ABSTRACT

Farmers have many options for choosing equipment that is required to grow and harvest a crop. Farmers may own their own equipment, lease it, or have the field operations completed using custom operators. For those farmers who choose to own most of their equipment, there are additional decisions about the size and quantity of equipment needed. This paper uses a 15-year dataset of farm financial data from the Kansas Farm Management Association (KFMA) to examine how depreciation, machinery repairs, and the use of custom operators vary by farm profitability quintiles. Results indicate that the most profitable farms also have the highest levels of depreciation but that the machinery level is probably not excessive.

The Effects of Machinery Costs on Net Farm Income

By Gregg Ibendahl

Introduction

Crop production in the United States requires some use of farm equipment. Even on farms employing minimum or no-till production, a planter (with tractor) and harvester will still have to be employed. Fertilizer and chemical applications need some type of machine for delivery as well. For those farmers not strictly no-till, some type of tillage tool is needed too. In addition, many farms employ grain carts and trucks to transport grain.

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Farmers have many choices for equipment, other than the types of field operations, to use for production. Farmers can own all their own equipment, use custom operators for all fieldwork, or use a combination of their own equipment in conjunction with specific custom field operations. For those farmers owning equipment, additional decisions involve how often to trade equipment, the size of equipment to purchase, and whether the farm should maintain any excess machinery capacity.

These equipment decisions are very important for most farms because they can greatly affect profitability. According to Kansas Farm Management Data, machinery costs account for 40 percent of total crop production expenses. After land, machinery is the second biggest asset category on most farms. This paper uses a 15-year dataset of farm financial data from the Kansas Farm Management Association (KFMA) to examine how depreciation, machinery repairs, and the use of custom operators vary by farm profitability quintiles in order to determine the best strategy for equipment management and accomplishing field operations.

Those farmers who depend more on custom operators for their field operations don't have to worry whether they are fully employing their equipment or keeping it maintained. The disadvantage is a farmer loses some control over when a field operation is accomplished as the custom operator has their own schedule with others demanding their services. In addition, the use of custom operators may be more expensive than owning the equipment, especially if the equipment is used often.

Purchasing equipment allows a farmer to complete field operations on a timelier basis. However, the farmer is responsible for maintaining and operating the equipment. In addition, farmers need to have adequate equipment for their farm size. Extra equipment will help ensure all field operations are completed in a timely manner and provide some insurance due to mechanical failures. The tradeoff is that equipment is expensive and equipment that is underutilized costs the farmer money.

Farmers also have to determine the frequency of machinery replacement. Newer equipment should be more reliable and require fewer repairs. The tradeoff is that replacing equipment more often results in more depreciation, which reduces profits. Newer equipment may be more efficient though, which could help profitability.

Background

According to Edwards (2009), good machinery managers can reduce machinery costs by $25 per acre. This could represent the difference between a profit and a loss. Estimating machinery costs and determining whether to own the equipment or use equipment from other sources is no simple task. According to Beaton, et al. (2005), custom rates for an average size farm are 25 percent lower than the true cost. If this is true, then farmers might be better off using more custom operations on their farm. Custom harvest operators control 30 percent of the crop acres in Iowa (Edwards, 2009). Edwards also describes the advantages and disadvantages to owning equipment and using custom operators. Agricultural engineers have developed methods of estimating machinery costs (Schuler & Frank, 1991), but using actual farm records is best.

Data

For this project, 15 years of Kansas Farm Management Association (KFMA) data was used (1999 through 2013). The data was screened so that only non-irrigated crop farms were part of the analysis. Few farms in the KFMA program are classified as irrigated so removing them doesn't eliminate many farms but leaving them in just adds another compounding factor to consider. Also, most variables were converted to a per crop acre basis so that farms of different sizes could be compared. The depreciation costs are actually management or economic depreciation which attempts to value the actual decrease in asset value each year. As shown in Dumler, Burton, and Kastens (2000), management and other none tax depreciation methods are more accurate at matching depreciation costs to the actual costs of owning equipment. Tax depreciation is not used since the acceleration effects masks true income by overstating the actual costs to a farmer in the early years of the asset. Farm income available to pay expenses and provide for family living is better reflected though management depreciation. Tax depreciation is used to calculate taxes even when management depreciation to analyze farms. As a consequence, the pre-tax net farm income in the study is also based on management depreciation.

