Cross Hedging Grain Sorghum in Missouri

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Annually between 1994 and 1998 over 400,000 acres of grain sorghum have been harvested in Missouri with an average yield of 86/bushels/acre. The average value of production during this period was over $90 million. Grain sorghum (milo) is an important crop for some Missouri producers. Many sorghum producers also produce corn, soybean, or wheat. Each of these commodities has an actively traded futures market where producers can hedge all or a portion of their production. There is no futures market for sorghum (milo). Thus, producers of sorghum may seek to produce alternative crops for which they can hedge. Hedging is defined by Purcell (p. 354) as, "the establishing of a position in the futures market that is equal and opposite the position, or intended position, in the cash market with an objective of transferring cash price risk to someone else." Hedging is for cash commodities that have active futures markets. However, sorghum producers can cross hedge sorghum production. Cross hedging is the process of hedging a cash commodity in the futures market of a different, but related, commodity. Some of the explanation below was taken verbatim after obtaining permission from Graff et al.

Cross hedging will generally work well for reducing price risk if (1) the price of the commodity being cross hedged and the price of the futures commodity are closely related and follow one another in a predictable manner, meaning hedged price risk is less than unhedged price risk and (2) large enough quantities are being traded to meet cross hedged futures contract size specifications. Cross hedge price risk refers to the price actually received by hedging relative to what was expected, and unhedged price risk refers to general price level variability.

The focus of this fact sheet is to introduce the concept of cross hedging and to recommend strategies for cross hedgers of grain sorghum. These techniques are applicable to both long hedgers wanting to reduce input price risk and short hedgers trying to set selling prices. They can be applied to marketing strategies involving either futures or options markets.

Cross Hedging Issues

The corn futures contract is used for cross hedging grain sorghum because milo prices follow corn prices closely, as they are substitutes in feed rations. The prices of grain sorghum and corn tend to move in similar patterns because individuals purchase the underpriced commodity or sell the overpriced commodity. For example, hog producers will substitute sorghum for corn and vice-versa depending upon the corn price relative to the sorghum price. This substitution causes the two prices to converge toward each other, creating a relatively stable price relationship.

When hedging corn using corn futures, the general recommendation is to use one 5,000-bushel contract for each 5,000 bushels of corn to be hedged. However, when cross hedging grain sorghum in corn futures, the one-to-one relationship is not necessarily the optimal futures-to-cash hedge ratio. It may be less risky to take a larger or smaller
position in the futures market than the cash market position being hedged depending on the price relationship between corn and sorghum.

Determining the Hedge Ratio

Determining the size of the futures position to take requires calculating a cross hedge ratio. The cross hedge ratio is found by estimating the relationship between the corn futures price and the cash grain sorghum price according to the following equation:

$$\text{Expected Cash Price} = \beta_0 + \beta_1 \text{ (Futures Price)}$$ (1)

where $\beta_0$ is the intercept or expected basis and $\beta_1$ is the cross hedge ratio. This equation identifies the historical relationship between the corn futures price and cash grain sorghum price and allows the hedger to determine the grain sorghum cash price that could be expected by cross hedging with corn futures.

The cross hedge ratio ($\beta_1$) is the corn futures contract quantity position divided by the grain sorghum cash market quantity being hedged. It is also an estimate of the relative price change between the corn futures market and the sorghum cash market. A hedge ratio of 1.0 implies a one-for-one hedge where for every $1 per bushel change in the corn futures price, the grain sorghum cash price changes by $1 per cwt. A hedge ratio of 1.5 implies that for each $1 per bushel change in the corn futures price, the grain sorghum cash price changes by $1.50 per cwt. A hedge ratio of 0.8 implies that for each $1 per bushel change in the corn futures price, the grain sorghum cash price changes by 80 cents per cwt.

The cross hedge ratio ($\beta_1$) also indicates that the futures contract of 5,000 bushels of No. 2 Yellow Corn is the hedge ratio ($\beta_1$) times the cwt of cash grain sorghum being hedged. The following equation is used with the corn futures contract specification to calculate the approximate amount of cash grain sorghum to hedge.

$$\text{Cash Quantity Hedged} = \frac{\text{Futures contract quantity}}{\beta_1}$$ (2)

In this equation, $\beta_1$ is the hedge ratio. The Futures contract quantity is the bushel amount per futures contract. For example, a No. 2 Yellow Corn contract on the Chicago Board of Trade (CBOT) is 5,000 bushels. Cash quantity hedged is the cwt of cash grain sorghum hedged per futures contract.

Location may create differences in hedge ratios and expected basis patterns. For instance, grain sorghum at Macon will not have the same hedge ratio and basis behavior as grain sorghum at Charleston because local supply and demand conditions differ (Figure 1). Many of the hedge ratios and expected basis levels for the cross hedging examples in this fact sheet have been calculated based on specific sites in Missouri, therefore the estimates provided may not be representative of other locations.

Cross Hedging Risk

Several statistics help measure the risk of a proposed cross hedge. The R-square, resulting from the estimation of equation 1, is the proportion of total variability in the
dependent variable (grain sorghum cash price) explained by the independent variable (corn futures price). An R-square value of 0.91 means 91 percent of the variation in cash grain sorghum price is explained by the corn futures price. The higher the R-square, the stronger the relationship between the two commodities and the less risk the cross hedge will involve. An R-square value of 1.0 implies a perfect correlation between the dependent and independent variables.

