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Why is Revenue More Variable over the Growing Season in Kansas than Illinois?

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Introduction

This article examines why revenue is more variable over the growing season for Kansas than Illinois farms. Revenue variability is a function of 3 factors: (1) variability of price, (2) variability of yield, and (3) the correlation between changes in price and yield. The analysis finds that variability of yield is the primary factor associated with the higher revenue variability of Kansas farms. The so-called "natural hedge", which is a negative correlation between price and yield, exists but is a much less important factor.

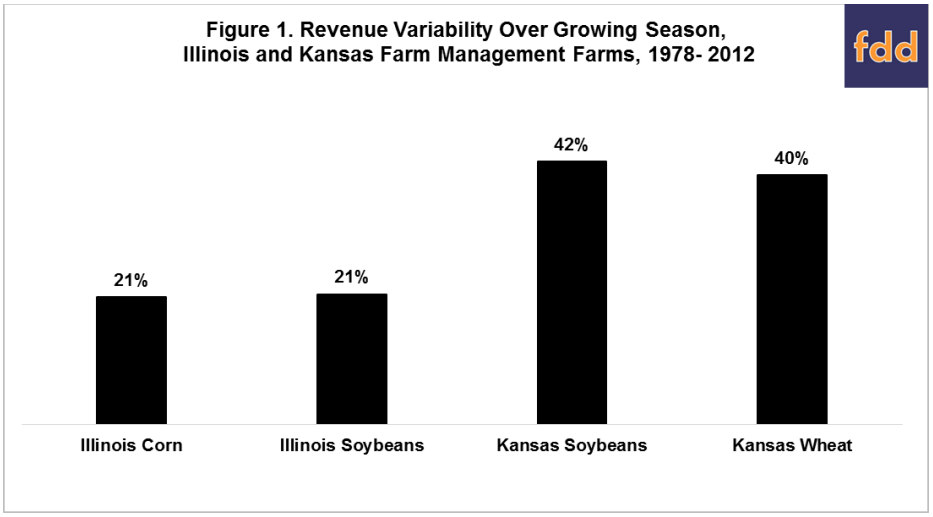
Data and Procedures

Data are available for 185 farm observations as follows: corn in Illinois, 61 farms; soybeans in Illinois, 61 farms; soybeans in Kansas, 28 farms; and wheat in Kansas, 35 farms. Other state-crop combinations have

fewer than 20 farm observations, which is questionable for statistical inferences. Revenue per acre at harvest is calculated as the price during the insurance harvest discovery period times the farm yield per planted acre during the same crop year (see data note 1). Revenue per acre expected prior to planting for the crop year is calculated as the insurance price during the pre-plant price discovery period times the Olympic average of the farm's plant yields for the 5 prior crop years (see data note 2). Percent change in revenue, price, and yield is then calculated. For example, percent change in revenue equals: [(harvest revenue minus pre-plant expected revenue) divided by pre-plant expected revenue]. Variability is measured as the standard deviation of percent changes across the years in the analysis period (see data notes 3 and 4). Insurance prices are from the U.S. Department of Agriculture (USDA), Risk Management Agency and a data set compiled by Art Barnaby of Kansas State University.