The variables used in the analysis include: net farm income per acre; total crop acres; percent of crop acres that are rented; the location in the state of the farm (by KFMA region); the crop machinery investment per acre, the machinery depreciation per acre; the total crop production cost per acre; the total crop machinery cost per acre; the percentage of crop production costs that are machinery; the machinery repair cost per acre; the machinery hire cost per acre; and the quintile ranking of net farm income for each farm by year.

Analysis

The first step was to graph the quintiles of net farm income per acre by year. This is shown in Figure 1. The quintiles for each year were determined by ranking the net farm income per acre for each year from highest to lowest. The top 20 percent of net farm income per acre farms were assigned a one, the next 20 percent of farms a two, etc., until the lowest 20 percent of net farm income farms were assigned a five. As shown on the graph, the bottom 20 percent of farms lose a little money each year while everyone else makes money on average. The top 20 percent really do well especially starting in 2007. Farms may or may not be in the same quintile each year and the quintile calculation was redone each year.

The next steps were to examine the effects of farm size on net farm income and on the amount of depreciation taken. Figure 2 is an analysis of grouping all the years together to see if farm size affects the net farm income per acre. To account for differences in average profitability each year, the net farm income number is adjusted to reflect how the average of a specific year varies from the average over all years (this was the only part of the analysis that attempted to combine years). As this figure indicates, there appears to be little or no returns to scale for farms as they become larger. Figure 3 shows how depreciation per acre is affected by farm size for each of the quintiles of profitability. The size of the farm doesn't appear to affect the amount of depreciation taken but the most profitable farms tend to have more depreciation. Some of the later analysis confirms that the most profitable farms have higher depreciation.

The last steps were to examine how the various expenses affected the five quintiles of farm profitability on a per year basis. Figure 3 shows the Smoothed Machinery

Depreciation per Acre for Different Farm Sizes by Quintiles. Several of the figures use a smoothing function to reduce the degree of change from year to year. This process makes the line graphs more linear and helps to show multi-year changes. Figure 4 shows the Smoothed Crop Machinery Investment per Acre by Year for the Five Quintiles of Farm Profitability. Figure 5 shows the Smoothed Machinery Depreciation per Acre by Year for the Five Quintiles of Farm Profitability. Figure 6 shows the Smoothed Total Crop Production Costs per Acre by Year for the Five Quintiles of Farm Profitability. Figure 7 shows the Smoothed Total Crop Machinery Cost per Acre by Year for the Five Quintiles of Farm Profitability. Figure 8 shows the Smoothed Machinery Cost as a Percentage of Total Crop Cost by Year for the Five Quintiles of Farm Profitability. Figure 9 shows the Smoothed Machinery Repair Costs per Acre by Year for the Five Quintiles of Farm Profitability. Figure 10 shows the Smoothed Machinery Hire Expense per Acre by Year for the Five Quintiles of Farm Profitability.

Finally the relationship between depreciation and machinery repairs was examined. Farms with more depreciation expense per acre should have lower repair costs, as the higher depreciation costs would likely indicate new equipment. It is possible though, higher depreciation expenses per acre represent not new equipment but more equipment on a farm compared to a similar farm with equipment the same age. There is a correlation between depreciation and machinery repairs of 0.403.

Discussion

As shown in Figures 4 and 5, the most profitable farms had the highest levels of machinery investment along with the highest levels of depreciation expenses. These two figures go together as by definition, with the use of management depreciation, a higher level of machinery investment causes more depreciation. What might be unexpected though is the result of the most profitable farms having the greatest depreciation. This is due to the fact that the most profitable farms own either the most equipment or the newest equipment. The least profitable quintile of farms has the least depreciation expense. While this result might be difficult to explain, one possible answer is that the extra profits from the most profitable farms allowed them to purchase more and newer equipment.

Another result seen in Figures 4 and 5 that was expected is the increase in machinery over the last seven or eight years. These were very profitable years for most farmers so it is not surprising that farmers attempted to lower taxable income by purchasing more equipment or trading more often.

Figures 6, 7, and 8 show how all crop expenses and machinery crop expenses vary by year and farm profitability quintile. Somewhat unexpectedly, the most profitable farms have both the highest total crop expenses and also the highest machinery expenses. Given the most profitable farms had the most equipment (from Figure 4), the higher machinery expenses of the most profitable farms can be explained. However, the higher levels of total crop expenses are less intuitive. Perhaps higher quality land is a factor.

