel 2016).

In the study by Bottazzi, Secchi and Tamagni (2008), the persistence of profits is explored focusing on the auto-regressive structure of profitability measures' differentials. This stemmed off the original work of Dennis Mueller (1977) in the manufacturing industry. The main topic of persistence in profits is focused on the relative positioning of firms relative to other firms in the same sector and year, and utilizing an autoregressive structure of all firms' positioning to determine the coefficients for any insight in the impact the previous year's relative positioning of the firm had on the current position. Many basic economic concepts can be drawn between the manufacturing industry and the agriculture industry in understanding the persistence of profits.

Mueller (1977) initiated persistence in profits literature within the manufacturing industry. The study examined the rate of return on capital in 472 firms that were categorized into profit groups. The first hypothesis was that all firms' profit levels move to an industry average, and the alternative was that a firm is more likely to move to a higher profit group if it was originally in a higher profit group. Probabilities were calculated for each firm in the 24 years of data, resulting in 64 probability estimates in each year. The analysis suggested that the closer the firm is to the middle of the profit rankings, the more likely it will change profit groups (Mueller 1977). Thus indicating that higher profit firms tend to have lasting higher profits, and lower profit firms tend to have consistently lower profits.

A continuation of the previous work occurred in Mueller (1986). Utilizing a Nash-Cournot equilibrium, Mueller (1986) examined the relationship between profitability levels and their relative position in terms of market-share from 1950-1972. In Mueller (1986), 38% of the 1,000 largest manufacturing firms were acquired by 1972, which raised questions about the link to profitability over the long run and the effects of mergers and acquisitions. Similarly, the agricultural industry has been consolidating through acquisitions and liquidations of farms around the country. The link between profitability measures and farm acquisitions and liquidations is not likely to be found due to the nature of the data needed to evaluate that relationship. There is not sufficient data recorded to determine which farms take over liquidated farms, or acquire farms. One needs to be conscious of this discrepancy when examining the results of the study.

Measuring persistence in the profits of farms can help distinguish well managed farms from the crowd. It can then be used to examine the characteristics of those top performing farms to pinpoint characteristics needed in that region for a farm to consistently be a top farm in terms of profitability. This study will examine the persistence of profitability in an aim to expand literature in agriculture to include techniques utilized in other industries such as manufacturing and service industries.

2.6 Linking Profitability, Efficiency, and Growth

Many studies have been conducted examining the effects certain factors have on productivity and profitability, but most have yet to draw inferences on the connection between the two. O'Donnell (2010) examined productivity and profitability changes of U.S. agriculture by utilizing indices for each state over a 45-year period up to 2004. The productivity indices were also broken down into technical change or efficiency change. The main suggestion from the results is that technical change is the main driver of productivity growth. However, O'Donnell (2010) doesn't examine the relationship between productivity and profitability. Another study by Ball et al. (2010) examines the effect research and development (R&D) has on productivity, price change, and profitability. The findings confirm an anticipated positive effect R&D had on productivity, but there is not statistical significance in the positive effect R&D had on profitability. Again, the link between the two is not examined.

Recently, Mugera, Langemeier, and Ojede (2016) were able to analyze productivity and profitability. The study examined the productivity and profitability of Kansas farms similarly to O'Donnell (2010), and found the main driver of both productivity and profitability to be technical change. Small farms and livestock operations were identified as having the most profitability increase potential from productivity increases.

In the final section of the study done by Bottazzi, Secchi and Tamagni (2008), the relationship between growth (total sales growth), profitability (ROS), and productive efficiency (labor productivity) was explored. Due to difficulty in developing a satisfactory parametric approximation of the data, Kendall's τ rank correlation coefficients were calculated and presented with associated *p*-values. These coefficients suggest that productivity and profitability have a substantially stronger link when comparing to the link between productivity and growth, and the link between profitability and growth. This stronger link remains when examining all three years of 1999, 2000, 2002, across both sectors, and the risk ratings of the firms. A multi-factor productivity index is estimated, with parameter estimates obtained from fixed effects, and is analyzed in place of labor productivity. The results are the same as before and corroborate the Kendall coefficients are higher between productivity and profitability, stable over time, and robust through different risk ratings.

Patrick and Kuhns (2016) examined farm debt that has reached similar levels to the 1980s, where real estate debt grew with the value of assets not growing as quickly causing debt to asset ratios to increase to historic highs. This combined with historic high interest rates caused many farms to default when land values declined. Today, however, assets grew with debt mainly through farm real estate values increasing from 2000 to 2013, and the decrease in land values and lower farm income are increasing the non-real estate debt. This is different from the 1980s in the sense that interest rates for a majority of these real estate loans are historic lows compared to the 1980s historic high interest rates. The devaluation of farm real estate and increase in non-real estate debt will be a contributing factor in financial stress levels of farms in the foreseeable future, especially if interest rates rise causing higher interest payments (Patrick and Kuhns 2016).

Profitability, efficiency, and growth of Kansas farms has been examined in many studies, but few have examined the three performance measures together to determine any links between the three. This study will accumulate more empirical evidence of any links present between the profitability, efficiency, and growth of Kansas farms, and lead to more research on the connections between these three performance measures. The components this study will add to the persistence in profitability literature focuses on the relative positioning of the profitability of farms. This will add a new perspective in observing the persistence in the ability of farms to differentiate themselves in order to generate consistently different than average profits. Finally, the strongest link between efficiency, profitability, and growth will be found and identified under new market dynamics of 2014 and 2015.

Chapter 3 - Methodology

3.1 Introduction

This section describes the methods used to examine the relationships among efficiency, profitability, and growth of Kansas farms from 2005 to 2015. Section 3.2 describes the methods employed to estimate farm efficiency, profitability indicators, and growth measures. Section 3.3 provides a description of the farm financial categorization employed. Section 3.4 discusses how efficiency measures of the Kansas farms are evaluated. Section 3.5 examines the farm profitability analysis. Section 3.6 concludes with determining connections between efficiency, profitability, and growth.

3.2 Efficiency, Profitability, and Growth Measures

Many Kansas farms are diversified with multiple crops and livestock production. Methods chosen will allow for comparisons across various farm types. This section will discuss methods to calculate variables needed to conduct this analysis.

3.2.2 Farm Efficiency Scores

In order to examine the efficiency of farms, input efficiency scores can be used to evaluate the efficient use of resources to create outputs. This can be estimated non-parametrically using data envelope analysis (DEA). This nonparametric approach measures farm efficiency relative to other farms in the data set and does not impose a functional form. A short-run efficiency measure is economic or cost efficiency (CE), which assumes that producers are cost minimizers and is calculated under variable returns to scale. Following Yeager and Langemeier (2016) who utilize CE as a short-run efficiency measure for Kansas farms, the following method is used.

CE can be calculated by dividing the minimum cost of a farm under variable returns to scale by the observed cost of each farm:

$$\text{CE} = \frac{c_i' x_i^*}{c_i' x_i}, \tag{1}$$

where c is a vector of input prices, x is a vector of input quantity used, i indicates the farm of interest and $*$ indicates the optimal value (Coelli, et al. 2005; Yeager and Langemeier 2016).

The denominator in Equation (1) represents the actual cost incurred for the individual farm, while the numerator is determined using the following linear program:

$$\text{Min}_{x^*} c_i' x_i^* \tag{2}$$

subject to:

$$x_{1,1}z_1 + x_{1,2}z_2 + \ldots + x_{1,f}z_f \le x_{1,i}^*$$

$$\ldots$$

$$x_{n,1}z_1 + x_{n,2}z_2 + \ldots + x_{n,f}z_f \le x_{n,i}^*$$

$$y_{1,1}z_1 + y_{1,2}z_2 + \ldots + y_{1,f}z_f - y_{1,i}^* \ge 0$$

$$\ldots$$

$$y_{m,1}z_1 + y_{m,2}z_2 + \ldots + y_{m,f}z_f - y_{m,i}^* \ge 0$$

$$z_1 + z_2 + \ldots + z_f = 1.$$

All notation described in Equation (1) stands and y is a vector of outputs; z_f measures the degree of use of the fth farm's production technology; the subscript f denotes the number of farms; the subscript n represents the number of inputs; and the subscript m represents the number of outputs (Coelli, et al. 2005; Yeager and Langemeier 2016).

3.2.3 Profitability Indicators

Profitability indicators will be used to examine financial performance of the sampled farms. The most common farm profitability measures are: operating profit margin ratio (OPMR), return on assets (ROA), and return on equity (ROE). The calculations of the profitability measures are:

$$OPMR_{i,t} = (NFIO_{i,t} + Interest\ Expense_{i,t} - Unpaid\ Family\ \&\ Operator\ Labor_{i,t}) \div Value\ of\ Farm\ Production_{i,t} \quad (3)$$

$$ROA_{i,t} = (NFIO_{i,t} + Interest\ Expense_{i,t} - Unpaid\ Family\ \&\ Operator\ Labor_{i,t}) \div Average\ Total\ Farm\ Assets_{i,t} \quad (4)$$

$$ROE_{i,t} = (NFIO_{i,t} - Unpaid\ Family\ \&\ Operator\ Labor_{i,t}) \div Average\ Total\ Farm\ Equity_{i,t}, \quad (5)$$

where *i* indicates the farm of interest, and *t* represents the respective year from 2005-2015. The profitability indicators are defined within the recommendations of the Farm Financial Standards Council (FFSC 2015) and are simple profitability measures.

3.2.3 Growth Measures

A single growth measure was examined, the percentage growth of value of farm production. Value of farm production is gross revenue less purchases of assets included in the calculation of gross revenue, such as purchased inventory utilized in production (FFSC 2015). This growth is calculated by dividing the increase in value of farm production from the previous year by the previous year’s value. The percentage growth of value of farm production is different from a simple growth measure utilizing a farm’s total assets. Value of farm production growth was chosen over total asset growth to eliminate any affect that changes in market value may have on assets such as real estate. This change in asset value is not the result of business operations and should not be treated as a growth measure.

3.3 Farm Financial Classification

The next step is to classify farms into different financial classifications. Distinguishing farms with higher and lower financial positions will account for the influence that the financial position has on the profitability of a farm. To do so, a method employed by the USDA examining if NFIO is positive or negative, and if the debt-to-asset ratio is 0.4 and less or greater than 0.4 is used (Hoppe and Banker 2010). NFIO is earnings from operations, and under rationale assumptions in economics, a larger value of NFIO is preferred. The higher the leverage of a farm, the more financing expenses they will incur which will lower cash flows and leave the farm exposed to foreclosures or bankruptcy in a lower profitable economy. Table 3.1 shows the classification matrix for determining if a farm is classified in risk class one, two, three, or four.

Table 3.1 USDA Financial Position Based on Combined Net Income and Solvency Status

	Positive Net Farm Income from Operations	Negative Net Farm Income from Operations
Debt-to-asset ratio no more than 0.40	Risk class 1: Favorable	Risk class 2: Marginal-income
Debt-to-asset ratio more than 0.40	Risk class 3: Marginal-Solvency	Risk class 4: Vulnerable

Source: Hoppe and Banker 2010

3.4 Efficiency Analysis

Calculated efficiency scores will be examined next to determine if there are any farm characteristics that help explain the efficiency of these farms. Examining the relative efficiency level of farms in Kansas will reveal farms that are producing along the frontier. Utilizing an input-efficiency measure for each farm is appropriate and standard in the agricultural economics literature due to the assumed nature of farms to be cost minimizers.

Comparing the CE and characteristics of consistently lower risk class farms against high risk farms' average CE and characteristics may provide insight about significantly important farm characteristics of lower risk class farms that can be imitated by higher risk rated farms to work toward becoming more efficient. An approach to evaluate the CE of farms is to examine the effects that farm characteristics have on cost efficiencies through OLS regressions examining coefficient signs, magnitudes, and their statistical significance. This analysis aims to find farm characteristics that might have a causal relationship with cost efficiency, and utilizes economic theory to determine which variables to examine the relationship between the CEs of the farms and the chosen variables. These explanatory variables include: crop-labor percentage, ROA and OPMR separately, farm growth in net farm income and value of farm production, and two size variables of total assets and value of farm production. Equation 6 shows one regression set up for analyzing the CE.

$$CE_{i,t} = \beta_1 \text{Crop-Labor Percentage}_{i,t} + \beta_2 \text{OPMR}_{it} + \beta_3 \text{Value of Farm Production Growth}_{i,t} + \beta_4 \text{Average Total Assets}_{i,t} + \beta_5 \text{Risk Class 2 dummy}_{i,t} + \beta_6 \text{Risk Class 3 dummy}_{i,t} + \beta_7 \text{Risk Class 4 dummy}_{i,t} \quad (6)$$

The expected signs of these explanatory variables are shown in Table 3.2. Crop-labor percentage does not have an expected sign, but is thought to have a significant effect on the cost efficiency of farms due to it serving as a farm type variable. OPMR and ROA do not have an expected sign because farms can be profitable but not cost efficient, or cost efficient but not profitable. These profitability measures are included in the regression analysis to try and determine if profitable farms are also cost efficient. ROA as an explanatory variable, substitutes OPMR in another regression to account for any profitability explanation of CE. The value of farm production growth and average total assets of a farm may have a positive effect on CE due to economies of scale where a farm is better able to perform cost wise when getting larger. This analysis will reveal if there are economies of scale present in terms of CE. The risk class 2 dummy variable is expected to have a negative effect on cost efficiency because farms in this classification are not profitable with negative NFIO, and therefore should not be performing as efficiently as risk class 1 farms. The risk class 3 dummy variable is expected to have a positive effect on CE because these farms are more leveraged with positive NFIO and have more incentive to operate efficiently to cover interest payments of their higher level of loans compared to risk class 1 farms. Finally, the risk class 4 dummy variable may have a positive or negative effect on CE. This analysis will determine if risk class 4 farms are incentivized by their higher interest payments to improve their profitability levels through cost efficiency improvements compared to risk class 1 farms with a positive sign, but if the sign is negative the risk class 4 farms will be deemed not as profitable and not as cost efficient as risk class 1 farms.

Table 3.2 Cost Efficiency Regression Explanatory Variables with Expected Signs

Explanatory Variables	Expected sign
Crop-Labor Percentage	Uncertain
Operating Profit Margin Ratio (OPMR)	Uncertain
Return on Assets (ROA)	Uncertain
Value of Farm Production Growth	Positive
Average Total Assets	Positive
Risk Class 2 dummy	Negative
Risk Class 3 dummy	Positive
Risk Class 4 dummy	Uncertain

Note: ROA substitutes OPMR in alternative regression and are not used in the same regression

3.5 Farm Profitability

Distinguishing profitable from not profitable farms is vital for farm managers and other stakeholders such as lenders. This first step after examining the financial characteristics is to determine the persistence in profitability of farms. In order to visualize the distribution of farms that perform well in general, the distribution of farms within risk classes is examined to see how often a farm has been classified in a higher risk class, or how consistently a farm has been classified in a lower risk class.

The OPMR and ROA profitability ratios indicate whether the operation is utilizing its assets and net worth effectively when benchmarking similar farms in the area, or its own previous values. Overall, these indicators allow us to examine how profitable a farm is.