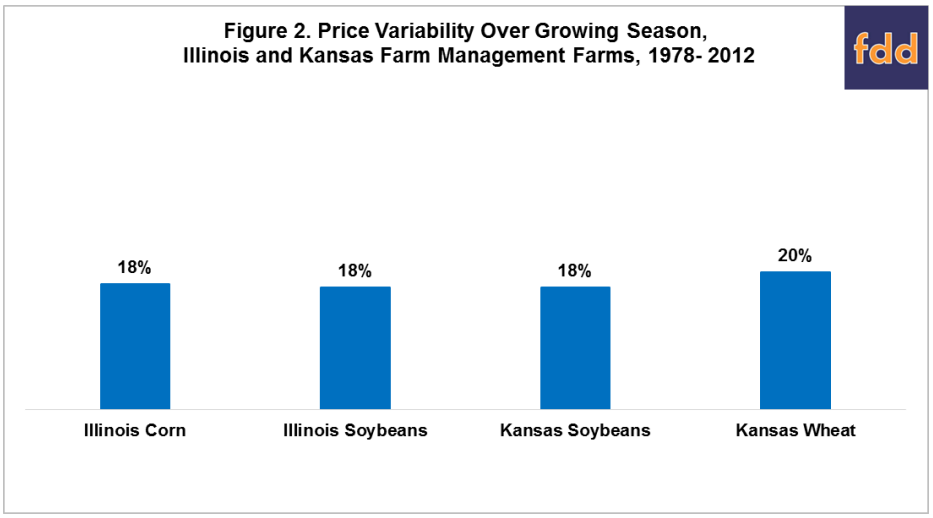
Revenue Variability

Variability of revenue over the growing season averages approximately 40% for the farms in Kansas growing soybeans and wheat, or twice as large as the average revenue variability for Illinois corn and soybeans (see Figure 1). Revenue variability is measured as the standard deviation of the percent changes in revenue between the pre-plant and harvest insurance price discovery periods across the 1978-2012 crop years. Figure 1 in this article presents the same visual as Figure 1 in the *farmdoc daily* article of July 13, 2016. Figure 1 in the July 13 article presents the average percent loss for the years when a loss occurs (see data note 5).



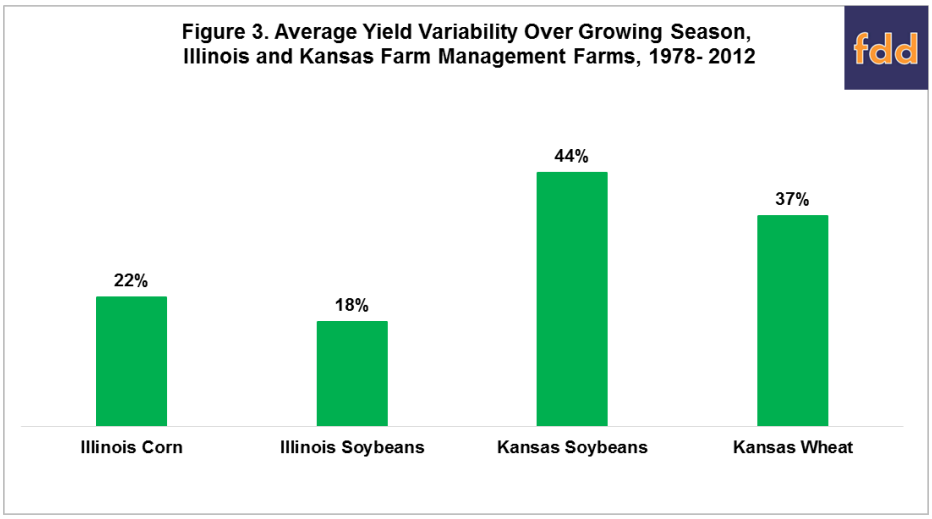
Price Variability

Variability of price over the growing season is nearly identical for all 4 crop-state combinations (see Figure 2). The same price variability is expected for Illinois and Kansas soybeans because the same insurance price discovery periods and Chicago November soybean futures contract are used. The similarity in price variability implies that price variability cannot explain the higher revenue variability for the Kansas crops.