Figure 8 shows the result of computing the ratio between machinery crop expenses and total crop expenses. Here, the most profitable farms had the lowest levels of machinery costs as a percentage of total costs. Total costs would include machinery and land costs. While the most profitable farms had the greatest amounts of machinery, in the bigger picture of total crop expenses, their machinery expenses were actually the lowest. Thus, the most profitable farms were using more expenses like seed, chemical, and fertilizer. This could be an indication that either the crop mix of the most profitable farms is different or that these farms had better land, which might respond better to more fertilizer. An analysis with a focus on specific areas of the state might reveal some of soil and crop mix differences.

Figures 9 and 10 show the analysis of machinery hire and machinery repair; as the graphs tend to jump around and the quintiles are not consistent, not much can be inferred from these figures.

Machinery repair costs and depreciation have a positive correlation of 0.403. Normally, one would expect this to be a negative relationship as higher depreciation would mean newer equipment and thus lower repairs. However, as mentioned there is a positive relationship. This might be explained by the higher depreciation levels indicating more equipment rather than just newer equipment.

Conclusion

In summary, this paper shows contrary results over what might be expected. The most profitable farms have the highest machinery investment per acre and the highest total crop expenses as well as the highest depreciation costs. This is likely a result of the most profitable farms having the best farmland that could be worked the most intensively. Using farmland more intensively would require a higher machinery investment than for land that was farmed less intensively. Another explanation is that the most productive farms purchased more machinery to help lower taxes.

Despite the most profitable farms having more equipment value per acre (with a corresponding higher depreciation cost), these farms were not overspending on equipment relative to the least profitable farms. The most profitable farms actually had the lowest ratio of machinery to total crop costs.

Finally, while farms certainly raised their level of equipment investment over the last several years, the increase in machinery is not out of proportion to other expenses. Machinery costs, as a percentage of other costs, have actually gone down for all farm profitability levels. Likely other factors, like crop mix and farm location, are having some effect and these should be tested.

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Figure 1. Net farm Income by Year for each Farm Quintile