Another statistic used to measure cross hedging risk is the Root Mean Squared Percentage Error (RMSPE), which is the Root Mean Squared Error (RMSE) as a percentage of the respective commodity’s average cash price. The RMSPE is a relative measure of the dispersion of the cash prices from their expected values for a given futures price. The more dispersed the cash prices are from their expected given futures prices, the greater the RMSPE and the poorer the fit of the regression equation.

An RMSPE value of zero implies a perfect relationship between the dependent (cash grain sorghum price) and independent variable (corn futures price). As the RMSPE increase, the cross hedge risk increases. An RMSPE value of 10 percent can be interpreted to mean that 68 percent of the time the hedged cash price would be expected to lie within 10 percent of the expected cash price. Generally, as the R-squared values increase, the RMSPE values decrease.

Data Used

Weekly price data were used for all analyses. Cash price data were gathered from several Missouri locations between 1993 and 1999 (DTN AgDayta). Locations used for this study were Lamar, Charleston, Macon, St. Louis, Kansas City, and Hannibal. These locations were selected based on geographical dispersion and location to major river terminals. Futures prices used were for the nearby futures contract (Bridge). The futures contract was rolled to the next contract at the end of the previous month before it expired. For example, during February, the corn futures price was from the March contract; however, for the first week of March the corn futures price rolled to the May contract.

Grain Sorghum Cross Hedging Ratios for Missouri

This section explores cross hedging milo in corn futures for several Missouri locations. Hedging risk (basis plus hedge ratio) can be evaluated by the R-squares and RMSPEs reported in Table 1. R-square values close to 1.0 and RMSPE values close to zero indicate milo price is highly correlated with the corn futures price and basis risk is low. Locations with relatively high R-squares and low RMSPEs, such as Kansas City, have lower risk associated with hedging milo in corn futures. Although the R-square values are consistently close to 1.0 across all contracts and locations, the RMSPE values vary from 2.54 percent to 12.60 percent, indicating there is risk associated with the cross hedge.

An example of cross hedging milo in corn futures would work as follows. A milo grower in Macon, Missouri, wants to reduce price risk by hedging the selling price of milo using the December CBOT Corn futures contract. Given a December contract futures price for corn of $2.53 per bushel in March, referring to Table 1, the hedge ratio and expected basis (intercept) for Macon are $2.04 and –$1.49, respectively. Using equation 1, the expected milo cash price would be $3.68/cwt (-$1.48 + 2.04 X $2.53/bu). The amount to hedge can be found using equation 2. One December CBOT Corn
A contract represents 5,000 bushels, and using the hedge ratio of 2.04, the quantity of milo hedged per contract would be approximately 2,450 cwt (5,000 ÷ 2.04).

An alternative method that uses this same information to graphically illustrate the expected hedged price is shown in Figure 2. Weekly Charleston cash milo prices during July and August were plotted against weekly September corn futures prices and an estimated line was fit through these points. To determine the expected cash price, move vertically from the futures price, on the horizontal axis, to the fitted line. Then, move horizontally to the associated cash price on the vertical axis. This is the expected cash price for milo given the corn futures price. The more dispersed the actual prices are around the line, the more risk the cross hedger faces that the expected and realized cross hedged prices will not be the same.

Using the corn futures price of $3.25 per bushel (point A), and moving vertically to the fitted line (point B), and horizontally to the cash price (point C), the expected cash price approximately $5.50 per cwt. The hedge ratio is the slope of the fitted line, 1.55, interpreted to mean that an increase in corn futures price of $1 per bushel typically results in a cash milo price increase of about $1.55 per cwt.

The graphical method of estimating the hedge ratio and expected basis is rough and is provided merely to show the regression in an illustration, which helps to establish the expected cash price. The dispersion of the actual points around the line provides an indication of how dependable or risky the cross hedge is. Actual points dispersed far from the line suggest more hedging risk (basis and hedge ratio variability) than actual prices close to the fitted line.

References:


DTN AgDayta. “Cash Grain Sorghum Prices.” Obtained via use agreement, Fall 1999.


Table 1. Cross Hedging Estimates for Hedging Milo at Various Missouri Locations in Corn Futures, January 1993 through December 1999.

<table>
<thead>
<tr>
<th>Location/ Corn futures month</th>
<th>Hedge ratio( (B_1) )</th>
<th>Intercept ( (B_0) )</th>
<th>RMSPE**</th>
<th>R-square</th>
<th>Milo cwt. hedged per 5,000-bu corn contract</th>
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* Milo prices are given in $/cwt and corn futures prices are given in $/bu.
**RMSPE is a root mean squared percentage error, which is RMSE as a percentage of the respective average milo price.
Figure 1. Weekly Grain Sorghum Cash Price for Charleston and Macon between January 1993 and December 1999.

![Graph showing weekly grain sorghum cash price for Charleston and Macon between January 1993 and December 1999.]

Figure 2. Charleston Grain Sorghum Cash Price against September Corn Futures Price, July 1993 through August 1999.

![Graph showing the relationship between Charleston grain sorghum cash price and September corn futures price.]

- Actual Sorghum Price
- Predicted Sorghum Price from Cross Hedge Ratio