The first analysis of farm profitability examines the explanatory value that farm characteristics, including lagged profitability measures and risk classes have on profitability measures. This is accomplished through OLS regressions, regressing the profitability measure by one year or two year lags, including a nonlinear relationship through squared lagged variables, and including risk class dummy variables. Before these regressions will be evaluated for the significance in the relationship between explanatory variables and the profitability measure, the adjusted-R^2 values will be compared and economic theory will be used to determine the most appropriate regression and which regression structures are to be evaluated.

The second approach to measure persistence in profits is to look at the autoregressive structure of the yearly relative positioning profitability measures' differentials. A model for studying persistence in profitability dynamics is the simple autoregressive process in equation (7), where $w_{i,t}$ stands for the relative positioning of each farm *i* in time *t* with respect to the yearly average of the respective profitability measure, and $\epsilon_{i,t}$ represents the statistical error term.

$$w_{i,t} = \beta w_{i,(t-1)} + \epsilon_{i,t} \tag{7}$$

To calculate the relative position of each farm, the cross sectional mean of each profitability ratio variable being investigated is averaged over all farm's observed profitability ratios in each observed year. That average is then subtracted from each observed data point to give each farm's relative position in a given year, shown in equation (8). The relative positioning calculation for each farm given a year is

$$w_{i,t} = W_{i,t} - \frac{1}{n}\sum_{i=1}^{n} W_{i,t}. \tag{8}$$

Where $W_{i,t}$ represents the profitability measure observed from the respective farm, *i*, in year, *t*, and n number of farms.

This method of studying the regressive structure of the relative positioning of the farms is based off the work of Bottazzi, Secchi and Tamagni (2008). It observes the persistence in profits through the variable coefficients which allow the study to focus on the persistence of deviations from any type of normal profit rates the farm has had over the time period observed.

A final method of examining the relative persistence in profits will be to run a panel auto-regression of the relative profitability measures, $w_{i,t}$, over the sample period. This will result in coefficients that represent the degree that farms tended to remain at their relative profitability levels over the sample period from 2005 to 2015.

These profitability methods aim to measure persistence in profitability, and the persistence in relative profitability. The auto-regression analyses utilize the previous year's observed data to try and explain the profitability level of farms.

3.6 Linking Efficiency, Profitability, and Growth

The final step in this study is to examine the links between efficiency, profitability, and growth of the farms. Typically, determining the links between two variables is done by examining their correlation. The statistical application in this section looks to form a significant linkage among efficiency, profitability, and growth variables of the farms in the sample. The standard correlation coefficients are first calculated among the three variables to examine basic correlations between variables.

Further analysis is conducted on the relationships between these performance measures in order to find any explanatory power of profitability or growth on the cost efficiency of each farm. OLS regressions are conducted by regressing the CE of farms on their: crop labor percentage (to consider mixed operation effects); both ROA and OPMR separately (to consider the affect profitability has on a farm's efficiency); value of farm production growth (capturing any affect growth has on CE); and a farm size variable, average total assets (to capture economies of scale effects). Other possible explanatory variables are included in different regressions to explore which set of explanatory variables contributes to the best model in exploring a linear relationship in explaining CE. These alternative variables include NFIO growth in place of value of farm production growth; value of farm production as a size variable when value of farm production growth is not included in the explanatory variables. By comparing the statistical significance and the adjusted R-squared of each model from 2006-2015, inferences can be made about the relationship between and impact on CE of these explanatory variables.

The next chapter will discuss the data used in this analysis in detail.

Chapter 4 - Data

4.1 Introduction

This study utilizes an eleven-year panel data set from 2005 to 2015. Section 4.2 describes the source of data and the criteria used to select farms for the study from the data source. Section 4.3 displays the farm characteristics. Section 4.4 shows farm financial classification and yearly characteristics. Finally, section 4.5 presents means of the variables ranked by quartiles.

4.2 Data Source

The farms selected for this study were members of the Kansas Farm Management Association (KFMA) from 2005 to 2015. The data were acquired from the Kansas Farm Management Data Bank (Langemeier 2010). The requirements to be included in the study were for a farm to have continuous reporting to the association during the eleven-year period from 2005 to 2015. Furthermore, three farms were deleted from the sample due to financial data and farm characteristics being far from a typical agriculture producer in Kansas. The resulting number of Kansas farms in this sample is 564.

4.3 Farm Characteristics

Variables of interest include crop acres, pasture acres, number of workers, age of operators, unpaid family and operator labor, and a crop labor percentage variable. The crop labor percentage represents approximate percent of time workers commit to crop enterprises compared to their livestock enterprise, if applicable.

The average crop acres have increased from 1,322 acres in 2005 to 1,534 acres in 2014. Pasture acres were lowest in 2005 and 2007 around 570 acres, and has stayed relatively close to 600 acres for the remaining years with the exceptions of 2015, at 627 acres, 2008 and 2009 both at 618 acres. Average number of workers on the farm was consistent across the years around

1.54, except a drop in 2007 to 1.51 and a spike in 2014 and 2015 with 1.57 and 1.58 average number of workers, respectively. The average operator's age consistently increased over the sample period reaching 62.28 years in 2015. Unpaid family and operator labor has increased steadily through the years totaling a 146 percent increase. The first sampled year, 2005, averaged $31,044 in unpaid family and operator labor, and 2015 averaged $76,397. The crop-labor percentage was around 79 or 80 percent with a drop in 2011 at 77 percent, and a small spike in 2015 at 82 percent.

In order to compare sizes of farms, a variable that indicates the size or capability of a farm is needed, such as the value of farm production. It is the sum of livestock, crop, and other income generated by a farm minus accrual feed purchases. Net Farm Income from Operations (NFIO) is gross revenue minus total operating and financing expenses (FFSC 2015).

The value of farm production has increased from $322,248 in 2005 to $640,464 in 2013. The 2015 average has returned to 2008 and 2009 levels at $504,637 in value of farm production. NFIO averages in 2005 and 2006 were $68,570, and $55,009, respectively, and increased to between $124,158 and $145,054 in 2007, 2008, and 2009. The years 2010, 2011, 2012, and 2013 had averages above $156,000, but the NFIO average dropped to $119,903 and $4,816 in 2014 and 2015, respectively. Total non-farm taxable income ranged from $24,392 to $45,802 in 2005 and 2012, respectively. The higher incomes centered around later years and the 2015 total non-farm taxable income is $30,177.

Other variables included are: total non-farm taxable income (to show off-farm or other income sources); profitability ratios such as operating profit margin ratio (OPMR) calculated utilizing value of farm production, rate of return on assets and rate of return on equity ratios; two leverage ratios, debt to asset and debt to equity; and the cost efficiency (CE) indices. These CE indices include an input price and quantity vectors, and an output quantity and price vectors.

The input price vector consists of: labor, labor cost divided by the number of workers; crop input; fuel; livestock input; and capital prices. The latter four input prices are from U.S. agricultural price indices, as Kansas agricultural price indices were not available for the entire sample period. Implicit input quantities are computed by dividing each respective input cost by each input price described above for crop input, fuel, livestock input, and capital. The input quantity vector consists of the number of workers on the farm (labor), and the implicit quantities listed above (crop, fuel, livestock, and capital). The crop input consisted of seed, fertilizer, herbicide and insecticide, crop marketing and storage, and crop insurance. Fuel comprised of fuel, auto expense, irrigation energy, and utilities. Livestock input included dairy expense, purchased feed, veterinarian expense, and livestock marketing and breeding. The capital input included repairs, machine hire, general farm insurance, property taxes, organization fees, publications, travel, conservation, interest, cash farm rent, and interest charge on net worth. The vector of outputs consists of implicit crop and livestock quantities, which are computed by dividing crop income and livestock income by USDA crop price and livestock price indices which serve as the output price vector (USDA 2017).

Table 4.1 shows a significant decrease of NFIO in 2015 compared to previous years; NFIO was under $5,000 compared to previous years of NFIO being at least $100,000 since 2007. Furthermore, the OPMR fell in 2014 to 0.102 with a previous low of 0.134 in 2006. In 2015, the OPMR was -0.104, and only 158 out of the 564 farms had positive OPMR. The average ROA for farms was similar to OPMR levels in 2014 and 2015 with a new low of 0.027 in 2014 and a -0.018 average ROA in 2015, but the previous low was in 2006 at 0.040. On average, the leverage position of farms has consistently improved from initial debt to asset average of 0.299 in 2005 during the entire sample period. A small spike occurred in 2014 of 0.208 from a previous year average of 0.198 in 2013, that fell to 2015’s average debt-to-asset ratio of 0.186. The average CE of the sample farms reached its highest levels of 0.547 and 0.544 in 2014 and 2015 since an average CE of 0.547 in 2006.

Table 4.1 Average Farm Characteristics Data, Profitability Measures, and Efficiency Measure 2005-2015

	2015	2014	2013	2012	2011	2010
Farm Characteristics						
Number of Farms	564	564	564	564	564	564
Crop Acres	1,506	1,534	1,517	1,520	1,507	1,484
Pasture Acres	627	615	594	598	611	608
Number of Workers	1.58	1.57	1.54	1.54	1.53	1.54
Operator's Age	62.28	61.29	60.32	59.34	58.34	57.37
Crop Labor Percentage	82%	80%	79%	78%	77%	80%
Profitability Measures						
Value of Farm Production	$ 504,637	$ 615,521	$ 640,464	$ 635,937	$ 602,020	$ 538,050
Net Farm Income from Operations	$ 4,816	$ 119,903	$ 157,636	$ 159,294	$ 166,267	$ 156,081
Total Non-Farm Taxable Income	$ 30,177	$ 31,959	$ 34,043	$ 45,802	$ 37,290	$ 32,878
Unpaid Family and Operator Labor	$ 76,397	$ 74,565	$ 70,091	$ 66,046	$ 62,633	$ 58,481
Operating Profit Margin Ratio	-0.104	0.102	0.163	0.174	0.202	0.215
Asset/Liability Characteristics						
Rate of Return on Assets	-0.018	0.027	0.047	0.053	0.063	0.065
Rate of Return to Equity[1]	-0.031	0.024	0.049	0.056	0.068	0.069
Debt-to-Asset Ratio	0.186	0.208	0.198	0.191	0.195	0.208
Debt-to-Equity Ratio[1]	0.228	0.262	0.246	0.235	0.242	0.263
Productive Efficiency						
Cost Efficiency (CE)	0.544	0.547	0.465	0.470	0.501	0.361

[1]Note: ROE and D/E ratios include some farms with negative equity and negative NFIO resulting in positive ratios for some poorly positioned farms

Table 4.1 continued.

	2009	2008	2007	2006	2005
Farm Characteristics					
Number of Farms	564	564	564	564	564
Crop Acres	1,453	1,438	1,366	1,366	1,322
Pasture Acres	618	618	570	591	574
Number of Workers	1.54	1.54	1.51	1.55	1.56
Operator's Age	56.32	55.51	54.58	53.96	52.96
Crop Labor Percentage	80%	80%	79%	79%	79%
Profitability Measures					
Value of Farm Production	$ 485,363	$ 510,007	$ 430,337	$ 324,638	$ 322,248
Net Farm Income from Operations	$ 124,158	$ 145,054	$ 127,738	$ 55,009	$ 68,570
Total Non-Farm Taxable Income	$ 29,304	$ 31,854	$ 27,977	$ 27,434	$ 24,392
Unpaid Family and Operator Labor	$ 56,228	$ 53,795	$ 51,499	$ 30,916	$ 31,044
Operating Profit Margin Ratio	0.180	0.219	0.230	0.134	0.168
Asset/Liability Characteristics					
Rate of Return on Assets	0.063	0.088	0.085	0.040	0.052
Rate of Return to Equity[1]	0.065	0.098	0.091	0.031	0.051
Debt-to-Asset Ratio	0.250	0.260	0.278	0.298	0.299
Debt-to-Equity Ratio[1]	0.334	0.351	0.385	0.424	0.426
Productive Efficiency					
Cost Efficiency (CE)	0.514	0.502	0.445	0.547	0.503

[1]Note: ROE and D/E ratios include some farms with negative equity and negative NFIO resulting in positive ratios for some poorly positioned farms

4.4 Risk Classification Characteristics

Farms were classified into the four risk classifications to assess their financial standing and access to credit. The distribution of farms characterized in each risk class from years 2005 to 2015 are shown in Table 4.2. The number of farms characterized as favorable has trended upward through 2013. However, the number of farms classified as favorable has dropped by more than 11 percent in 2014 compared to 2013 and an additional 27 percent in 2015. There is also a spike in vulnerable farms by more than doubling from 2013 in 2014, and increasing an additional 52 percent in 2015. More specific risk class changes are discussed in the results section.

Table 4.2 Kansas Farm Risk Class Distribution 2005-2015

	Favorable[1]	Marginal-income[2]	Marginal-solvency[3]	Vulnerable[4]
2015	280	198	36	50
2014	384	79	68	33
2013	433	38	78	15
2012	422	43	88	11
2011	418	44	85	17
2010	417	38	95	14
2009	377	42	115	30
2008	375	32	130	27
2007	355	29	148	32
2006	318	49	135	62
2005	322	44	155	43

[1] Favorable Risk Classification; positive net farm income with a debt-to-asset ratio less than or equal to 0.4
[2] Marginal-income Risk Classification; negative net farm income with a debt-to-asset ratio less than or equal to 0.4
[3] Marginal-solvency Risk Classification; positive net farm income with a debt-to-asset ratio more than 0.4
[4] Vulnerable Risk Classification; negative net farm income with a debt-to-asset ratio more than 0.4

4.5 Farm Characteristics Categorized by Quartiles Data

The farms were sorted by OPMR, ROA, and CE in quartiles to assess if there is a difference between the top and bottom 25 percent of farms. Table 4.3, Table 4.4, and Table 4.5 show the average farm characteristics, profitability measures, and the efficiency measure by the top and bottom quartiles, sorted by OPMR, ROA, and CE respectively. The top quartile contains farms with the highest performance measure used for sorting, and the bottom quartile contains farms with the lowest performance measure used for sorting.

Data sorted by OPMR, shown in Table 4.3, show a drop in the amount of crop acres, and a rise in the amount of pasture acres of the top quartile farms in 2014. The top farms of 2014, in terms of OPMR, only had lower crop acres in 2005 and 2006. The top farms have the highest amount of pasture acres, and lowest crop labor percentage in 2014 during the entire study sample period. This suggests that the highest performing farms in 2014 consisted of fewer primarily crop farms and more farms with a higher concentration of livestock. The OPMR can also be seen as the lowest level for bottom farms in 2014 and then even more so in 2015, -0.30 and -0.84 respectively. These lowest years of OPMR are in contrast to the next lowest average OPMR for bottom farms of -0.20 in 2009. The lowest years of OPMR do not coincide with the low prices of livestock, but they do coincide with significantly lower national crop prices (NASS n.d.). Top farms also averaged the second highest CE for 2015, 0.71, since 2006, 0.72.

Data sorted by ROA, shown in Table 4.4, shows similar decreases in highly concentrated crop farms for 2014, OPMRs for both bottom and top quartiles, and high CE for 2014 and 2015. Trends through the sample period across both top and bottom quartile farms remained fairly similar through the three different sorting methods of OPMR, ROA, and CE shown in Table 4.3, Table 4.4, and Table 4.5. Another observation for each of the three ranking orders is that the average operator's age is consistently higher on the bottom 25 percent when compared to the top 25 percent all years.