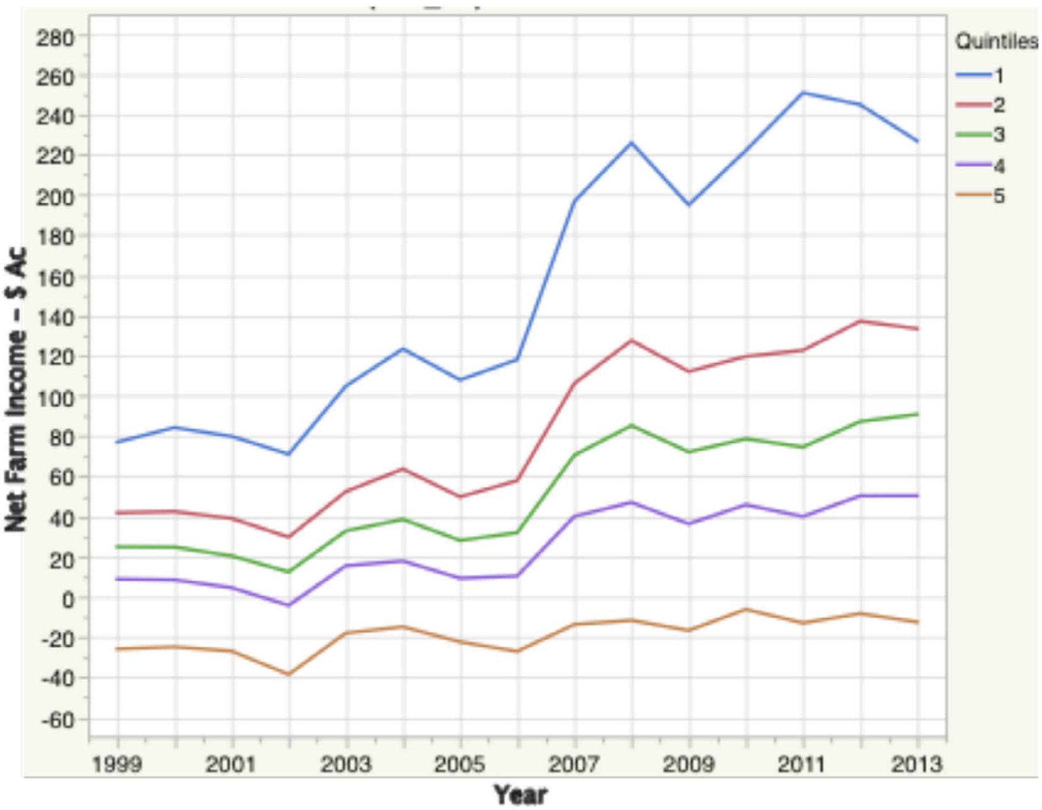

Figure 2. Regression of Net Farm Income per Acre by Farm Size

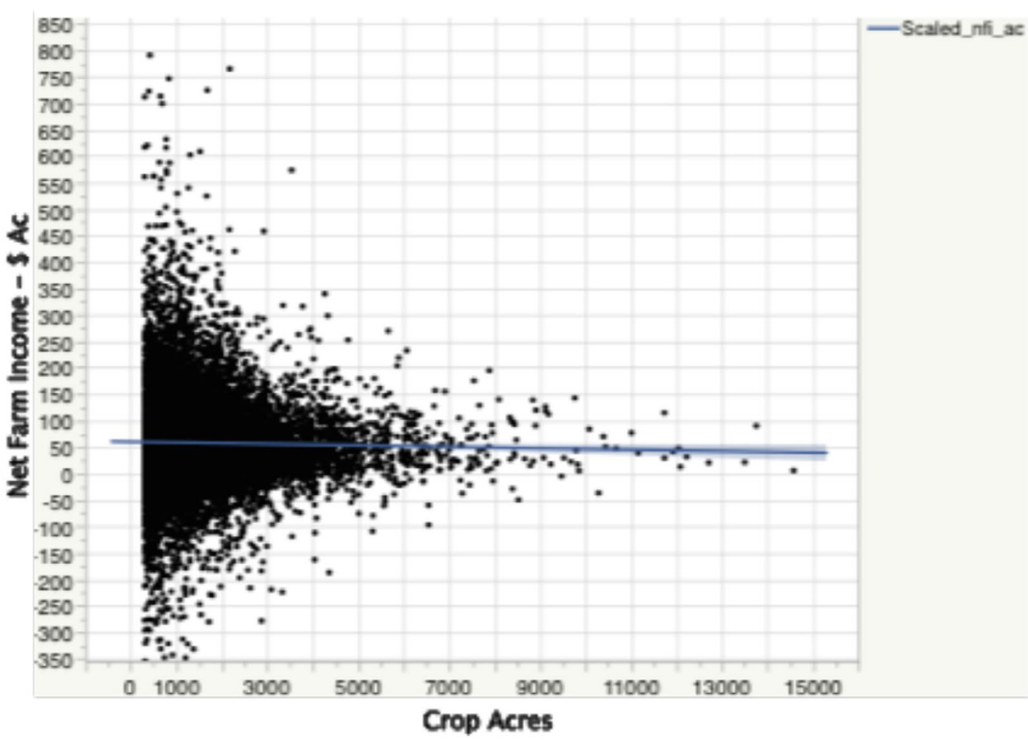

Figure 3. Smoothed Machinery Depreciation per Acre for Different Farm Sizes by Quintiles