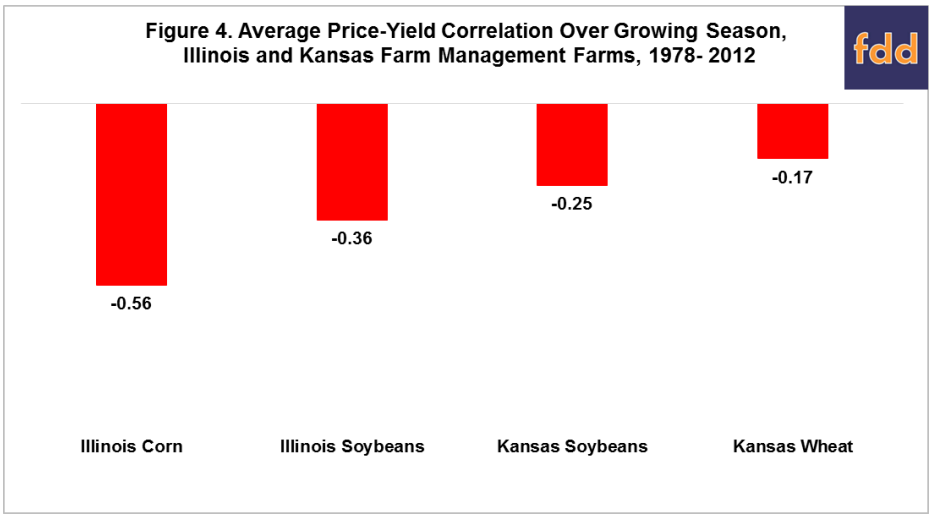
Yield Variability

Variability of yield over the growing season is more than 50% larger for the Kansas crops (see Figure 3). In particular, yield variability of Kansas soybeans is 2.4 times larger than yield variability of Illinois soybeans. Since the same crop is being compared, this difference underscores the likely role that yield variability plays in explaining the higher revenue variability of Kansas crops.



Price-Yield Correlation

A negative price-yield correlation dampens revenue variability because changes in price and changes in yield tend to be in opposite directions. The so-called “natural hedge” that results from a negative price-yield correlation is strongest for the Illinois farms growing corn (see Figure 4). Their average price-yield correlation is -0.56. Moreover, the difference in the natural hedge for Illinois corn vs. Illinois soybeans is greater than the difference in the natural hedge for Illinois soybeans vs. Kansas soybeans. The more negative average price-yield correlation for the Illinois crops is consistent with their lower revenue variability.

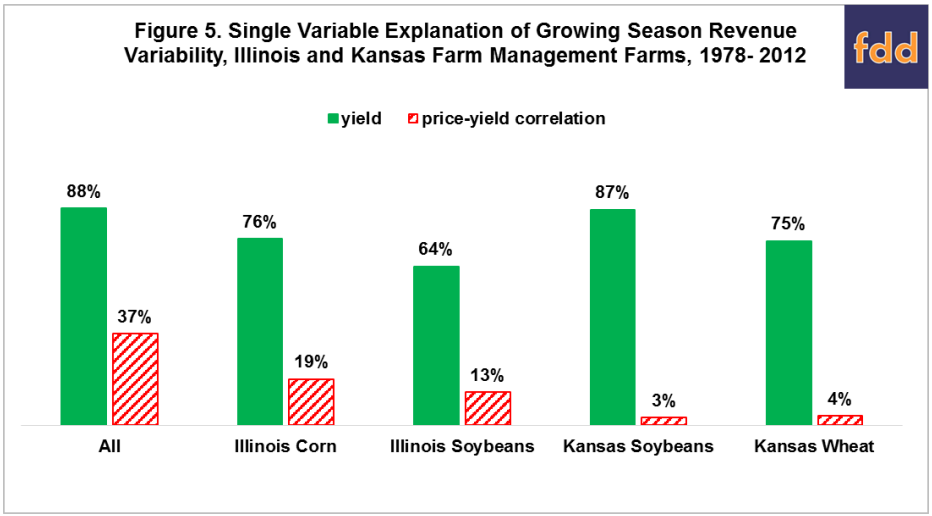


Only 7 of the 185 farm observations have a positive price-yield correlation. All 7 are for Kansas, with 5 for wheat and 2 for soybeans. The highest positive price-yield correlation is for a Kansas farm growing soybeans, +0.15. The most negative price-yield correlation is for an Illinois farm growing corn, -0.76. A total of 56 farm observations have a price-yield correlation that is more negative than -0.50. They were distributed: Illinois corn, 44; Illinois soybeans, 10; and Kansas soybeans, 2. For Illinois corn, 72% of the farm observations (44 of 61) had a price-yield correlation that was more negative than -0.50.