However, when comparing the different sets of top performing farms based on sorting by OPMR, ROA, and CE, there is a distinction in the magnitude of some farm characteristics. In

2015 top farms, in terms of CE, averaged a 90 percent crop-labor percentage. This is higher than top farms in terms of OPMR and ROA that only averaged 80 percent and 79 percent respectively. All three sorting methods consistently have the top 25 percent of farms as having a higher average number of workers than the respective bottom 25 percent of farms, except for the top CE performing farms in 2006 and 2015. Top CE performing farms in 2006 have an average of 1.56 workers compared to the bottom CE performing farms' average number of workers in 2006 of 1.57. Top CE performing farms in 2015 have an average of 1.62 workers compared to the bottom CE performing farms with an average of 1.70 workers. Additionally, top CE performing farms have a lower average risk rating in 2015 and 2014 at 1.18 and 1.19 respectively. These compare to top farms in terms of OPMR and ROA average risk rating of 1.23 and 1.24 in 2015, and 1.28 and 1.37 in 2014, respectively.

Table 4.3 Average Kansas Farm Characteristics Data, Profitability Measures, and Efficiency Measure by Operating Profit Margin Ratio Quartiles 2005-2015

	2015		2014		2013		2012	
	Top 25%	Bottom 25%	Top 25%	Bottom 25%	Top 25%	Bottom 25%	Top 25%	Bottom 25%
Farm Characteristics								
Number of Farms								
Crop Acres	1,767	1,008	1,509	1,417	1,790	1,198	1,781	987
Pasture Acres	738	603	1,336	228	522	644	653	491
Number of Workers	1.84	1.25	1.89	1.30	1.62	1.48	1.58	1.25
Operator's Age	61.45	64.55	59.89	62.85	59.48	62.99	58.80	61.18
Crop Labor Percentage	80%	78%	65%	89%	79%	74%	82%	77%
Average Risk Rating	1.23	2.33	1.28	2.14	1.23	1.72	1.20	1.78
Profitability Measures								
Value of Farm Production	$757,481	$210,537	$893,513	$350,095	$892,622	$367,524	$832,546	$305,338
Net Farm Income from Operations	$156,110	-$122,133	$337,458	-$53,249	$355,862	-$12,557	$333,654	$2,898
Total Non-Farm Taxable Income	$26,676	$39,314	$28,847	$46,320	$39,996	$36,044	$63,985	$52,419
Unpaid Family and Operator Labor	$78,044	$70,339	$82,751	$66,187	$71,447	$67,653	$64,504	$60,745
Operating Profit Margin Ratio	0.13	-0.84	0.31	-0.30	0.34	-0.18	0.34	-0.15
Asset/Liability Characteristics								
Rate of Return on Assets	0.03	-0.08	0.09	-0.06	0.11	-0.03	0.10	-0.03
Rate of Return to Equity[1]	0.03	-0.11	0.10	-0.09	0.12	-0.05	0.12	-0.05
Debt-to-Asset Ratio	0.15	0.21	0.21	0.23	0.19	0.21	0.14	0.20
Debt-to-Equity Ratio[1]	0.18	0.27	0.27	0.30	0.23	0.26	0.16	0.25
Productive Efficiency								
Cost Efficiency (CE)	0.71	0.36	0.69	0.39	0.60	0.35	0.59	0.35

[1]Note: ROE and D/E ratios include some farms with negative equity and negative NFIO resulting in positive ratios for some poorly positioned farms

Table 4.3 continued.

	2011		2010		2009		2008	
	Top 25%	Bottom 25%	Top 25%	Bottom 25%	Top 25%	Bottom 25%	Top 25%	Bottom 25%
Farm Characteristics								
Number of Farms								
Crop Acres	1,883	1,139	1,881	925	1,900	861	1,800	838
Pasture Acres	578	435	561	579	368	669	267	996
Number of Workers	1.64	1.31	1.74	1.38	1.57	1.45	1.50	1.39
Operator's Age	57.14	60.73	55.83	58.89	55.65	57.98	55.60	57.06
Crop Labor Percentage	79%	76%	83%	74%	90%	67%	91%	68%
Average Risk Rating	1.18	1.79	1.16	1.78	1.31	2.18	1.31	2.11
Profitability Measures								
Value of Farm Production	$919,581	$287,839	$819,568	$258,295	$734,058	$231,972	$739,562	$246,249
Net Farm Income from Operations	$394,256	-$105	$355,136	$4,356	$284,338	-$7,085	$324,394	-$3,270
Total Non-Farm Taxable Income	$30,291	$47,058	$20,489	$48,502	$20,877	$37,525	$23,850	$35,402
Unpaid Family and Operator Labor	$62,567	$59,700	$60,785	$55,572	$57,122	$54,314	$52,862	$51,964
Operating Profit Margin Ratio	0.38	-0.17	0.38	-0.15	0.34	-0.20	0.40	-0.15
Asset/Liability Characteristics								
Rate of Return on Assets	0.13	-0.04	0.13	-0.04	0.13	-0.05	0.18	-0.04
Rate of Return to Equity[1]	0.15	-0.06	0.14	-0.06	0.16	-0.09	0.22	-0.08
Debt-to-Asset Ratio	0.18	0.18	0.16	0.23	0.24	0.27	0.20	0.29
Debt-to-Equity Ratio[1]	0.21	0.22	0.20	0.29	0.31	0.37	0.25	0.41
Productive Efficiency								
Cost Efficiency (CE)	0.68	0.34	0.47	0.26	0.65	0.38	0.63	0.42

[1]Note: ROE and D/E ratios include some farms with negative equity and negative NFIO resulting in positive ratios for some poorly positioned farms

Table 4.3 continued.

	2007		2006		2005	
	Top 25%	Bottom 25%	Top 25%	Bottom 25%	Top 25%	Bottom 25%
Farm Characteristics						
Number of Farms						
Crop Acres	1,832	799	1,428	1159	1,329	1,042
Pasture Acres	408	566	555	515	758	363
Number of Workers	1.64	1.24	1.49	1.45	1.76	1.23
Operator's Age	53.79	55.93	53.49	54.82	51.27	54.41
Crop Labor Percentage	86%	72%	82%	79%	72%	85%
Average Risk Rating	1.35	2.14	1.54	2.53	1.61	2.33
Profitability Measures						
Value of Farm Production	$654,243	$187,727	$378,110	$214,920	$441,271	$168,200
Net Farm Income from Operations	$283,500	$2,265	$138,461	-$25,172	$163,481	-$6,371
Total Non-Farm Taxable Income	$25,372	$42,762	$16,734	$45,223	$19,732	$36,667
Unpaid Family and Operator Labor	$53,608	$48,178	$31,762	$29,081	$34,561	$27,463
Operating Profit Margin Ratio	0.39	-0.16	0.33	-0.16	0.34	-0.14
Asset/Liability Characteristics						
Rate of Return on Assets	0.16	-0.04	0.10	-0.04	0.11	-0.04
Rate of Return to Equity[1]	0.19	-0.09	0.11	-0.09	0.13	-0.07
Debt-to-Asset Ratio	0.23	0.30	0.22	0.37	0.27	0.29
Debt-to-Equity Ratio[1]	0.30	0.43	0.28	0.60	0.37	0.41
Productive Efficiency						
Cost Efficiency (CE)	0.57	0.34	0.72	0.40	0.63	0.37

[1]Note: ROE and D/E ratios include some farms with negative equity and negative NFIO resulting in positive ratios for some poorly positioned farms

Table 4.4 Average Kansas Farm Characteristics Data, Profitability Measures, and Efficiency Measure by Return on Assets Quartiles 2005-2015

	2015		2014		2013		2012	
	Top 25%	Bottom 25%	Top 25%	Bottom 25%	Top 25%	Bottom 25%	Top 25%	Bottom 25%
Farm Characteristics								
Number of Farms								
Crop Acres	1,801	1,242	1,425	1,540	1,969	1,195	1,911	982
Pasture Acres	737	513	1,124	222	357	648	438	532
Number of Workers	1.87	1.50	1.94	1.40	1.68	1.47	1.62	1.25
Operator's Age	61.11	62.48	59.09	61.41	57.77	62.85	55.40	61.26
Crop Labor Percentage	79%	79%	65%	90%	82%	74%	84%	76%
Average Risk Rating	1.24	2.44	1.37	2.21	1.38	1.74	1.41	1.78
Profitability Measures								
Value of Farm Production	$773,892	$299,411	$877,044	$396,868	$935,503	$367,296	$904,133	$305,108
Net Farm Income from Operations	$156,791	-$121,399	$324,639	-$50,326	$346,348	-$12,706	$328,544	$2,567
Total Non-Farm Taxable Income	$27,508	$31,959	$23,900	$35,212	$29,842	$35,531	$31,908	$52,631
Unpaid Family and Operator Labor	$79,352	$77,913	$84,045	$70,593	$74,710	$67,653	$68,121	$60,461
Operating Profit Margin Ratio	0.12	-0.61	0.30	-0.27	0.31	-0.18	0.31	-0.15
Asset/Liability Characteristics								
Rate of Return on Assets	0.03	-0.10	0.10	-0.07	0.13	-0.03	0.14	-0.03
Rate of Return to Equity[1]	0.03	-0.15	0.12	-0.10	0.15	-0.05	0.16	-0.05
Debt-to-Asset Ratio	0.16	0.27	0.22	0.25	0.22	0.21	0.20	0.20
Debt-to-Equity Ratio[1]	0.18	0.36	0.29	0.34	0.29	0.26	0.25	0.25
Productive Efficiency								
Cost Efficiency (CE)	0.71	0.39	0.68	0.40	0.54	0.35	0.55	0.35

[1]Note: ROE and D/E ratios include some farms with negative equity and negative NFIO resulting in positive ratios for some poorly positioned farms

Table 4.4 continued.

	2011		2010		2009		2008	
	Top 25%	Bottom 25%	Top 25%	Bottom 25%	Top 25%	Bottom 25%	Top 25%	Bottom 25%
Farm Characteristics								
Number of Farms								
Crop Acres	1,971	1,151	2,073	911	2,031	876	1,903	841
Pasture Acres	548	434	495	605	317	624	253	995
Number of Workers	1.74	1.31	1.74	1.36	1.64	1.45	1.57	1.39
Operator's Age	54.20	60.72	52.60	58.82	52.65	57.66	52.76	57.11
Crop Labor Percentage	79%	76%	85%	74%	91%	67%	92%	68%
Average Risk Rating	1.40	1.81	1.41	1.75	1.51	2.18	1.55	2.09
Profitability Measures								
Value of Farm Production	$960,787	$294,960	$853,637	$251,599	$774,727	$237,874	$761,655	$238,189
Net Farm Income from Operations	$381,225	-$1,139	$338,093	$3,438	$275,987	-$7,166	$311,285	-$2,387
Total Non-Farm Taxable Income	$19,817	$46,458	$19,374	$49,121	$18,508	$37,995	$21,835	$35,017
Unpaid Family and Operator Labor	$66,933	$59,800	$60,598	$54,455	$58,658	$54,462	$56,287	$51,964
Operating Profit Margin Ratio	0.35	-0.17	0.35	-0.15	0.31	-0.20	0.36	-0.16
Asset/Liability Characteristics								
Rate of Return on Assets	0.16	-0.04	0.15	-0.04	0.15	-0.05	0.23	-0.04
Rate of Return to Equity[1]	0.20	-0.06	0.18	-0.06	0.20	-0.09	0.31	-0.08
Debt-to-Asset Ratio	0.22	0.19	0.22	0.22	0.29	0.28	0.26	0.28
Debt-to-Equity Ratio[1]	0.29	0.23	0.28	0.28	0.41	0.39	0.36	0.40
Productive Efficiency								
Cost Efficiency (CE)	0.63	0.34	0.43	0.27	0.61	0.37	0.59	0.42

[1]Note: ROE and D/E ratios include some farms with negative equity and negative NFIO resulting in positive ratios for some poorly positioned farms

Table 4.4 continued.

	2007		2006		2005	
	Top 25%	Bottom 25%	Top 25%	Bottom 25%	Top 25%	Bottom 25%
Farm Characteristics						
Number of Farms						
Crop Acres	1,935	786	1,596	1,180	1,533	1,052
Pasture Acres	357	573	492	540	589	364
Number of Workers	1.76	1.21	1.62	1.49	1.89	1.25
Operator's Age	51.30	56.09	50.51	54.35	49.82	54.22
Crop Labor Percentage	88%	72%	85%	79%	77%	85%
Average Risk Rating	1.62	2.11	1.74	2.58	1.81	2.35
Profitability Measures						
Value of Farm Production	$687,144	$183,562	$444,190	$223,353	$476,537	$170,207
Net Farm Income from Operations	$267,335	$2,126	$138,184	-$24,826	$159,049	-$6,668
Total Non-Farm Taxable Income	$20,267	$42,499	$15,358	$44,504	$20,620	$37,335
Unpaid Family and Operator Labor	$56,468	$47,843	$33,153	$29,097	$35,639	$27,654
Operating Profit Margin Ratio	0.35	-0.17	0.28	-0.15	0.30	-0.14
Asset/Liability Characteristics						
Rate of Return on Assets	0.21	-0.04	0.12	-0.04	0.13	-0.04
Rate of Return to Equity[1]	0.28	-0.08	0.15	-0.09	0.17	-0.08
Debt-to-Asset Ratio	0.32	0.29	0.30	0.39	0.34	0.31
Debt-to-Equity Ratio[1]	0.47	0.42	0.43	0.63	0.51	0.45
Productive Efficiency						
Cost Efficiency (CE)	0.52	0.35	0.68	0.40	0.59	0.37

[1]Note: ROE and D/E ratios include some farms with negative equity and negative NFIO resulting in positive ratios for some poorly positioned farms

Table 4.5 Average Kansas Farm Characteristics Data, Profitability Measures, and Efficiency Measure by Cost Efficiency Quartiles 2005-2015

	2015		2014		2013		2012	
	Top 25%	Bottom 25%	Top 25%	Bottom 25%	Top 25%	Bottom 25%	Top 25%	Bottom 25%
Farm Characteristics								
Number of Farms								
Crop Acres	1,957	1,112	1,602	1,224	1,357	1,359	1,420	1,273
Pasture Acres	419	659	899	271	1,192	277	1190	278
Number of Workers	1.62	1.70	1.64	1.52	1.55	1.54	1.63	1.54
Operator's Age	61.60	63.02	61.30	62.11	60.18	61.25	59.02	60.60
Crop Labor Percentage	90%	69%	78%	80%	66%	81%	66%	79%
Average Risk Rating	1.18	2.20	1.19	2.04	1.26	1.79	1.31	1.80
Profitability Measures								
Value of Farm Production	$742,951	$309,302	$850,761	$367,794	$716,701	$450,345	$752,262	$437,018
Net Farm Income from Operations	$130,739	-$96,402	$297,522	-$8,964	$262,446	$24,898	$261,897	$45,796
Total Non-Farm Taxable Income	$29,143	$30,872	$25,790	$34,696	$35,278	$33,425	$58,977	$52,266
Unpaid Family and Operator Labor	$79,057	$75,075	$78,506	$69,259	$70,461	$64,314	$68,298	$63,404
Operating Profit Margin Ratio	0.09	-0.48	0.28	-0.17	0.29	-0.05	0.28	-0.01
Asset/Liability Characteristics								
Rate of Return on Assets	0.02	-0.06	0.08	-0.04	0.08	-0.01	0.08	0.00
Rate of Return to Equity[1]	0.02	-0.09	0.09	-0.06	0.09	-0.03	0.09	-0.01
Debt-to-Asset Ratio	0.14	0.24	0.16	0.25	0.17	0.22	0.17	0.21
Debt-to-Equity Ratio[1]	0.16	0.31	0.20	0.33	0.20	0.28	0.20	0.27
Productive Efficiency								
Cost Efficiency (CE)	0.77	0.31	0.75	0.35	0.67	0.29	0.68	0.29

[1]Note: ROE and D/E ratios include some farms with negative equity and negative NFIO resulting in positive ratios for some poorly positioned farms

Table 4.5 continued.