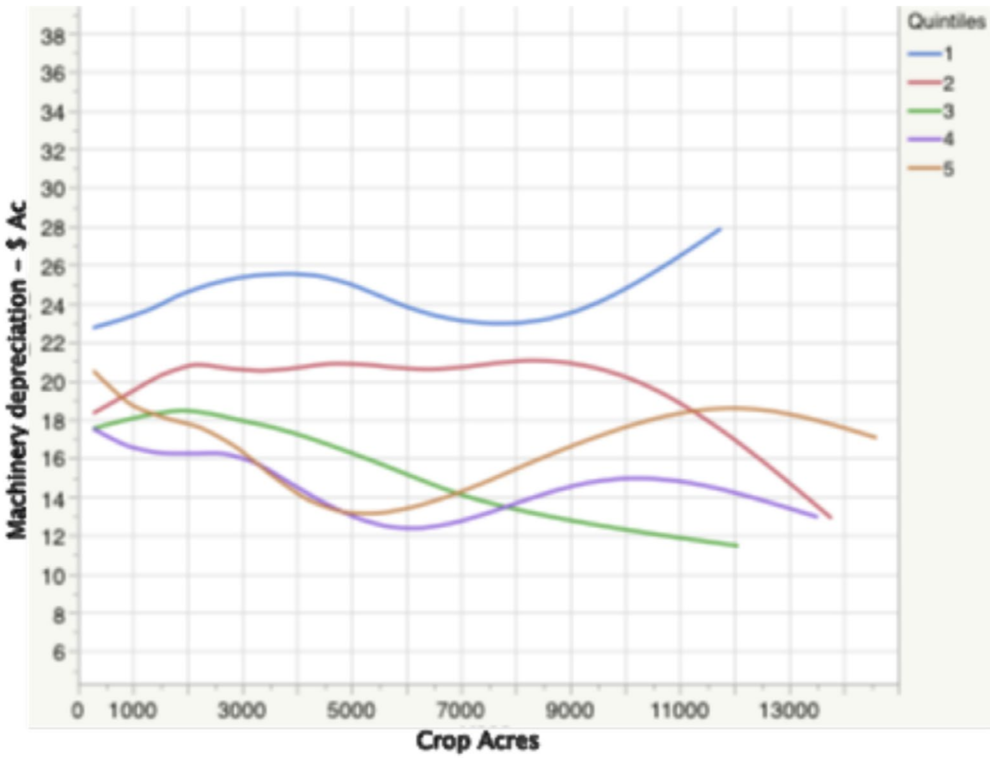

Figure 4. Smoothed Crop Machinery Investment per Acre by Year for the Five Quintiles of Farm Profitability

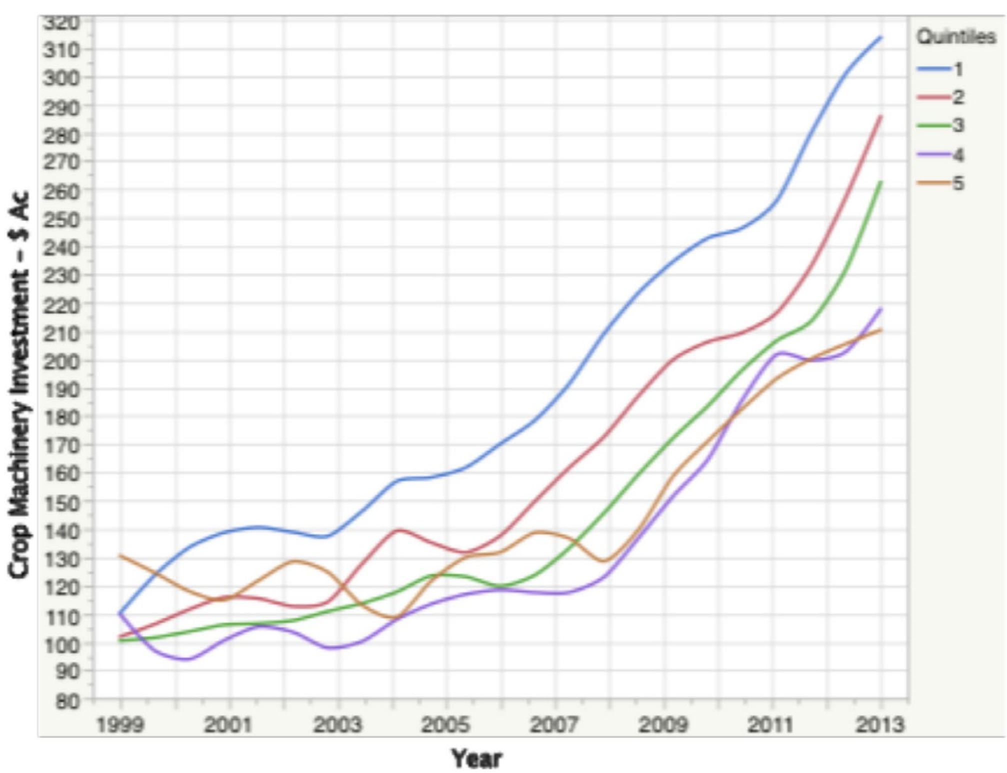

Figure 5. Smoothed Machinery Depreciation per Acre by Year for the Five Quintiles of Farm Profitability

