Measuring Systematic Risk for Crop and Livestock Producers

Todd H. Kuethe, J. Todd Hubbs, Timothy G. Baker, and Bruce Erickson

Much has been said about risk in agriculture in recent months, as unprecedented price fluctuations in both input and outputs have producers looking for ways to protect themselves. It is common to think of risk in terms of variability in revenue, which reflects price and production risk. While revenue variability of a given commodity is a good place to start, part of this risk is mitigated because farmers often have some diversity of enterprises—more than one crop, and sometimes also livestock. There is, however, a remaining level of risk which cannot be diversified away, and this non-diversifiable risk is called systematic risk.

Our measurement of systematic risk in agriculture borrows from the field of finance where systematic risk is defined as the part of a security’s risk which is common to all securities and thus cannot be eliminated through portfolio diversification. Systematic risk in production agriculture could be viewed similarly using a commodities portfolio. These systematic risks are often the result of economy-wide shocks which affect agricultural producers in the form of exchange rates, recessions, energy price shocks, and policy interventions, such as Farm Bill legislation. Modeling systematic risk may provide useful information on the potential effects of the current economy on U.S. agricultural producers.

Modeling Systematic Risk

In finance beta is a measure of a stock's volatility in relation to the market. By definition the market has a beta of 1, and individual stocks are rated according to how much they deviate from the market. A stock that swings more than the market over time has a beta above 1; if a stock moves less than the market overall, the stock's beta is less than 1.

Beta values for five major commodities: corn, soybeans, wheat, cattle, and hogs, were measured using returns from annual state-wide cash receipts for each commodity obtained from the USDA for Iowa, Illinois, and Indiana. Cash receipts represent the quantity sold times the price received for all producers in the state for a given year. We selected the Reuters-CRB Index (CCI) to represent a well diversified commodities portfolio. The CCI averages prices across a number of agricultural, metal, and energy commodities. All data were collected annually for the period 1958 – 2007.

Historic Patterns of Systematic Risk

The five figures that follow portray the calculated beta values. Figure 6 portrays both beta and the variance of the commodities index itself. In each graph shaded areas represent recession periods, defined as a reduction in the United States gross domestic product (GDP) for at least two consecutive quarters. Vertical lines indicate farm bill legislation. The vertical dashed line represents the end of the Bretton Woods Accord in 1973. At that time currencies of many of the world’s major economies were no longer pegged to the U.S. dollar, thus allowing exchange rates to vary. In addition, United States terminated convertibility of dollars to gold in 1973.
Figures 1-3. Dynamic beta values for corn, soybeans, and wheat. These graphics show how corn, soybean, and wheat prices have fluctuated compared to other commodities. In each graph shaded areas represent recession periods, vertical lines indicate farm bill legislation, and the vertical dashed line represents the end of the Bretton Woods Accord in 1973.
Figures 4 and 5. Dynamic beta values for cattle and hogs. These graphics show how cattle and hog prices have fluctuated compared to other commodities. In each graph shaded areas represent recession periods, vertical lines indicate farm bill legislation, and the vertical dashed line represents the end of the Bretton Woods Accord in 1973.

Figure 6. Systematic Risk in U.S. Agriculture for several commodities. Units are normalized to 1967 revenues, and account for both beta and the variance of the commodities index itself.
When comparing the beta values for the five commodities, it is interesting to note that corn and soybeans show an upward trend over the last 50 years, but any trends are less obvious for wheat. Livestock betas are lower than for corn, soybeans, or wheat. And, the corn and soybean betas calculated for Iowa tend to be higher than for Illinois or Indiana.

Figure 6 accounts for both beta and the variance of the commodities index itself. These findings provide evidence that systematic risk levels vary substantially over time, and provide a number of insights for agricultural producers and policy makers:

**More Risk Under Variable Exchange Rates** Systematic risk levels have been higher and have changed much more year-to-year after the end of the Bretton Woods accord in 1973. These events drastically altered international exchange rates and mark one the largest macroeconomic changes since the end of World War II.

**Less for Livestock than Crops** When comparing across commodities it is interesting to note that the levels of systematic risk for cattle and hogs are consistently lower and less volatile than for corn and soybeans. However, all five commodities follow the same general pattern in response to economic conditions. Also, the order of systematic risk from greatest to smallest of soybeans, corn, wheat, hogs, and cattle is consistent throughout the time period.

**Not Tied to Recessions** Recessionary periods do not show a consistent effect on the levels of systematic risk. For example, during the recession of the early 1970’s systematic risk declined for each of the five commodities, while risk levels increased for all five commodities during the recession of the early 1990’s.

**No Consistent Effect from Farm Bill Legislation** The farm bill is the primary agricultural and food policy tool of the federal government, and has sector and economy-wide effects related to international trade, environmental preservation, food safety, and rural prosperity. However, the relationship between farm bills and changes in systematic risk is not consistent and the lowest levels of risk do not correspond in any obvious way to newly-introduced farm legislation.

**Systematic Risk Increasing Rapidly Since 2002** Systematic risk has increased rapidly since 2002 for all commodities, reaching record highs for both corn and soybeans. This indicates that agricultural producers are bearing heightened levels of risk which cannot be controlled through agricultural diversification.

**Conclusions**

In assessing the systematic risk of a commodity, this study finds great variation in betas for corn, soybeans, wheat, cattle and hogs over time calculated against a commodity index. Since 2002, systematic risk is expanding for all commodities, but the impact on corn is especially pronounced. Corn, soybean, and wheat systematic risk peaked in the early 1970s and these levels were only exceeded in the final two years for corn and soybeans. Cattle and hog systematic risk is relatively low throughout the period in comparison to corn, soybeans and wheat.
For More Information

The full scientific paper of this analysis will be presented at the 2009 NCCC-134 USDA CSREES regional committee for Applied Commodity Price Analysis, Forecasting, and Market Risk Management in April, 2009. After its presentation, it will be posted on their web site, available at: http://www.farmdoc.uiuc.edu/nccc134/paperarchive.html