	2011		2010		2009		2008	
	Top 25%	Bottom 25%	Top 25%	Bottom 25%	Top 25%	Bottom 25%	Top 25%	Bottom 25%
Farm Characteristics								
Number of Farms								
Crop Acres	1,628	1,156	1,509	1,221	1,631	1,001	1,377	1,238
Pasture Acres	993	233	1,340	196	893	387	787	572
Number of Workers	1.62	1.46	1.75	1.53	1.62	1.54	1.62	1.56
Operator's Age	57.67	60.17	56.85	58.27	56.13	56.48	56.20	55.36
Crop Labor Percentage	71%	75%	64%	83%	77%	73%	77%	78%
Average Risk Rating	1.20	1.91	1.30	1.79	1.30	2.16	1.41	2.14
Profitability Measures								
Value of Farm Production	$859,208	$353,097	$665,525	$375,811	$636,514	$293,183	$572,756	$413,630
Net Farm Income from Operations	$357,624	$25,079	$257,581	$46,975	$233,005	$18,666	$237,766	$51,694
Total Non-Farm Taxable Income	$28,843	$43,177	$35,261	$46,690	$21,301	$32,548	$22,801	$36,470
Unpaid Family and Operator Labor	$63,300	$59,100	$63,670	$56,658	$60,491	$54,196	$56,090	$50,223
Operating Profit Margin Ratio	0.37	-0.06	0.32	0.02	0.30	-0.06	0.35	0.06
Asset/Liability Characteristics								
Rate of Return on Assets	0.12	-0.02	0.09	0.01	0.10	-0.02	0.13	0.02
Rate of Return to Equity[1]	0.13	-0.03	0.10	-0.01	0.12	-0.05	0.14	0.00
Debt-to-Asset Ratio	0.17	0.21	0.19	0.26	0.21	0.32	0.17	0.36
Debt-to-Equity Ratio[1]	0.20	0.26	0.24	0.34	0.26	0.48	0.20	0.56
Productive Efficiency								
Cost Efficiency (CE)	0.71	0.30	0.55	0.20	0.72	0.31	0.71	0.30

[1]Note: ROE and D/E ratios include some farms with negative equity and negative NFIO resulting in positive ratios for some poorly positioned farms

Table 4.5 continued.

	2007		2006		2005	
	Top 25%	Bottom 25%	Top 25%	Bottom 25%	Top 25%	Bottom 25%
Farm Characteristics						
Number of Farms						
Crop Acres	1,439	1,071	1,323	1,069	1,383	1,032
Pasture Acres	879	279	760	449	906	423
Number of Workers	1.60	1.52	1.56	1.57	1.68	1.66
Operator's Age	54.48	55.07	54.40	54.55	52.72	53.08
Crop Labor Percentage	71%	78%	76%	76%	71%	78%
Average Risk Rating	1.43	2.18	1.36	2.52	1.40	2.33
Profitability Measures						
Value of Farm Production	$571,584	$274,924	$371,840	$233,891	$422,187	$240,522
Net Farm Income from Operations	$228,612	$40,572	$125,496	-$2,064	$143,328	$23,499
Total Non-Farm Taxable Income	$24,027	$33,090	$17,634	$37,765	$19,736	$24,776
Unpaid Family and Operator Labor	$53,321	$50,368	$31,111	$29,777	$33,211	$31,002
Operating Profit Margin Ratio	0.35	0.03	0.29	-0.05	0.30	0.04
Asset/Liability Characteristics						
Rate of Return on Assets	0.13	0.01	0.08	-0.01	0.09	0.01
Rate of Return to Equity[1]	0.15	-0.02	0.09	-0.06	0.10	-0.02
Debt-to-Asset Ratio	0.23	0.35	0.18	0.38	0.23	0.36
Debt-to-Equity Ratio[1]	0.30	0.54	0.22	0.61	0.30	0.55
Productive Efficiency						
Cost Efficiency (CE)	0.66	0.25	0.76	0.33	0.71	0.30

[1]Note: ROE and D/E ratios include some farms with negative equity and negative NFIO resulting in positive ratios for some poorly positioned farms

4.6 Farm Characteristics of Fully Cost Efficient Farms

Farms with CE scores of 1.0 are fully cost efficient farms. The number of farms that were fully cost efficient ranged from two farms in 2009, 2010, and 2011, to five farms in 2015. The averages for all farm characteristics vary greatly from year to year, due to the small sample of farms that are fully CE. Table 4.6 shows the number of fully efficient farms and their average farm characteristics.

In 2005, 2006, 2007, 2010, 2014, and 2015, the average CE farm had more than 1,000 crop acres. In 2009 and 2014 the average pasture acres for the CE farms were more than 3,800 and 4,400 acres respectively. These years of more pasture acres are substantially more than the other years in the sample with the next highest pasture acreage averaging at just over 2,000 acres in 2007 and six years where it averaged less than 1,000 acres. Interestingly, in 2011, 2012, and 2013, the average number of workers for CE farms were less than 1.0, suggesting that it was part-time farmers that were able to be more CE farms in those years compared to larger operations that hire labor. In 2011, the two fully CE farms held no debt, while in comparison to 2013 where the D/A ratio was almost 0.33 and the D/E ratio was over 0.48. The debt levels stay reasonable in the other years of the sample period with the next highest ratio just below 0.24. Overall, the average farm characteristics change from year to year and is likely due to the limited number of fully CE farms.

Table 4.6 Average Kansas Farm Characteristics Data and Profitability Measures of Fully Cost Efficient Farms 2005-2015

	2015	2014	2013	2012	2011	2010
Farm Characteristics						
Number of Farms	5	4	3	4	2	2
Crop Acres	1,253	1,182	376	820	553	1,064
Pasture Acres	547	4,452	353	635	515	69
Number of Workers	1.96	1.45	0.97	0.90	0.80	4.10
Operator's Age	75.20	55.25	63.33	63.25	71.00	58.00
Crop Labor Percentage	67%	44%	49%	62%	85%	58%
Profitability Measures						
Value of Farm Production	$612,463	$988,651	$388,235	$380,985	$478,861	$1,573,751
Net Farm Income from Operations	$182,778	$484,449	$153,789	$178,283	$271,838	$1,002,610
Total Non-Farm Taxable Income	$54,031	$26,786	$37,499	$36,455	$20,434	$27,749
Unpaid Family and Operator Labor	$49,980	$64,125	$49,933	$48,750	$39,950	$48,125
Operating Profit Margin Ratio	0.223	0.439	0.314	0.356	0.484	0.607
Asset/Liability Characteristics						
Rate of Return on Assets	0.045	0.125	0.101	0.066	0.071	0.469
Rate of Return to Equity[1]	0.047	0.139	0.129	0.067	0.071	0.487
Debt-to-Asset Ratio	0.047	0.093	0.326	0.058	0.000	0.007
Debt-to-Equity Ratio[1]	0.049	0.102	0.483	0.062	0.000	0.007

[1]Note: ROE and D/E ratios include some farms with negative equity and negative NFIO resulting in positive ratios for some poorly positioned farms

Table 4.6 continued.

	2009	2008	2007	2006	2005
<u>Farm Characteristics</u>					
Number of Farms	2	3	4	3	4
Crop Acres	915	556	1,749	1,137	2,417
Pasture Acres	3,808	980	2,061	1,825	1,237
Number of Workers	1.35	1.10	1.35	1.43	3.85
Operator's Age	61.50	55.33	60.25	61.00	56.50
Crop Labor Percentage	65%	49%	69%	73%	67%
<u>Profitability Measures</u>					
Value of Farm Production	$441,189	$232,460	$645,722	$334,086	$1,312,023
Net Farm Income from Operations	$172,630	$113,630	$337,688	$161,314	$569,638
Total Non-Farm Taxable Income	$72,826	$7,280	$38,285	$22,251	$15,976
Unpaid Family and Operator Labor	$60,417	$51,458	$57,188	$21,450	$47,250
Operating Profit Margin Ratio	0.256	0.303	0.451	0.459	0.424
<u>Asset/Liability Characteristics</u>					
Rate of Return on Assets	0.027	0.093	0.111	0.099	0.144
Rate of Return to Equity[1]	0.027	0.091	0.119	0.112	0.169
Debt-to-Asset Ratio	0.020	0.067	0.100	0.192	0.187
Debt-to-Equity Ratio[1]	0.021	0.072	0.111	0.237	0.229

[1]Note: ROE and D/E ratios include some farms with negative equity and negative NFIO resulting in positive ratios for some poorly positioned farms

Chapter 5 - Results

5.1 Introduction

The efficiency of farms and persistence in profitability will be discussed along with possible relationships between efficiency, profitability, and growth in this chapter. Section 5.2 examines the farm risk classification results. Section 5.3 presents results of the persistence in profits analysis. Section 5.4 presents the efficiency findings for this study's farms. Sections 5.5 lays out findings of the relationships between profitability, efficiency and growth of farms.

5.2 Farm Risk Classification Results

The movement of farms from one risk class to another can be seen through the number of years a farm stays within a risk class. This is determined by the number of farms with a very persistent risk rating over the eleven-year time span. Results shown in Table 5.1 indicate there is a relative tendency for favorably classified farms to remain in a favorable financial position over this 11-year span by 290 farms, over 51 percent of total farms, staying in a favorable financial position at least 9 out of the 11 years.

Table 5.1 Number of Years That Kansas Farms Were Classified in Each Risk Classification

	Favorable[1]	Marginal-income[2]	Marginal-solvency[3]	Vulnerable[4]
0 years	49	254	325	412
1-2 years	38	234	64	104
3-4 years	54	51	62	37
5-6 years	52	15	45	6
7-8 years	81	8	35	5
9-10 years	173	2	28	0
11 years	117	0	5	0

[1] Favorable Risk Classification; positive net farm income with a debt-to-asset ratio less than or equal to 0.4
[2] Marginal-income Risk Classification; negative net farm income with a debt-to-asset ratio less than or equal to 0.4
[3] Marginal-solvency Risk Classification; positive net farm income with a debt-to-asset ratio more than 0.4
[4] Vulnerable Risk Classification; negative net farm income with a debt-to-asset ratio more than 0.4

A significant decrease in the quantity of favorable and marginal-solvency farms occurred between 2014 to 2015 shown in Table 4.2. Table 5.2 and Table 5.3 show some farms transitioned into the marginal-income and vulnerable risk classes with 27 percent fewer favorable farms, 150 percent more marginal-income farms, and almost 52 percent more vulnerable farms from 2014 to 2015. The fewer farms in the favorable risk class for 2015 is caused by the amount of farms in 2014 staying in the favorable risk class dropping to only 60 percent, shown in Table 5.2. When compared to the previous nine years, the percentage that remained in the favorable position was consistently above 80 percent, with five of the nine years retaining over 90 percent of farms in the favorable risk class. Additionally, the number of farms transitioning from the marginal-income risk class to the favorable risk class in 2014 dropped from a high of 74 percent over the previous nine years to just over 45 percent. There was an increase in vulnerable farms in 2015, which is due to the more than 63 percent of vulnerable farms remaining classified as vulnerable, and a higher transition of farms beginning in 2013 and 2014 from marginal-solvency to vulnerable classification all shown in Table 5.2. Another transition percentage that stands out are the transitions of vulnerable farms to favorable farms in 2011, 2012, and 2013. These years having a large percentage of farms transitioning into the favorable position are due to the low number of farms that were classified as vulnerable farms in those years; 17 farms in 2011, 11 farms in 2012, and 15 farms in 2013.

All of these transitions were driven by changes in NFIO, with a decrease of nearly 24 percent in 2013 and a 96 percent decrease in 2015 down to an average NFIO of $4,816. The average solvency of farms remained relatively at the same level from 2012 to 2014 varying slightly from a debt to asset ratio of 0.217 to 0.209 but actually decreased in 2015 to a debt to asset ratio of 0.197. This suggests that in the current environment, farms are being affected by changes in NFIO more so than by changes in solvency levels.

Table 5.3 shows the number of farms related to each risk class transition as discussed and shown in Table 5.2. The transition of farms out of the favorable risk class is clearly into the marginal-income risk class. This shows that farms that have transitioned out of the favorable position are keeping their solvency level low during the less profitable years of 2014 and 2015. The farms will need to work on keeping their solvency low, and not rely upon debt, but rather on management techniques to become more cost efficient moving forward.