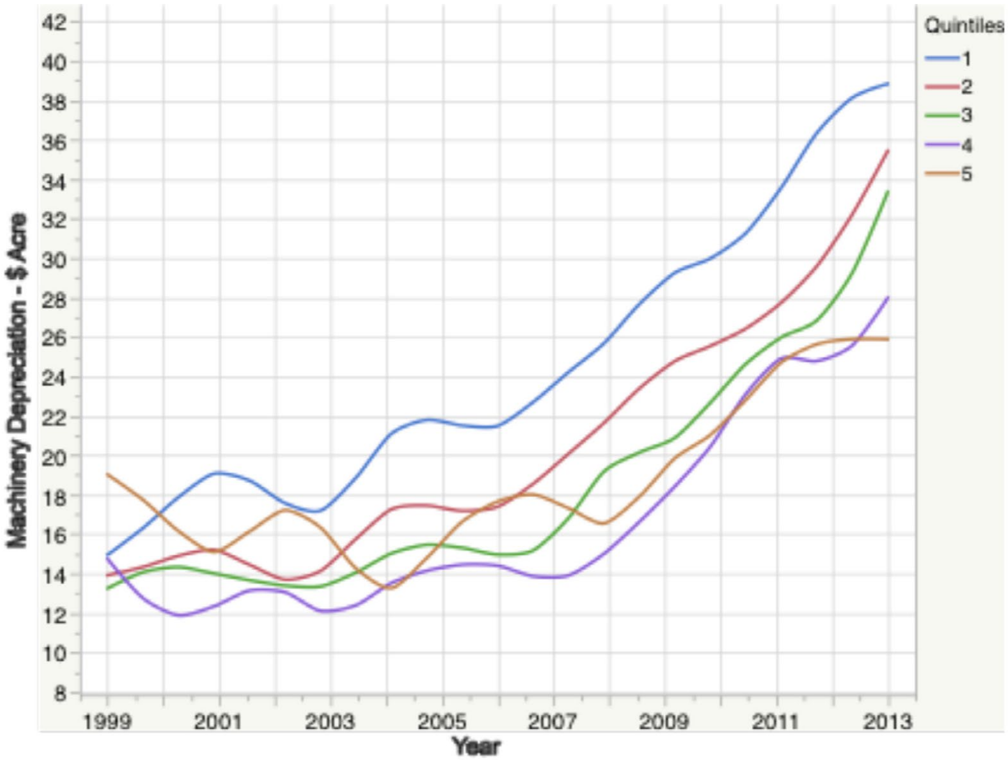

Figure 6. Smoothed Total Crop Production Costs per Acre by Year for the Five Quintiles of Farm Profitability