Comparative Explanatory Power

Price variability, yield variability, and price-yield correlation are all significant explanatory variables of revenue variability. The reason is a fundamental mathematical formula. To gain perspective on which

variable is likely to be the most important determinant of revenue variability, explanatory power of price variability, yield variability, and price-yield correlation as a single explanatory variable is examined (see data note 6). Price variability is the same for all farm observations of a given crop-state combination. Thus, it has no ability to explain revenue variability across farms in a given crop-state combination. When all 185 observations are examined, explanatory power of price variability is 19%. In comparison, explanatory power of revenue variability and price-yield correlation is 88% and 37%, respectively (see Figure 5). The finding that price variability has the lowest explanatory power as a single variable when all observations are examined is consistent with the previously discussed similarity of price variability across the 4 crop-state combinations. Similar to the results for all observations, explanatory power is clearly higher for yield variability than for price-yield correlation for each of the crop-state combinations. Explanatory power of price-yield correlation is higher for the Illinois than Kansas crops.



Summary Observations

- Before discussing the summary observations, it is important to note that growing season losses are likely to be smaller for the farms in this study since they have survived as farms since 1973. It is difficult if not impossible to know the magnitude of this bias. Its importance is likely reduced in this analysis because it compares crop farms in Illinois and Kansas. It seems reasonable that many of the impacts associated with long term survival are likely to be similar for Illinois and Kansas crop farms. Nevertheless, this data issue should be kept in mind.
- Revenue variability over the growing season is twice as high for soybeans and wheat on Kansas farms as for soybeans and corn on Illinois farms.
- Yield variability over the growing season is higher for the Kansas than Illinois crops. In particular, yield variability is 2.4 times larger for Kansas soybeans than for Illinois soybeans.
- The correlation between price and yield changes over the growing season is negative for farms in all 4 crop-state combinations. This so-called natural hedge dampens revenue variability. The natural hedge is higher for the Illinois crops, especially Illinois corn.
- Higher yield variability and a smaller natural hedge (negative price-yield correlation closer to 0) both help explain the higher revenue variability over the growing season for Kansas crops.
- Single variable regression results imply that yield variability is likely more important than the natural hedge in explaining the higher revenue variability of the Kansas than Illinois crops.
- Regression results also imply a more prominent role for yield variability than the natural hedge in explaining variation in revenue variability across farms for the same crop in a state.
- These findings suggest that reducing yield variability is critical to reducing revenue variability for both individual farms and the U.S. farm sector as a whole. The emphasis on crop insurance as a risk management tool should not detract from the important roles new production technology and the effective management of this technology plays in reducing farm level risk.

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References and Data Sources

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Data Notes

1. Crop insurance prices were collected for the state-crop combination.
2. An Olympic average removes the low and high values before calculating the average.
3. Since a 5 year Olympic average is used to measure projected yield, variability of yield cannot be calculated for the first 5 years, 1973-1977. Hence, the number of observations is 35, not 40.
4. Findings are similar when projected yield is measured as a trend yield for the crop year based on a linear regression of planted yields between 1973 and 2012.
5. A third *farmdoc daily* article that utilizes the same data as used in these 2 articles appeared on July 21, 2016. It was titled, “County-Farm Loss Basis: Evidence from Illinois and Kansas Farm Management Data.”
6. Explanatory power is the square of the correlation coefficient between 2 variables, in this case revenue variability with, separately, price variability, yield variability, and price-yield correlation.