Table 5.2 Percentage of Kansas Farms Risk Class Transitioning Percentage

Favorable[1] farms transition to:	Marginal-income	Marginal-solvency	Vulnerable	Remained Favorable
14-15	37.8%	0.8%	1.3%	60.2%
13-14	14.3%	2.8%	1.8%	81.1%
12-13	6.4%	3.1%	0.7%	89.8%
11-12	6.9%	2.2%	1.0%	90.0%
10-11	7.2%	2.9%	1.2%	88.7%
09-10	4.2%	3.4%	0.0%	92.3%
08-09	7.5%	0.8%	0.5%	91.2%
07-08	4.8%	2.0%	0.6%	92.7%
06-07	4.7%	3.5%	0.6%	91.2%
05-06	8.7%	4.7%	1.6%	85.1%

Marginal-income[2] farms transition to:	Favorable	Marginal-solvency	Vulnerable	Remained Marginal-income
14-15	45.6%	1.3%	2.5%	50.6%
13-14	57.9%	2.6%	0.0%	39.5%
12-13	74.4%	0.0%	2.3%	23.3%
11-12	63.6%	4.5%	2.3%	29.5%
10-11	60.5%	0.0%	2.6%	36.8%
09-10	54.8%	4.8%	2.4%	38.1%
08-09	56.3%	0.0%	6.3%	37.5%
07-08	58.6%	0.0%	0.0%	41.4%
06-07	65.3%	2.0%	8.2%	24.5%
05-06	47.7%	2.3%	6.8%	43.2%

Marginal-solvent[3] farms transition to:	Favorable	Marginal-income	Vulnerable	Remained marginal-solvency
14-15	14.7%	14.7%	32.4%	38.2%
13-14	10.3%	2.6%	25.6%	61.5%
12-13	21.6%	1.1%	9.1%	68.2%
11-12	17.6%	1.2%	4.7%	76.5%
10-11	25.3%	0.0%	8.4%	66.3%
09-10	35.7%	2.6%	4.3%	57.4%
08-09	13.1%	0.8%	10.0%	76.2%
07-08	17.6%	0.7%	11.5%	70.3%
06-07	17.0%	0.0%	8.1%	74.8%
05-06	11.6%	0.6%	23.9%	63.9%

Vulnerable[4] farms transition to:	Favorable	Marginal-income	Marginal-solvency	Remained vulnerable
14-15	9.1%	9.1%	18.2%	63.6%
13-14	20.0%	0.0%	46.7%	33.3%
12-13	27.3%	0.0%	45.5%	27.3%
11-12	17.6%	0.0%	70.6%	11.8%
10-11	7.1%	0.0%	71.4%	21.4%
09-10	16.7%	10.0%	46.7%	26.7%
08-09	0.0%	3.7%	48.1%	48.1%
07-08	9.4%	6.3%	59.4%	25.0%
06-07	16.1%	3.2%	56.5%	24.2%
05-06	11.6%	2.3%	46.5%	39.5%

[1] Favorable Risk Classification; positive net farm income with a debt-to-asset ratio less than or equal to 0.4
[2] Marginal-income Risk Classification; negative net farm income with a debt-to-asset ratio less than or equal to 0.4
[3] Marginal-solvency Risk Classification; positive net farm income with a debt-to-asset ratio more than 0.4
[4] Vulnerable Risk Classification; negative net farm income with a debt-to-asset ratio more than 0.4

Table 5.3 Yearly Risk Class Transition Matrix: Number of Farms Transitioning Between Risk Classes

Risk Class Transitions: Years	1-1	1-2	1-3	1-4	2-1	2-2	2-3	2-4	3-1	3-2	3-3	3-4	4-1	4-2	4-3	4-4
14-15	231	145	3	5	36	40	1	2	10	10	26	22	3	3	6	21
13-14	351	62	12	8	22	15	1	0	8	2	48	20	3	0	7	5
12-13	379	27	13	3	32	10	0	1	19	1	60	8	3	0	5	3
11-12	376	29	9	4	28	13	2	1	15	1	65	4	3	0	12	2
10-11	370	30	12	5	23	14	0	1	24	0	63	8	1	0	10	3
09-10	348	16	13	0	23	16	2	1	41	3	66	5	5	3	14	8
08-09	342	28	3	2	18	12	0	2	17	1	99	13	0	1	13	13
07-08	329	17	7	2	17	12	0	0	26	1	104	17	3	2	19	8
06-07	290	15	11	2	32	12	1	4	23	0	101	11	10	2	35	15
05-06	274	28	15	5	21	19	1	3	18	1	99	37	5	1	20	17

1 Favorable Risk Classification; positive net farm income with a debt-to-asset ratio less than or equal to 0.4
2 Marginal-income Risk Classification; negative net farm income with a debt-to-asset ratio less than or equal to 0.4
3 Marginal-solvency Risk Classification; positive net farm income with a debt-to-asset ratio more than 0.4
4 Vulnerable Risk Classification; negative net farm income with a debt-to-asset ratio more than 0.4

Table 5.4 displays the farm characteristics by the favorable and vulnerable risk classes. When examining the CE between favorable farms and vulnerable farms, the favorable farms have a consistently higher CE ratio than the vulnerable farms. Farms that are generating positive incomes should be utilizing their inputs in a more cost efficient manner. Another key observation between the averages of the two risk classifications is that 2015 is the only year with favorable farms averaging a negative OPMR, and that in 2015, these top performing farms are struggling to generate a strong OPMR.

Differences between the three performance measures were tested utilizing t-tests with a 95 percent confidence interval. For all sampled years, the vulnerable and favorable risk classes had significantly higher CE averages with 2015 levels being -0.007 for favorable farms and -0.644 for vulnerable farms. The calculated p-values, that determines the likelihood that the two samples are not the same, fit well outside the 95 percent confidence levels. The same can be said for the OPMR and the ROA, where in each year the favorable and vulnerable farms had significantly higher profitability measures of 0.003 ROA and 0.64 CE for favorable farms, -0.098 ROA and 0.43 CE for vulnerable farms.

When utilizing t.tests to determine if farm characteristics of low risk farms are significantly different than high risk farms, several characteristics were found to be different between the two risk classes. During the entire sample period lower risk farms had significantly higher values of the three performance measures: OPMR, ROA, and value of farm production growth; and average net worth except in 2013. Lower risk farms also had significantly higher levels of value of farm production and total average assets in 2005, 2009, 2010, 2011, and 2012. Favorable farms had a significantly higher crop-labor percentage compared to vulnerable farms in 2006, 2008, 2009, 2010, but in 2014 the mix up changed and high risk farms had the higher crop-labor percentage. Total crop acres changed in a similar manner with favorable farms having higher crop acres in 2009, 2010, and 2012, but 2014 favorable farms had significantly lower number of crop acres compared to vulnerable farms. Another characteristic of the farms is that the average age of favorable farms was significantly older than vulnerable farms in 2006, 2009, 2010, 2011, 2013, 2014, and 2015. The number of workers was found to not be statistically different between favorable and vulnerable farms during any of the sample period.

Table 5.4 Average Kansas Farm Characteristics Data, Profitability Measures, and Efficiency Measure of Favorable and Vulnerable Risk Classes 2005-2015

	2015		2014		2013		2012	
Farm Characteristics	Favorable[2]	Vulnerable[3]	Favorable[2]	Vulnerable[3]	Favorable[2]	Vulnerable[3]	Favorable[2]	Vulnerable[3]
Number of Farms	280	50	384	33	433	15	422	11
Crop Acres	1,584	1,840	1,476	2,423	1,479	2,178	1,581	881
Pasture Acres	612	722	689	177	578	1267	594	533
Number of Workers	1.57	2.00	1.59	1.62	1.50	1.89	1.58	1.48
Operator's Age	62.74	58.82	62.29	57.18	61.19	58.20	60.29	59.55
Crop Labor Percentage	82%	78%	78%	95%	80%	75%	79%	76%
Profitability Measures								
Value of Farm Production	$582,636	$546,547	$632,675	$640,149	$639,775	$782,432	$679,908	$398,237
Net Farm Income from Operations	$93,195	-$178,401	$164,352	-$127,178	$185,731	-$83,283	$191,377	-$51,764
Total Non-Farm Taxable Income	$27,038	$34,652	$29,361	$46,590	$32,098	$39,875	$45,367	$37,441
Unpaid Family and Operator Labor	$78,377	$81,872	$76,071	$65,507	$70,748	$72,760	$66,706	$62,727
Operating Profit Margin	-0.007	-0.644	0.105	-0.331	0.140	-0.262	0.156	-0.320
Asset/Liability Characteristics*								
Rate of Return on Assets	0.003	-0.098	0.037	-0.094	0.052	-0.065	0.055	-0.091
Rate of Return to Equity[1]	-0.002	-1.539	0.039	-0.119	0.057	-0.328	0.058	-0.087
Debt-to-Asset Ratio	0.122	0.569	0.135	0.594	0.138	0.591	0.141	0.563
Debt-to-Equity Ratio[1]	0.161	1.580	0.183	2.946	0.187	2.879	0.190	2.417
Productive Efficiency								
Cost Efficiency (CE)	0.641	0.431	0.590	0.401	0.487	0.356	0.496	0.349

Note: [1] ROE and D/E ratios include some farms with negative equity and negative NFIO resulting in positive ratios for some poorly positioned farms

[2] Favorable; positive net farm income with less than or equal to a debt-to-asset ratio of 0.4

[3] Vulnerable; negative net farm income with more than a debt-to-asset ratio of 0.4

Table 5.4 Continued.

	2011		2010		2009		2008	
Farm Characteristics	Favorable[2]	Vulnerable[3]	Favorable[2]	Vulnerable[3]	Favorable[2]	Vulnerable[3]	Favorable[2]	Vulnerable[3]
Number of Farms	418	17	417	14	377	30	375	27
Crop Acres	1,580	1,509	1,540	1,044	1,495	1,031	1,499	1,090
Pasture Acres	619	468	622	653	611	802	535	733
Number of Workers	1.58	1.23	1.55	1.69	1.51	1.48	1.57	1.35
Operator's Age	58.98	54.18	58.22	53.29	57.09	53.47	56.36	53.19
Crop Labor Percentage	78%	81%	81%	65%	82%	63%	82%	61%
Profitability Measures								
Value of Farm Production	$655,355	$420,894	$577,628	$310,796	$504,383	$310,606	$536,645	$349,515
Net Farm Income from Operations	$205,100	-$45,865	$188,657	-$72,321	$152,946	-$36,526	$180,232	-$54,672
Total Non-Farm Taxable Income	$35,366	$52,616	$29,715	$19,981	$30,196	$37,474	$32,245	$32,634
Unpaid Family and Operator Labor	$63,270	$54,741	$58,847	$64,688	$56,366	$55,000	$55,184	$46,767
Operating Profit Margin	0.169	-0.247	0.184	-0.370	0.164	-0.259	0.194	-0.326
Asset/Liability Characteristics*								
Rate of Return on Assets	0.064	-0.099	0.063	-0.120	0.070	-0.064	0.100	-0.076
Rate of Return to Equity[1]	0.069	-0.125	0.067	-0.642	0.075	0.065	0.115	-0.524
Debt-to-Asset Ratio	0.149	0.724	0.155	0.768	0.156	0.647	0.160	0.649
Debt-to-Equity Ratio[1]	0.203	1.283	0.212	5.766	0.214	1.284	0.220	-1.071
Productive Efficiency								
Cost Efficiency (CE)	0.536	0.320	0.380	0.244	0.556	0.395	0.538	0.386

Note: [1] ROE and D/E ratios include some farms with negative equity and negative NFIO resulting in positive ratios for some poorly positioned farms
[2] Favorable; positive net farm income with less than or equal to a debt-to-asset ratio of 0.4
[3] Vulnerable; negative net farm income with more than a debt-to-asset ratio of 0.4

Table 5.4 Continued.

	2007		2006		2005	
Farm Characteristics	Favorable[2]	Vulnerable[3]	Favorable[2]	Vulnerable[3]	Favorable[2]	Vulnerable[3]
Number of Farms	355	32	318	62	322	43
Crop Acres	1,392	1,271	1,342	1,537	1,347	1,287
Pasture Acres	542	814	564	729	595	417
Number of Workers	1.55	1.54	1.54	1.74	1.63	1.40
Operator's Age	55.74	55.19	55.31	52.21	54.02	52.91
Crop Labor Percentage	80%	75%	80%	74%	79%	84%
Profitability Measures						
Value of Farm Production	$434,974	$336,195	$326,000	$345,789	$335,313	$217,752
Net Farm Income from Operations	$155,775	-$40,767	$85,094	-$47,709	$93,565	-$23,030
Total Non-Farm Taxable Income	$25,843	$59,763	$23,196	$43,701	$18,125	$34,285
Unpaid Family and Operator Labor	$53,324	$44,177	$31,521	$28,633	$33,001	$27,858
Operating Profit Margin	0.193	-0.316	0.164	-0.174	0.160	-0.194
Asset/Liability Characteristics*						
Rate of Return on Assets	0.089	-0.075	0.055	-0.047	0.058	-0.078
Rate of Return to Equity[1]	0.099	-0.124	0.055	-0.233	0.061	-0.412
Debt-to-Asset Ratio	0.166	0.716	0.168	0.710	0.173	0.701
Debt-to-Equity Ratio[1]	0.230	5.082	0.233	0.240	0.242	1.821
Productive Efficiency						
Cost Efficiency (CE)	0.480	0.325	0.606	0.392	0.543	0.351

Note: [1] ROE and D/E ratios include some farms with negative equity and negative NFIO resulting in positive ratios for some poorly positioned farms
[2] Favorable; positive net farm income with less than or equal to a debt-to-asset ratio of 0.4
[3] Vulnerable; negative net farm income with more than a debt-to-asset ratio of 0.4

5.3 Profitability Persistence

Panel auto-regressions were conducted on the profitability measures, OPMR and ROA, utilizing fixed effects under the assumption that OPMR and ROA are not random from one year to the next. These profitability measures are important to examine over time to see if management is consistent in its ability to make the farm profitable. Table 5.5 and Table 5.6 display the coefficients of the auto-regressions of OPMR and ROA respectively.

The coefficients indicate that marginal-income classified farms and vulnerable farms were negative and statistically significant on OPMR and ROA in their respective models. However, the coefficients on the marginal-solvency dummy variable are statistically significant in some of the models, but have different signs between the OPMR auto-regressions and the ROA auto-regressions. The coefficients on the OPMR model in Table 5.5 that are significant for the marginal-solvency dummy variable have negative signs. This suggests that marginal-solvency farms have lower OPMR compared to favorable farms. The opposite is true for the coefficients in Table 5.6 on the ROA model for marginal-solvency dummy variables. These coefficients are positive, which indicates that marginal-solvency farms have higher ROA than their favorable counterparts. This can be understood when analyzing the effect that leverage has on ROE discussed in the literature review. Being leveraged can boost ROE through less expensive access to financing of debt instruments rather than equity financing instruments, which in turn can boost ROA.