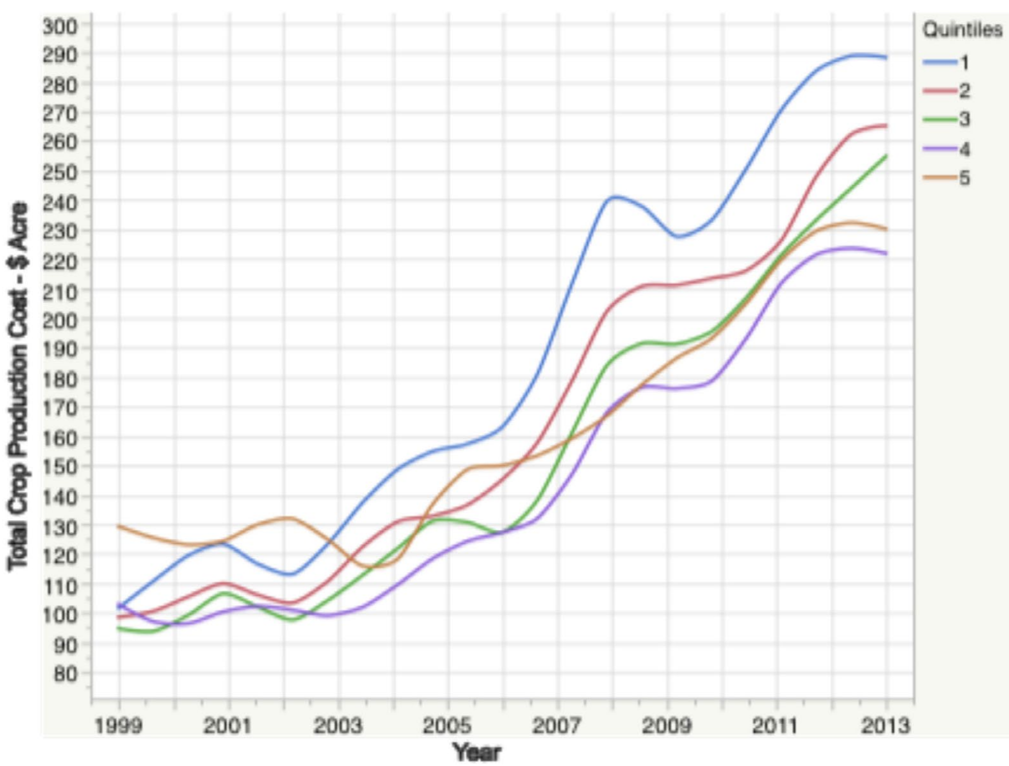

Figure 7. Smoothed Total Crop Machinery Cost per Acre by Year for the Five Quintiles of Farm Profitability

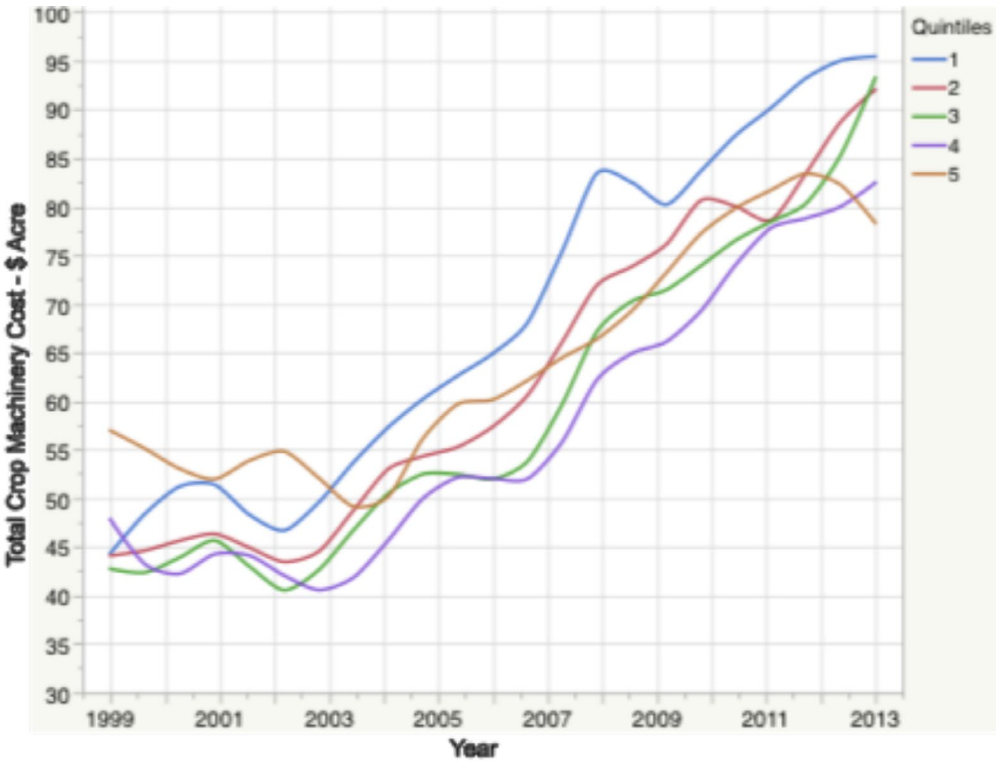

Figure 8. Smoothed Machinery Cost as a Percentage of Total Crop Cost by Year for the Five Quintiles of Farm Profitability