Table 5.5 Panel Auto-Regression Results for Kansas Farm Operating Profit Margin Ratio (OPMR) with Risk Classification Dummies 2006-2015

Panel Auto-Regression Models:	1 Year Lagged	2 Year Lagged	1 Year Lagged Non-Linear	2 year Lagged Non-Linear
1 Year Lagged OPMR	0.055** (0.016)	0.043** (0.017)	-0.033* (0.018)	-0.050** (0.019)
1 Year Lagged Squared OPMR			-0.128** (0.014)	-0.132** (0.014)
2 Year Lagged OPMR		-0.027 (0.018)		-0.011 (0.021)
2 Year Lagged Squared OPMR				0.045** (0.017)
Risk dummy class 2	-0.591** (0.012)	-0.614** (0.013)	-0.593** (0.012)	-0.615** (0.013)
Risk dummy class 3	-0.022 (0.014)	-0.030* (0.016)	-0.026* (0.014)	-0.033** (0.016)
Risk dummy class 4	-0.462** (0.019)	-0.510** (0.023)	-0.466** (0.019)	-0.514** (0.023)
Constant	0.133** (0.005)	0.137** (0.006)	0.153** (0.005)	0.153** (0.007)

Risk Class 1 Favorable Risk Classification; positive net farm income with a debt-to-asset ratio less than or equal to 0.4
Risk Class 2 Marginal-income Risk Classification; negative net farm income with a debt-to-asset ratio less than or equal to 0.4
Risk Class 3 Marginal-solvency Risk Classification; positive net farm income with a debt-to-asset ratio more than 0.4
Risk Class 4 Vulnerable Risk Classification; negative net farm income with a debt-to-asset ratio more than 0.4
Note: Standard errors are in parentheses
** 95% confidence interval
* 90% confidence interval
1 Year Lagged: 2006-2015
2 Year Lagged: 2007-2015

Table 5.6 Panel Auto-Regression Coefficients for Kansas Farm Return on Assets (ROA) with Risk Classification Dummies 2006-2015

Panel Auto-Regression Models:	1 Year Lagged	2 Year Lagged	1 Year Lagged Non-Linear	2 year Lagged Non-Linear
1 Year Lagged ROA	0.077** (0.013)	0.067** (0.013)	0.049** (0.015)	0.036** (0.016)
1 Year Lagged Squared ROA			0.172** (0.051)	0.195** (0.055)
2 Year Lagged ROA		-0.080** (0.014)		-0.062** (0.017)
2 Year Lagged Squared ROA				-0.108** (0.054)
Risk dummy class 2	-0.113** (0.004)	-0.115** (0.004)	-0.113** (0.004)	-0.115** (0.004)
Risk dummy class 3	0.008* (0.004)	0.005 (0.004)	0.008* (0.004)	0.006 (0.004)
Risk dummy class 4	-0.136** (0.006)	-0.146** (0.006)	-0.136** (0.006)	-0.146** (0.006)
Constant	0.055** (0.002)	0.060** (0.002)	0.054** (0.002)	0.059** (0.002)

1 Favorable Risk Classification; positive net farm income with a debt-to-asset ratio less than or equal to 0.4
2 Marginal-income Risk Classification; negative net farm income with a debt-to-asset ratio less than or equal to 0.4
3 Marginal-solvency Risk Classification; positive net farm income with a debt-to-asset ratio more than 0.4
4 Vulnerable Risk Classification; negative net farm income with a debt-to-asset ratio more than 0.4
Note: Standard errors are in parentheses
** 95% confidence interval
* 90% confidence interval
1 Year Lagged: 2006-2015
2 Year Lagged: 2007-2015

In addition to panel regressions, auto-regressions of OPMR and ROA were analyzed for each year of the sample with risk class dummies with no constant included due to risk class dummies serving as a proxy for the baseline profitability measure for each model. Different combinations of one year lagged and two year lagged, linear and non-linear regressions; utilizing squared values of the lagged explanatory variables, and risk class dummies were analyzed. The best fitting model, measured by the adjusted R-squared for all sampled years, is the two-year lagged non-linear regression model for both OPMR and ROA. This suggests that OPMR can best be explained by a non-linear relationship of one and two-year lagged variables, squared values of those lagged variables, and risk classification dummy variables. The resulting coefficients are displayed in Table 5.7 and Table 5.8 for each sampled year.

The significance of the coefficients on the one-year lagged and two year lagged squared OPMR explanatory variables in the two-year lagged non-linear regression model for OPMR in 2015, labeled in Table 5.7, show that these explanatory variables have less significance in explaining each year's respective OPMR for the sampled Kansas farms. This suggests that any steady persistence in profits that might have existed during previous years, shown through the statistical significance in the one-year lagged, two-year lagged, and squared lagged explanatory variables of OPMR, did not transfer to 2015. However, we do see that the vulnerable and marginal-income risk classes consistently have a statistically significant negative impact on OPMR compared to favorable farms. This stands to reason due to both of these classifications utilizing negative NFIO as a criterion.

The regression coefficients in Table 5.8 show that ROA has a larger magnitude explained by the one and two-year lagged squared ROA explanatory variables. This shows that 2015 has a stronger non-linear relationship compared to previous years. Another observation from the coefficients suggests that farms classified as marginal-solvent in 2015 are not able to significantly increase their ROA, due to their higher level of leverage inherent in their risk classification, compared to the favorably classified farms.

Table 5.7 Two-Year Lagged Auto-Regression Coefficients for Kansas Farm Operating Profit Margin Ratio (OPMR) with Risk Classification Dummies 2007-2015

	2015	2014	2013	2012	2011	2010	2009	2008	2007
1 year Lagged OPMR	-0.096 (0.083)	0.277** (0.047)	0.350** (0.038)	0.259** (0.031)	0.319** (0.040)	0.343** (0.040)	0.366** (0.044)	0.442** (0.033)	0.339** (0.045)
1 year Lagged squared OPMR	-0.425** (0.052)	-0.107* (0.059)	0.224** (0.056)	0.214** (0.036)	0.199** (0.030)	0.032 (0.021)	0.074* (0.045)	0.360** (0.041)	-0.033 (0.053)
2 year Lagged OPMR	0.491** (0.089)	0.190** (0.046)	0.240** (0.034)	0.326** (0.032)	0.285** (0.042)	0.313** (0.036)	0.316** (0.043)	0.309** (0.040)	0.483** (0.043)
2 year Lagged squared OPMR	0.135 (0.130)	0.065 (0.070)	0.094** (0.039)	0.088** (0.024)	0.073** (0.024)	0.352** (0.036)	0.091** (0.045)	0.081 (0.056)	0.368** (0.086)
Risk dummy class 2	-0.643** (0.037)	-0.447** (0.028)	-0.465** (0.031)	-0.410** (0.028)	-0.483** (0.032)	-0.448** (0.034)	-0.644** (0.039)	-0.570** (0.037)	-0.373** (0.044)
Risk dummy class 3	-0.027 (0.084)	0.087** (0.029)	0.070** (0.022)	0.053** (0.019)	0.070** (0.023)	0.060** (0.020)	0.034 (0.022)	0.064** (0.017)	0.048** (0.019)
Risk dummy class 4	-0.645** (0.072)	-0.375** (0.041)	-0.327** (0.049)	-0.340** (0.052)	-0.262** (0.050)	-0.310** (0.052)	-0.240** (0.041)	-0.344** (0.037)	-0.281** (0.039)

1 Favorable Risk Classification; positive net farm income with a debt-to-asset ratio less than or equal to 0.4
2 Marginal-income Risk Classification; negative net farm income with a debt-to-asset ratio less than or equal to 0.4
3 Marginal-solvency Risk Classification; positive net farm income with a debt-to-asset ratio more than 0.4
4 Vulnerable Risk Classification; negative net farm income with a debt-to-asset ratio more than 0.4
Note: Standard errors are in parentheses
** 95% confidence interval
* 90% confidence interval
1 Year Lagged: 2006-2015
2 Year Lagged: 2007-2015

Table 5.8 Two-Year Lagged Auto-Regression Coefficients for Kansas Farm Return on Assets (ROA) with Risk Classification Dummies 2007-2015

	2015	2014	2013	2012	2011	2010	2009	2008	2007
1 year Lagged ROA	0.104** (0.023)	0.216** (0.047)	0.304** (0.047)	0.257** (0.035)	0.360** (0.052)	0.397** (0.045)	0.377** (0.038)	0.451** (0.050)	0.338** (0.069)
1 year Lagged squared ROA	-0.841** (0.123)	-0.666** (0.229)	0.465* (0.270)	0.170 (0.136)	0.276 (0.181)	-0.501** (0.149)	-0.025 (0.116)	0.283* (0.153)	1.025** (0.287)
2 year Lagged ROA	0.288** (0.028)	0.224** (0.046)	0.126** (0.037)	0.328** (0.034)	0.236** (0.049)	0.197** (0.043)	0.256** (0.034)	0.166** (0.072)	0.568** (0.059)
2 year Lagged squared ROA	-1.105** (0.148)	-0.315 (0.267)	0.340** (0.144)	-0.026 (0.126)	-0.060 (0.173)	-0.074 (0.123)	-0.253** (0.096)	0.599** (0.290)	-0.630** (0.239)
Risk dummy class 2	-0.064** (0.003)	-0.086** (0.008)	-0.077** (0.011)	-0.071** (0.010)	-0.083** (0.012)	-0.054** (0.013)	-0.089** (0.012)	-0.097** (0.019)	-0.066** (0.019)
Risk dummy class 3	0.004 (0.007)	0.041** (0.009)	0.036** (0.008)	0.036** (0.007)	0.033** (0.009)	0.038** (0.008)	0.024** (0.007)	0.055** (0.010)	0.075** (0.009)
Risk dummy class 4	-0.087** (0.006)	-0.109** (0.012)	-0.096** (0.018)	-0.102** (0.019)	-0.117** (0.020)	-0.084** (0.020)	-0.064** (0.013)	-0.085** (0.020)	-0.066** (0.018)

1 Favorable Risk Classification; positive net farm income with a debt-to-asset ratio less than or equal to 0.4
2 Marginal-income Risk Classification; negative net farm income with a debt-to-asset ratio less than or equal to 0.4
3 Marginal-solvency Risk Classification; positive net farm income with a debt-to-asset ratio more than 0.4
4 Vulnerable Risk Classification; negative net farm income with a debt-to-asset ratio more than 0.4
Note: Standard errors are in parentheses
** 95% confidence interval
* 90% confidence interval
1 Year Lagged: 2006-2015
2 Year Lagged: 2007-2015

The results of the auto-regressions of each farm's relative profitability positioning in Table 5.9 sheds some insight into the persistence of profitability, or the convergence of farms' relative profitability position to the average. As an example, if the coefficient is closer to 1.0, then farms tended to remain at the same ranked level of relative profitability compared to the rest of the sample. The ROA w_{it} coefficients decrease over the sample period, with the highest coefficient in 2007 of 0.624 and the lowest coefficients in 2014 and 2015 of 0.116 and 0.180 respectively. The coefficients indicate that some farms more consistently differentiated themselves by capturing similar non-average profits in the years of 2006 through 2011 with coefficients above 0.40. However, in 2012 and similarly in 2013, the majority of farms' profitability improved and the ROA w_{it} coefficients dropped slightly to 0.327 and 0.335, respectively. This is due to some farms over performing and others underperforming compared to their previous relative position. Finally, in 2014 and 2015, everyone had lower profitability levels resulting in the previous year's relative profitability position having a significantly less effect on 2014 and 2015's relative profitability position. This indicates that these sampled Kansas farms' profitability levels converged in 2014 and 2015 towards the average profitability level which had decreased as an average over the sample.

The consistent significance in coefficients for both auto-regressions shows a continuous influence that a farm's previous year relative profitability positioning has on the relative profitability positioning in a given year in the sample. This leads to the conclusion that these farms are performing the best they can with given market and other external factors, and generally, each farm's relative profitability position will be determined by the farm's previous year relative positioning.

Table 5.9 Relative Profitability Regression Coefficients and Adjusted R-Squared: 2006-2015

	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006
Operating Profit Margin Ratio (OPMR) w_{it}										
OPMR Relative Positioning OPMR $w_{i,t-1}$ Coefficient	0.593*** (0.081)	0.422*** (0.050)	0.405*** (0.040)	0.332*** (0.034)	0.376*** (0.038)	0.487*** (0.028)	0.679*** (0.041)	0.518*** (0.037)	0.599*** (0.044)	0.464*** (0.042)
Adjusted R-Squared	0.086	0.111	0.151	0.142	0.148	0.351	0.322	0.258	0.244	0.175
Return on Assets (ROA) w_{it}										
ROA Relative Positioning ROA $w_{i,t-1}$ Coefficient	0.180*** (0.032)	0.116** (0.045)	0.335*** (0.039)	0.327*** (0.032)	0.437*** (0.040)	0.432*** (0.033)	0.462*** (0.028)	0.495*** (0.039)	0.624*** (0.053)	0.412*** (0.037)
Adjusted R-Squared	0.053	0.010	0.113	0.157	0.173	0.231	0.322	0.225	0.198	0.182

Note: Standard errors are in parentheses
*** 99% confidence interval
** 95% confidence interval

Panel auto-regression coefficients of the two relative profitability measures from 2006 to 2015 shown in Table 5.10 show the explanatory power of previous years' ability to generate similarly different from average profits through the sample period. These can be compared to the previous yearly auto-regression coefficients of the relative profitability measures to determine which years farms are able to consistently differentiate themselves.

Table 5.10 Relative Profitability Panel Regression Coefficients and P-Value: 2006-2015

	Operating Profit Margin Ratio (OPMR) Model w_{it}	Return on Assets (ROA) Model w_{it}
Relative Positioning $w_{i,t-1}$ Coefficient	0.493*** (0.015)	0.405*** (0.012)
Constant	0.000*** (0.004)	0.00*** (0.001)

Note: Standard errors are in parentheses
*** 99% confidence interval
** 95% confidence interval

Comparing the coefficient values in Table 5.9 to Table 5.10, the ability of farms to generate similarly different than average OPMR in 2015, 2009, 2008, and 2007 was higher than the average ability of farms to generate different than average OPMR throughout the sample period, and suggests these years farms were more successful than other years to differentiate themselves in terms of OPMR. However, the coefficient signaling persistence in profits in terms of ROA was higher than the sample periods average of 0.405 in 2006 through 2011. This suggests that farms were not able to generate similarly different than average ROA in 2012 to 2015 as they were the previous years.

This study excluded utilizing ROE within the profitability measurements due to some farms having negative equity and negative NFIO. This causes the ROE ratio to be inconsistent with the interpretation of the financial measure. This incorrect measurement of profitability suggests that a farm has a positive return on its equity, when in fact it had a negative return on negative equity.

5.4 Efficiency Results

The average CE scores for the sampled farms varied from year to year, with the average CE for the sample farms being above 0.50 for 2005, 2006, 2008, 2009, 2011, 2014, and 2015. CE average for 2007 dropped to 0.445 after the highest average for the sample in 2006 of 0.547. In 2010, CE dropped the lowest average for the sample of 0.361, but quickly rebounded in 2011 to 0.501. However, 2012 and 2013 seen another drop in average CE to 0.470 and 0.465 respectively. Finally, CE jumped again to the second year of the highest value of CE in 2014 of 0.547, and 2015 ended with another higher average CE of 0.544.

These higher CE scores are paired with the lowest NFIO averages from 2006 to 2015, signaling that producers might operate more cost consciously when NFIO is lower. Observing the relationship between OPMR and the cost efficiency, there is a clear negative relationship. This signals that managers are possibly more cost conscience and try to raise their CE level when the OPMR drops, and are not as worried about CE when OPMR levels are high.

The CE scores were regressed over several variables. These regressions explored feasible explanations of the CE of Kansas farms. Explanatory variables included are crop-labor percentage, ROA and OPMR separately, farm growth in net farm income and value of farm production, and two size variables of total assets or value of farm production. The resulting regression coefficients for each respective model are shown in Table 5.11 and Table 5.12.

The regression coefficients for utilizing ROA as the profitability explanatory variable are shown in Table 5.11. In this regression, risk classification dummy variables offer little to no statistical significance in explaining the CE of Kansas farms with the risk class 2 dummy, risk class 3 dummy, and risk class 4 dummy variables only having one year of significance, three years of significance, and three years of significance in explaining CE for a farm when compared to risk class 1 farms respectively. Crop-labor percentage is consistently statistically significant across the years for explaining CE with a positive sign. This signals that more highly concentrated a farm is in crops, the higher the CE the farm is likely to have. This relationship is increasing in magnitude with 2014 and 2015 having the largest crop-labor percentage coefficients of 0.584 and 0.680, respectively. This analysis suggests that crop farms tend to be more cost efficient than their livestock counterparts. In addition to that, average total assets is a statistically significant variable, with a very small coefficient, but it does have a positive sign showing there are economies of scale present with large farms having a marginally higher CE level.

The regression coefficients for utilizing OPMR as the profitability explanatory variable are shown in Table 5.12. This regression suggests that only the risk class 3 dummy variable does not have a consistent significance in affecting CE levels as risk class 1 farms, seen through it only being significant in three of the years. Risk class 2 and risk class 4 dummy variables have nine years and seven years of significant coefficients, respectively, showing significant difference in CE between risk class 2 and risk class 4 farms compared to risk class 1 farms. This regression also has a consistently impactful crop labor percentage on CE with the highest coefficient magnitudes in 2014 and 2015 of 0.607 and 0.668.