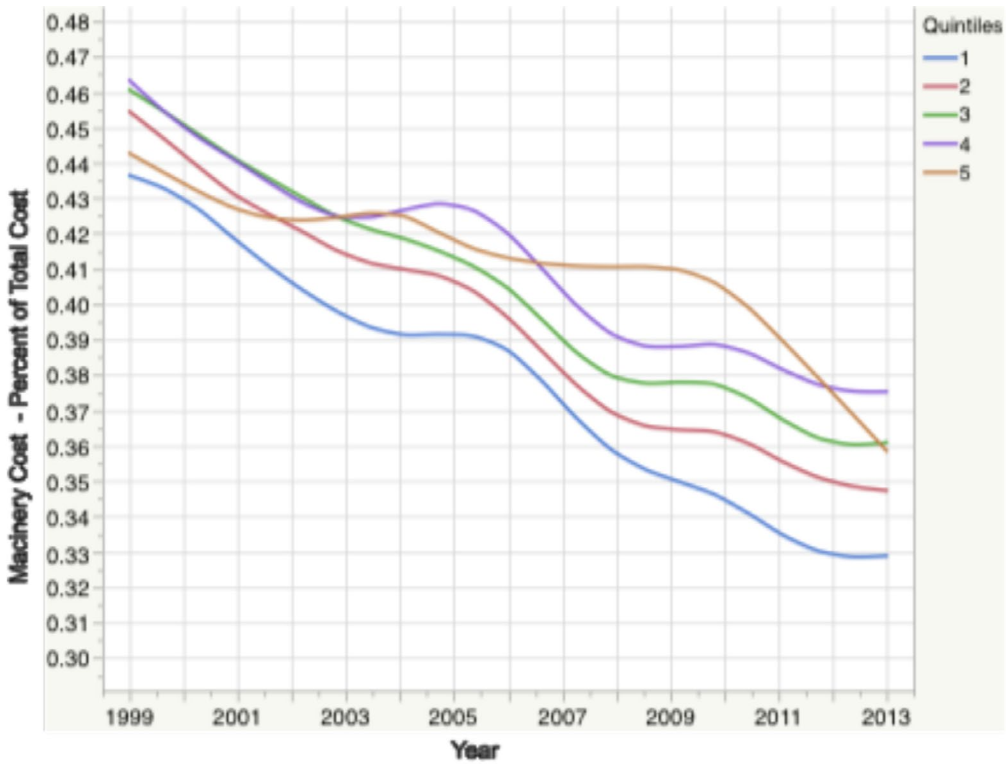

Figure 9. Smoothed Machinery Repair Costs per Acre by Year for the Five Quintiles of Farm Profitability

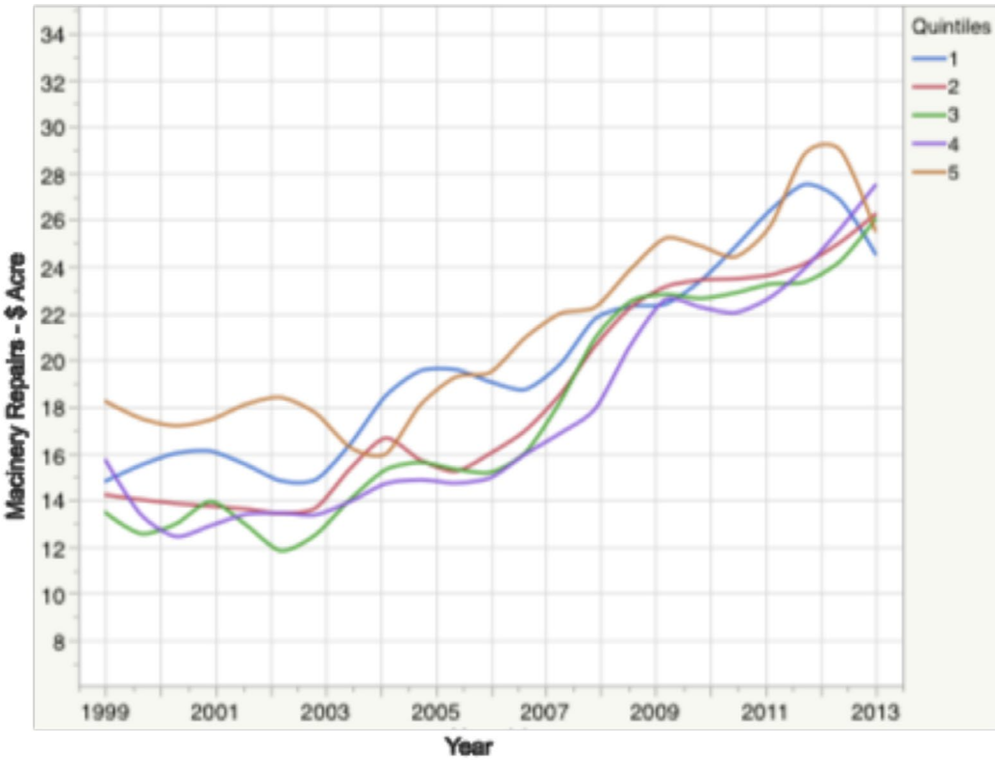

Figure 10. Smoothed Machinery Hire Expense per Acre by Year for the Five Quintiles of Farm Profitability