In 2010, 2011 and 2012 both regressions have positive significant coefficients on the risk class 3 dummy variables. This suggests that in those years, Kansas farms classified as a risk class 3 had higher CE levels than risk class 1 farms. Also, the significant coefficients for the risk class 2 dummy variables are significant and negative for the first time over the sample period analysis suggesting that Kansas farms in risk class 2 are not performing as cost efficiently as farms in risk class 1. The regression utilizing OPMR as the profitability explanatory variable also suggests that risk class 4 farms have a significant negative impact in CE compared to risk class 1 farms. All showing there are changing dynamics for different risk classes affecting CE from year to year.

Table 5.11 Cost Efficiency Score Regression Coefficients for Kansas Farms with Return on Assets: 2006-2015

	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006
Crop-Labor Percentage	0.680**	0.584**	0.393**	0.392**	0.419**	0.286**	0.466**	0.451**	0.342**	0.492**
	(0.013)	(0.011)	(0.016)	(0.017)	(0.015)	(0.014)	(0.017)	(0.018)	(0.016)	(0.016)
Return on Assets (ROA)	1.210**	0.096**	0.964**	0.819**	1.244**	0.523**	0.478**	0.479**	0.713**	1.109**
	(0.138)	(0.096)	(0.133)	(0.138)	(0.106)	(0.111)	(0.099)	(0.094)	(0.089)	(0.116)
Value of Farm Production Growth	-6.5E-08**	7.5E-08**	1.2E-07**	7.4E-08*	-5.7E-08	2.4E-07**	8.4E-08	-7.9E-08	-2.7E-07**	-1.7E-08
	(2.9E-08)	(2.7E-08)	(4.22E-08)	(4.55E-08)	(4.87E-08)	(5.04E-08)	(5.64E-08)	(6.34E-08)	(6.51E-08)	(9.77E-08)
Average Total assets	1.2E-08**	1.6E-08**	3.0E-08**	3.6E-08**	3.8E-08**	2.9E-08**	6.2E-08**	5.7E-08**	9.9E-08**	8.1E-08**
	(2.7E-09)	(2.59E-09)	(3.68E-09)	(4.19E-08)	(4.14E-09)	(3.95E-09)	(6.08E-09)	(7.06E-09)	(8.48E-09)	(7.80E-09)
Risk dummy class 2	-0.093**	0.003	0.006	-0.028	0.026	0.026	-0.027	0.006	0.048	-0.009
	(0.017)	(0.020)	(0.036)	(0.036)	(0.031)	(0.032)	(0.034)	(0.039)	(0.037)	(0.031)
Risk dummy class 3	0.011	-0.003	0.022	0.051**	0.064**	0.046**	0.008	0.004	0.015	-0.011
	(0.027)	(0.018)	(0.024)	(0.024)	(0.021)	(0.019)	(0.019)	(0.019)	(0.018)	(0.019)
Risk dummy class 4	-0.031	0.002	0.077	0.098	0.056	0.104**	0.073**	0.077*	0.013	-0.023
	(0.027)	(0.028)	(0.054)	(0.065)	(0.048)	(0.048)	(0.037)	(0.040)	(0.036)	(0.028)

Note: Standard errors are in parentheses
** 95% confidence interval
*   90% confidence interval

Table 5.12 Cost Efficiency Score Regression Coefficients for Kansas Farms with Operating Profit Margin Ratio: 2006-2015

	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006
Crop-Labor Percentage	0.668**	0.607**	0.400**	0.387**	0.423**	0.279**	0.484**	0.461**	0.361**	0.483**
	(0.013)	(0.012)	(0.015)	(0.017)	(0.014)	(0.014)	(0.016)	(0.018)	(0.016)	(0.015)
Operating Profit Margin Ratio (OPMR)	0.110**	0.438**	0.385**	0.389**	0.038**	0.255**	0.134**	0.225**	0.295**	0.595**
	(0.012)	(0.026)	(0.043)	(0.049)	(0.038)	(0.035)	(0.033)	(0.043)	(0.038)	(0.043)
Value of Farm Production Growth	-8.2E-08**	1.6E-07**	1.3E-07**	7.1E-08	5.3E-09	2.6E-07**	1.1E-07**	-6.3E-10	-1.3E-07**	-4.5E-08
	(3.0E-08)	(2.6E-08)	(4.0E-08)	(4.4E-08)	(4.5E-08)	(4.4E-08)	(5.6E-08)	(5.7E-08)	(5.8E-08)	(9.0E-08)
Average Total Assets	1.6E-08**	1.5E-08**	2.5E-08**	3.1E-08**	3.0E-08**	2.4E-08**	5.9E-08**	4.9E-08**	7.8E-08**	5.9E-08**
	(2.6E-09)	(2.7E-09)	(3.7E-10)	(4.2E-09)	(4.1E-09)	(3.9E-09)	(6.2E-09)	(7.2E-09)	(8.5E-09)	(7.6E-09)
Risk dummy class 2	-0.104**	0.040*	0.126**	0.097**	0.198**	0.130**	0.015	0.092*	0.130**	0.147**
	(0.016)	(0.023)	(0.041)	(0.042)	(0.036)	(0.037)	(0.042)	(0.047)	(0.042)	(0.033)
Risk dummy class 3	0.014	0.018	0.036	0.067**	0.079**	0.055**	0.015	0.009	0.020	0.009
	(0.027)	(0.019)	(0.023)	(0.023)	(0.021)	(0.018)	(0.020)	(0.019)	(0.018)	(0.018)
Risk dummy class 4	-0.083**	-0.023	0.126**	0.157**	0.070	0.146**	0.072*	0.120**	0.059	0.061**
	(0.025)	(0.027)	(0.054)	(0.064)	(0.046)	(0.047)	(0.037)	(0.043)	(0.038)	(0.028)

Note: Standard errors are in parentheses
** 95% confidence interval
*   90% confidence interval

5.5 Relationships Observed Between Farm Performance Measures

Through the analysis of risk classification and the efficiency regressions some possible relationships between these three performance measures have become apparent. The first connection seems to be between the profitability and efficiency of farms. When comparing the farms in the favorable and vulnerable risk classes in Table 5.4, a relationship between risk class and CE was found. Favorable farms had on average higher efficiency scores when compared to vulnerable farms.

Simple correlation coefficients show that the strongest relationship between the three performance measures is between the profitability of farms and their CE. More specifically, the correlation between OPMR and CE is the highest, at 0.604, shown in Table 5.13.

Table 5.13 Correlation Coefficients Between Profitability Measures, Efficiency Scores, and Growth of Kansas Farms 2015

	Operating Profit Margin and Cost Efficiency	Return on Assets and Cost Efficiency	Operating Profit Margin and Value of Farm Production Growth	Value of Farm Production Growth and Return on Assets	Value of Farm Production Growth and Cost Efficiency
Correlation Coefficient	0.6039	0.5671	0.5131	0.4371	0.4704

Farm characteristics were also examined to determine if certain characteristics were statistically different between the top 25 percent performing farms and bottom 25 percent performing farms in terms of OPMR, ROA, and CE.

After sorting farms by OPMR into quartiles, several farm characteristics were significantly different between the top 25 percent of farms and bottom 25 percent of farms. Top performing farms were larger with significantly higher levels of total farm assets and value of farm production for each year of the sample period with average total assets in 2015 being $3,627,288 for top farms and $2,171,397 for bottom farms, and average value of farm production in 2015 being $757,481 for the top 25 percent of farms and $210,537 for the bottom 25 percent of farms. Top farms also have a significant higher number of workers in each year except 2006, 2008, 2009, and 2013 with the 2015 average number of workers being 1.84 for the top and 1.25 bottom 25 percent of farms. The average operator's age for the top 25 percent of farms at 61.5 years is significantly less than the bottom 25 percent of farms average of 64.6 years in 2015, and the significance is the same in all years except 2006, 2007, and 2008.

Additional variables were found to be significantly different between top and bottom performing farms. The top 25 percent of farms' crop-labor percentages are significantly higher than the bottom 25 percent of farms in 2007, 2008, 2009, 2010, 2012, and 2013. The average crop-labor percentage in 2013 for the top 25 percent of farms is 79 percent and 73.8 percent for the bottom 25 percent of farms. However, the top farms had significantly lower crop-labor percentages in 2005 and 2014, with the 2014 average for the top 25 percent of farms being 64.6 percent and the bottom 25 percent of farms averaging 89.4 percent. This suggests that more profitable farms in terms of OPMR, consisted of more highly concentrated crop farms in the middle of the sample period, and 2014 transitioned to less concentrated crop farms performing better. The non-farm taxable income had a significant difference between top and bottom performing farms in all sample years except 2012 and 2013, with the averages for 2015 being $26,676 for the top 25 percent of farms and $39,314 for the bottom 25 percent of farms. Net working capital also had significantly higher values for the top 25 percent of farms compared to the bottom 25 percent of farms each year of the sample period with 2015 averages being $550,469 for the top 25 percent of farms and $202,200 for the bottom 25 percent of farms.

When sorting by ROA, similar farm characteristics were significantly different between the top 25 percent of farms and bottom 25 percent of farms as sorting by OPMR. The same size variables of value of farm production were significantly higher for top farms compared to bottom farms in the entire sample period, and total farm assets were significantly higher for top farms compared to bottom farms in all years except 2006 and 2013. The 2015 averages for value of farm production are $773,892 for the top 25 percent of farms and $299,411 for the bottom 25 percent of farms, and averages for the total farm assets are $3,603,139 for the top 25 percent of farms and $1,843,711 for the bottom 25 percent of farms. Top ROA farms also have significantly more workers during the sample period except 2006, 2008, 2009, and 2013 with 2015 averages of 1.87 for the top 25 percent of farms and 1.5 for the bottom 25 percent of farms. The top 25 percent of farms have a significantly lower operator's age than the bottom 25 percent of farms except in 2015. The average operator's age for 2014 is 59.1 years for the top 25 percent of farms and 61.4 years for the bottom 25 percent of farms.

The crop-labor percentage of the top 25 percent of farms were significantly higher than the bottom 25 percent of farms in 2006, 2007, 2008, 2009, 2010, 2012, and 2013. The average crop-labor percentages for 2013 are 82.2 percent for the top 25 percent of farms and 73.6 percent for the bottom 25 percent of farms. Crop-labor percentages for top and bottom farms were not statistically different in 2011 and 2015, but in 2005 and 2014, top farms had significantly lower crop-labor percentages with 2014 averages of 65.3 percent for the top 25 percent of farms and 90.3 percent for the bottom 25 percent of farms. This signals that in these two years, 2005 and 2014, either top ROA farms consisted of less crop centric farms performing better than typically in the past, or crop centric farms performed abnormally worse than typically compared to less crop focused farms.

More variables were significantly different. The average total crop acres of the top 25 percent of farms were significantly higher than the bottom 25 percent of farms over the sample period except 2014, with 2015 averages of 1,800 acres for the top 25 percent of farms and 1,242 acres for the bottom 25 percent of farms. Total non-farm taxable income was significantly lower for the top 25 percent of farms except for 2013 and 2015 where there was not statistical difference between the top and bottom farms. The average 2014 non-farm taxable income is $23,900 for the top 25 percent of farms and $35,212 for the bottom 25 percent of farms. Ending net working capital levels for top farms were significantly larger than bottom farms throughout the sample period with 2015 averages being $554,528 for the top 25 percent of farms and $155,103 for the bottom 25 percent of farms.

When farms are sorted by CE, similar farm characteristics are also found to be significantly different between the top 25 percent and bottom 25 percent of farms. Again, the size variables of value of farm production and average total assets are significantly higher for the top performing farms versus the bottom performing farms. The 2015 averages for value of farm production are $742,951 for the top 25 percent of farms, and $309,302 for the bottom 25 percent of farms. Average total assets for 2015 are $3,346,438 for the top 25 percent of farms and $2,414,520 for the bottom 25 percent of farms. There was no significant difference found between the top and bottom 25 percent of farms in regards to the number of workers for any year in the sample period, or any significant difference in the operator's age in the sample years except 2011 with the average age of the top 25 percent of farms being 57.7 years and the bottom 25 percent of farms being 60.2 years.

Crop-labor percentage was found the be significantly lower for the top 25 percent of farms for 2005, 2007, 2010, 2012, and 2013 with averages of 65.6 percent for the top 25 percent of farms and 81.4 percent for the bottom 25 percent of farms in 2013. In 2015 however, the top 25 percent of farms had significantly higher average crop-labor percent with 90.2 percent compared to the bottom 25 percent of farms with an average of 69.4 percent. Sorting by CE shows that at the end of the sample period, top performing farms consisted more of higher concentrated crop farms rather than less concentrated crop farms compared to ranking farms by the other two performance measures and later years of the sample period consisting of relatively lower concentrated crop farms.

The average total crop acres are significantly higher in the top 25 percent of farms compared to the bottom 25 percent of farms except in 2008 and 2013. The average total crop acres for 2015 are 1,957 acres for the top 25 percent of farms and 1,112 acres for the bottom 25 percent of farms. Average total non-farm taxable income is only significantly different between the top and bottom performing farms for five years, 2006, 2008, 2009, 2011, and 2014. The average values in 2014 are $25,790 for the top 25 percent of farms, and $34,696 for the bottom 25 percent of farms. The ending net working capital is significantly higher for the top performing farms compared to the bottom performing farms. The 2015 averages of ending net working capital are $552,823 for the top 25 percent of farms and $236,549 for the bottom 25 percent of farms.

Overall, sorting out the highest and lowest performing farms reveals that the size variables total farm assets and value of farm production, crop-labor percentage, and in some instances number of workers have a significant difference between the top 25 percent of farms and the bottom 25 percent of farms.

When examining the farms that had a CE of 1.0, farms generally didn’t remain fully CE through the entire sample period. However, some were able to be fully CE multiple times in this sample period. Five farms were able to be fully CE for two years, and one farm was able to remain fully CE from 2013 through 2015. This shows that a single farm was able to perform so well, they remained on the production possibilities frontier for the last three years of lower profitability. This empirical evidence shows that it is possible to perform persistently better than other farms through some competitive advantage through management decisions directing that farm through the low profitable landscape of 2014 and 2015. With so few farms performing fully CE, and many not being fully CE more than one year, it shows there is competition in the marketplace, and management decisions on operations and marketing need to be on the forefront if a farm desires to perform well.

Chapter 6 - Conclusion

6.1 Introduction

When measuring performance of farms, it is important to recognize relationships that are present between these measurements as well as farm characteristics. This thesis presented analysis of Kansas farms' performance measures and possible connections between performance measures and farm characteristics from 2005 to 2015. Performance measures were compared across risk classification to observe any significant differences between low and high risk farms, and farms ranked by OPMR, ROA, and CE.

6.2 Summary

The first two objectives of this thesis were to examine the profitability performance, and the relative efficiency levels of Kansas farms, and the final objective was to examine links between profitability, efficiency, and growth of Kansas farms. Farm level data were acquired from the Kansas Farm Management Association's Kansas Farm Management Data Bank. The requirements to be included in this study were for a farm to have continuous reporting to the association during the eleven-year period from 2005 to 2015, and exhibit financial data and farm characteristics typical to that of an agriculture producer in Kansas.

Farm efficiency scores were generated with a data envelope analysis that utilized input price vectors, as well as input and output quantity vectors. The resulting efficiency scores for each farm are their cost efficiency, or how relatively close they were to being cost efficient given their input use and resulting output compared to the other farms in each given year. Profitability measures were then derived for each farm following the methods of the Farm Financial Standards Council. These profitability measures include operating profit margin and return on assets. Growth measures were calculated by simply generating the percentage growth that each farm had for value of farm production. Finally, the farms were sorted into risk classifications borrowed from the USDA based on their NFIO and their debt-to-asset ratio.

After analyzing the risk classifications, several observations were made about the new financial position of farms. A lot of farms have moved out of the favorable risk class in 2014 and 2015, evidence that Kansas farms are becoming less profitable. However, these farms are still holding onto their low solvency. This is important for credit providers to understand as the interest rates and solvency levels are not as high as they were the 1980s when the farm debt crisis occurred. Most all of the farms transitioning out of the favorable risk class are moving into the marginal-income risk class that still has relatively low solvency levels. These farms will need to focus on cost efficiency to keep their solvency low in the future.

When comparing favorable and unfavorable farms, favorable farms had significantly higher performance measures for the sample period compared to vulnerable farms. These lower risk farms also had significantly higher size averages of value of farm production and average total assets for early and middle years of the sample period. The lack of significance in larger operations classified as favorable, shows that farms are not differentiated, or are not more likely to be in the favorable risk class rather than the vulnerable risk class by having a larger size of operation any more. Another characteristic of the favorable farms is that they were significantly more concentrated in crop production compared to vulnerable farms during the middle years of the sample period, but in 2014 this flipped and the vulnerable farms were significantly more concentrated in crop production. Finally, favorable farms were found to have a significantly higher age of operator compared to vulnerable farms. These favorable farms spend significantly more time on crop operations, and have older operators suggesting that more knowledgeable farmers and farmers that have been operating longer and are concentrated on crops. These two can be signals to stakeholders that these types of farms may be worth more of an in depth look if extending credit or investing in.

The analysis of the efficiency scores was conducted next. First, the farms were sorted by risk class to find any differences between low risk farms and high risk farms in terms of their efficiency. The CE for each farm were then regressed over several candidate explanatory variables to search for possible causation of cost efficient farms. These regressions revealed that risk classification has no significant explanation of a farm's CE score. Additionally, crop-labor percentage had a statistically significant positive coefficient suggesting that highly concentrated crop farms tend to be more cost efficient compared to less concentrated crop farms that spend more time on livestock. Suggesting that farmers that spend more time on crops tend to be more CE, which can be an important insight to producers that are considering alternative opportunities.

Results from analyzing the persistence of profitability suggest that there is a different dynamic between debt and the two profitability measures. Panel auto-regression coefficients suggest that more solvent profitable farms have a higher ROA, but lower OPMR than less solvent farms. There may have been persistence in profits for farms in the years previous to 2015 because of the significance of the yearly lagged regression coefficients.

The regressions of the calculated relative positioning of each farm suggest that some farms consistently differentiated themselves by capturing consistent non-average profits from years 2007 through 2011. However, the ability of farms to be profitable improved in 2012 and 2013, seen in the decrease in magnitude of coefficients relative to previous years. This signals that some farms were able to generate non-average profits, and change their relative profitability position due to high commodity prices. It is likely that some farms were underperforming compared to the average, while others were over performing. Then the profitability of farms converged to more similarly average profits in 2014 and 2015, compared to the widespread profitability levels during 2012 and 2013. This is shown from very low coefficients on the ROA relative positioning regressions in 2014 and 2015. Results from the OPMR relative positioning auto-regressions suggest that farms were generating more similar OPMR in 2010 through 2014, but diverged again in 2015, showing that some farms were able to differentiate themselves more in terms of having further from the average OPMR.

The results for the efficiency analysis, suggest that risk classification dummy variables offer little statistical significance in explaining the CE of Kansas farms. However, the crop-labor percentage ratio was reliably significant through the sampled years. Additionally, the relationship between CE and profitability measures was the strongest out of all the relationships between the three main performance measures. Specifically, the strongest correlation was between the OPMR and CE.

When ranking farms by their three respective performance measures, several farm characteristics were found to be significantly different between the top 25 percent of farms and bottom 25 percent of farms. Ranked by OPMR, farms were found to be significantly larger, utilized more workers, were slightly younger, and had less non-farm taxable income. Their crop-labor percentage had changed over time from highly concentrated crop farms in the top 25 percent of farms in the middle of the sample period, to significantly lower concentrated crop farms performing better in 2014.

When ranked by ROA, the top 25 percent of farms were found to have a larger operation in all years, more workers during the middle of the sample period, a lower age of the operator except in 2015, significantly more crop acres except in 2014 and 2015, less non-farm taxable income except 2013 and 2015, and higher levels of ending net working capital compared to the bottom 25 percent of farms. Similar changes occurred over time with the concentration of crop farms in the top 25 percent of farms as OPMR ranked farms; more crop concentrated farms were in the top 25 percent in most of the sample period, but less crop concentrated farms were in the top 25 percent in 2005 and 2014.

Finally, when ranked by CE, the top 25 percent of farms were significantly larger, held more ending net working capital, had less non-farm taxable income for the middle of the sample period and 2014, but there was no difference in the number of workers or operator's age between the top 25 percent and bottom 25 percent of farms. The crop concentration of the top 25 percent of farms is different for CE rank farms compared to the other two performance measures, these top 25 percent of farms were less crop concentrated in the middle years of the sample period and more concentrated in crop operations in 2015. However, the top performing farms still had more total crop acres than the bottom performing farms during the entire period except 2008 and 2013.

Overall, sorting by performance measures suggests that profitable farms don't necessarily have all the same characteristics as cost efficient farms shown in the difference in crop-labor percentage. However, larger farms, in terms of value of farm production and average total farm assets, are consistently performing better than smaller farms for all three performance measures. The years 2014 and 2015 represent a new dynamic of what farm characteristics determine the highest performing farms in Kansas.

This study identified changing dynamics in the risk classification of Kansas farms, found farms are now generating closer to average relative OPMR but further from average relative ROA, a significance in the crop-labor percentage variable in determining the CE of a farm, and the top 25 percent of farms in terms of OPMR and ROA as well as favorable risk class farms in 2014 had less of a crop concentration than the bottom 25 percent of farms and vulnerable risk class farms, but in 2015 there was significant difference between the top 25 percent of farms in terms of CE where they had a higher concentration of crop farms compared to the bottom 25 percent of farms ranked by CE.

The fully CE farms changed from year to year, but the single farm that remained fully CE in the last three years of the sample period show that a farm can differentiate themselves successfully under a particular set of economic circumstances that play well into a farm's management strengths. Operators can use this evidence as motivation to continually improve management skills and decisions in order to gain a competitive advantage over farms in their region.

6.3 Future Work Suggestions and Limitations

There are some areas for improvement, and new avenues to explore over the profitability, efficiency, and growth of Kansas farms. One aspect is utilizing a more robust risk classification variable. Possibly utilizing farm level specific variables to generate a risk classification based on probability of default more similar to a measure banks utilize, such as the Standard and Poor's (S&P) long-term credit rating, would increase the feasibility of using the risk class as a proxy for access to credit, and overall financial position of the farm.

Additionally, more research into the direction of the divergence of farm profitability in terms of their OPMR would shed insight into whether there are farms over performing, or underperforming. Further work on the relative positioning of farm profitability measures would allow for the analysis of more divergence and convergence tendencies of Kansas farms. Possible areas of interest include: regional analysis and operation type analysis. Further inquiry into the relationship between the performance measures needs to be done in order to understand any causal or more meaningful correlations that might be present in Kansas farms.

References

Ball, V. E., R. Färe, S. Grosskopf, and D. Margaritis. 2010. "Productivity and Profitability of US Agriculture: Evidence From a Panel of States." In *The Economic Impact of Public Support to Agriculture*, 125-139. New York: Springer.

Bjerga, A., and J. Wilson. 2016. *Farm boom fizzles as U.S. crop surplus expands financial strain.* January 17. Accessed March 27, 2017. http://www.stltoday.com/business/local/farm-boom-fizzles-as-u-s-crop-surplus-expands-financial/article_72dcf3ed-3aa4-5c28-823f-dc0f8e0d04ce.html.

Bjurek, H. 1996. "The Malmquist Total Factor Productivity Index." *The Scandinavian Journal of Economics* 98 (2): 303-313.

Bottazzi, G., A. Secchi, and F. Tamagni. 2008. "Productivity, profitability, and financial performance." *Industrial and Corporate Change* 17 (4): 711-751. doi:10.1093/icc/dtn027 .

Caves, D. W., L. R. Christensen, and W. E. Diewert. 1982. "The Economic Theory of Index Numbers and the Measurement of Input, Output, and Productivity." *Econometrica* 50 (6): 1393-1414.

Coelli, T.J., D.S. P. Rao, C.J. O'Donnell, and G.E. Battese. 2005. *An introduction to Efficiency and Productivity Analysis.* New York: Springer.

Diewert, W.E. 1992. "Fisher Ideal Output, Input and Productivity Indexes Revisited." *Journal of Productivity Analysis* 3 (3): 211-248. doi:10.1007/BF00158354.

Economic Research Service. 2016. "Macroeconomics & Agriculture Overview." *United States Department of Agriculture Economic Research Service.* November 04. Accessed March 27, 2017. https://www.ers.usda.gov/topics/international-markets-trade/macroeconomics-agriculture/.

Färe, R., S. Grosskopf, and C. A. K. Lovell. 1985. *The Measurement of Efficiency of Production.* Boston: Kluwer-Nijhoff Publishing.

Färe, R., S. Grosskopf, M. Norris, and Z. Zhang. 1994. "Productivity Growth, Technical Progress, and Efficiency Change in Industrialized Countries." *The American Economic Review* 84 (1): 66-83.

Farm Income Team. 2016. "Highlights From the Farm Income Forecast." *United State Department of Agirculture Economics Research Service.* August 30. Accessed October 13, 2016.

Featherstone, A., and M. Langemeier. 2015. "Credit Quality of Kansas Farms-2015 Data Update." *Kansas State University Department Of Agricultural Economics Extension Publication.*

FFSC, Farm Financial Standards Council. 2015. "Financial Guidlines For Agriculture."

Griffin, T., G. Ibendahl, and J. Stabel. 2016. "Do Profitable Farms Remain Profitable? Probability of Switching between Profit Categories." *Southern Agricultural Economics Association 2016 Annual Meeting.* San Antonio, Texas.

Hannula, M. 2002. "Total productivity measurement based on partial productivity ratios." *International Journal of Production Economics* 78 (1): 57-67.

Herbel, K., and M. Langemeier. 2012. "Persistence in Financial Performance." *Purdue Agriculture | Center for Commercial Agriculture.*

Hofstrand, D. 2008. *Opportunity Cost.* Iowa State University Extension and Outreach, Ag Decision Maker.

Hoppe, R. A., and D. E. Banker. 2010. *Sturcture and Finances of U.S. Farms: Family Farm Report, 2010 Edition.* EIB-66, U.S. Dept. of Agri., Econ. Res. Serv. July 2010.

Hoppe, R., and J. M. Macdonald. 2016. "Understanding America's Diverse Family Farms." *United State Department of Agriculture Economic Research Service.* February 01.

Ibendahl, G. 2013. "Are the Most Profitable Farms Always the Most Profitable?" 19th International Farm Management Congress Vol.3 Warsaw University of Life Sciences, Warsaw, Poland. July 21st - 26th, 2013.

Ibendahl, G.. 2016. "Net Farm Income by Decile Group." Agricultural Economics , Kansas State University.

Kuosmanen, T., and T. Sipiläinen. 2009. "Exact decomposition of the Fisher ideal." *Journal of Productivity Analysis* 31 (3): 137-150. doi:10.1007/s11123-008-0129-z.

Langemeier, M.R. 2010. "Kansas Farm Management SAS Data Bank Documentation." *Departement of Agricultural Economics, Staff Paper No. 11-01.*

Langemeier, M.R. 2011. "Financial Ratios Used in Financial Management." Farm Management Guide MF-270, Department of Agricultural Economics, Kansas State University.

Mueller, D.C. 1977. "The Persistence of profits above the norm." *Economica* (Wiley) 44 (176): 369-380. doi:10.2307/2553570.

Mueller, D.C. 1986. *Profits in the long run.* New York: Cambridge University Press.

Mugera, A., M. Langemeier, and A. Ojede. 2016. "Contributions of Productivity and Reative Price Changes to Farm-level Profitability Change." *American Journal of Agricultural Economics.* doi:10.1093/ajae/aaw029.

Mugera, A., M.R. Langemeier, and A.M. Featherstone. 2012a. "Labor Productivity Growth in the Kansas Farm Sector: A Tripartite Decomposition using Non-Parametric Approach." *Agriculture and Resource Economics Review* 41 : 298-312.

Mugera, A., M.R. Langemeier, and A.M. Featherstone. 2012b. "Labor Productivity Convergence in the Kansas Farm Sector: A Three-stage Procedure using Data Envelopment Analysis and Semiparametric Regression Analysis." *Journal of Productivity Analysis* 38 : 63-79.

NASS. n.d. "Cattle, Corn, Soybeans, Wheat - Price Received." *Monthly raw data 1994-2017.* National Agricultural Statistics Service. Accessed March 27, 2017. https://quickstats.nass.usda.gov/results/B0FF5B7B-EDC4-3201-B62F-F412C2CE76FD.

O'Donnell, C.J. 2010. *Nonparametric Estimates Of The Components Of Productivity And Profitability Change In U.S. Agriculture.* Centre for Efficiency and Productivity Analysis Working Paper Series No. WP02/2010.

Patrick, K., and R. Kuhns. 2016. "Trends in Farm Sector Debt Vary by Type of Debt and Lender." *Amber Waves* (USDA, Economic Research Service).

Schnepf, R. 2013. "U.S. Farm Income." Congressional Research Service, Washington, DC.

Scott, J. F., J. M. Scott, and O. J. Cacho. 2013. "Whole-farm returns show true profitability of three different livestock management systems." *Animal Production Science* 53 (8): 780-787. doi:10.1071/AN11248.

Silverman, B.W. 1986. *Density Estimation for Statistics and Data Analysis.* London: Chapman and Hall.

USDA. 2017. "Agricultural Price Indices." National Agricultural Statistics Service. Various Issues.

Wolf, C.A. 2010. "Understanding the milk-to-feed price ratio as a proxy for dairy farm profitability." *Journal of Dairy Science* 93 (10): 4942-4948.

Yeager, E. A., and M. R. Langemeier. 2016. "Economic efficiency adjusted for risk preferences." *Applied Economics.* doi:10.1080/00036846.2016.1223819.

Yeager, E.A., and M.R. Langemeier. 2011. "Productivity Divergence across Kansas Farms." *Agricultural and Resource Economics Review* 40 (2): 282-292. doi:10.1017/S1068280500008066.