NCCC-134
APPLIED COMMODITY PRICE ANALYSIS, FORECASTING AND MARKET RISK MANAGEMENT

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Suggested citation format:

McKenzie, A., and N. Singh. 2008. "Hedging Effectiveness around USDA Crop Reports." Proceedings of the NCCC-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management. St. Louis, MO. [http://www.farmdoc.uiuc.edu/nccc134].

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*Paper presented at the NCCC-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management
St. Louis, Missouri, April 21-22, 2008*

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Hedging Effectiveness around USDA Crop Reports

It is well documented that "unanticipated" information contained in USDA crop reports induces large price reactions in corn and soybean markets. Thus, a natural question that arises from this literature is: To what extent are futures hedges able to remove or reduce increased price risk around report release dates? This paper addresses this question by simulating daily futures returns, daily cash returns and daily hedged returns around report release dates for two storable commodities (corn and soybeans) in two market settings (North Central Illinois and Memphis Tennessee). Various risk measures, including "Value at Risk," are used to determine hedging effectiveness, and "Analysis of Variance" is used to uncover the underlying factors that contribute to hedging effectiveness.

Keywords: USDA Crop Reports, Storage Hedging, Value At Risk, Analysis of Variance.

Introduction

Futures markets have two primary functions in agricultural commodity markets: (1) a price discovery role and (2) a price risk management role. In order to perform the price discovery role futures markets require fundamental supply and demand information. One of the most important sources of information futures traders and market agents use to appraise the balance of supply and demand of agricultural commodities are USDA reports. Recent research has shown that corn and soybean futures prices continue to react to the release of new information contained in USDA crop reports (Good and Irwin). In addition, Milonas found that the release of crop reports resulted in significant cash price responses for these same markets. Given that both futures and cash prices react significantly to the release of USDA report information, there is potential price risk associated with storing commodities when reports are released. Futures hedging effectiveness to reduce this price risk is determined by co-movements (correlations) in cash and futures prices. If movements in cash and futures prices are highly correlated and basis (defined as the difference between cash and futures price) is stable, hedging will be effective. However, if reports illicit different price responses (in terms of magnitude and speed of adjustment) in futures and cash markets, then basis will become more volatile and hedging effectiveness will be compromised. In particular cash price reactions and hence hedging effectiveness may differ substantially across regions. For example, hedging performance around report release dates may be significantly worse for mid-south (deficit) grain markets, which typically experience wider and more volatile basis levels than their mid-west (surplus) counterparts.

Hedging effectiveness around USDA reports has important implications for producers, grain elevators, and other agribusiness firms who store, buy or sell grain around USDA crop report announcements. This paper will shed light on issues such as: What marketing strategy should be employed in the presence of USDA report induced event risk? And what potential losses might a firm storing, buying or selling grain around report announcements incur? These questions are of paramount importance for agribusiness firms who regularly trade and store cash grain around report announcement dates. For example, elevators store grain throughout the crop year and are susceptible to large losses when “news” leads to big price swings and hence negatively impacts their cash positions. If the standard storage hedge does not reduce efficiently the risk of returns around the event dates, a grain holder or trader will choose an alternative strategy, or simply stay in the cash only position. Similarly feed-mills and poultry firms are often forced to purchase grain to feed and supply livestock irrespective of market conditions, and are hence vulnerable to large price moves resulting from the release of USDA reports “news”.

In sum, the main objective of this paper is to examine futures hedging effectiveness around USDA crop reports. Hedging effectiveness is analyzed with respect to two storable commodities (corn and soybeans) in two market settings (North Central Illinois and Memphis Tennessee) for an eleven day event window surrounding report release dates. Specifically, Value at Risk (VAR) is used to quantify and compare price risk for hedged versus un-hedged cash positions. VAR levels derived from simulated short-futures hedging returns, cash returns and speculative short-futures returns, are then examined using Analysis of Variance (ANOVA) to uncover underlying factors that contribute to hedging effectiveness.

Data

The release dates of the USDA *Crop Production* reports were gathered from the National Agricultural Statistics Service (NASS)[1]. The monthly *Crop Production* reports are the most important and most widely anticipated releases of government-based estimates of forthcoming harvest production. These reports are issued around the 10th of each month and they estimate by state: the acreage, yields and production of various crops. For corn and soybeans, production reports are released in August, September, October, November and the final estimates are published in January. This paper examines daily cash and closing futures price (return) movements around reports released in August, September, October and November for the period from August 1992 through November 2006, yielding 60 historical events and 660 event window observations in total. Daily closing Chicago Board of Trade (CBOT) futures prices for nearby contracts (i.e. contracts that were nearest to maturity as of report release dates[2]) were obtained from Bridge Commodity Research Bureau. Nearby contracts are most actively traded by grain merchandisers for hedging purposes. Cash price data utilized in this study are corn and soybean prices from two local markets (spot markets). Spot (average elevator bid prices) prices were obtained from the USDA Agricultural Marketing Service (AMS) for Memphis, Tennessee, and North Central Illinois. Cash prices in surplus areas with excess supplies (e.g. North Central Illinois) are typically at the lower level than those in deficit areas which grow less bushels of grain and have a higher concentration of users (e.g. Memphis).

Modeling Approach

Value at Risk (VAR) is an easy-to-understand tool for evaluating and managing market risks. VAR uses standard statistical techniques to determine the worst expected loss over a given time interval, under normal market conditions, at a given confidence level (Jorion). Value at risk provides users with a summary measure of potential market risk. It is a risk management concept by which traders at the market can be informed, via single number, of the short term risk of potential losses. VAR has lately become one of the financial industry’s standards for measuring exposure to financial price risk. Today, few financial companies fail to set VAR as part of their daily reporting routine and a growing number of large agribusiness firms (e.g. Tyson Foods) employ VAR as a risk measure of the portfolio of their commodity inputs and outputs.

There are several accepted methods to compute VAR. In this study we used Monte Carlo simulation approach. To this end historical cash (North Central Illinois and Memphis) and futures returns were first calculated for the eleven day event window surrounding report release dates. More specifically, prices were taken: 6 days before announcement, starting from the day t=-6 to day t=-1, and 6 days after announcement, from day t=0 to day t=5. It was determined that using 6 days prior to the release of the report and 6 days after the release should allow enough time for market traders to form positions and for prices to accurately adjust to the new information contained in the report. Using more trading days could potentially lead to the problem of other information influencing the trading decisions and decreasing the ability to measure the response of the market to the event in question. Day t=0 represents the first trading day after the new information in the report was released, and day t=-1 the last trading day before the report was released.

Daily cash return for commodity i in market j during period t (CR_{ijt}) was calculated as the percentage change between price in period t and price in period t-1.

(1) $$CR_{ijt} = \ln(CP_{ijt} / CP_{ijt-1}) \times 100$$

where: CP_{ijt} - is the cash price for commodity i in market j, and t represents the day – in event time – around the report's release that can take value from t=-5 to t=5.

Similarly, daily short-futures return for commodity i during period t (FR_{it}) was calculated as the percentage change between price in period t and price in period t-1.

(2) $$FR_{it} = \ln(FP_{it} / FP_{it-1}) \times -100$$

where: FP_{it} is the futures price for commodity i , and t represents the day – in event time – around the report's release that can take value from t=-5 to t=5. "Short-futures" position implies that a trader has initially sold futures contracts and will earn a positive return if prices fall the following day. This is why the term $\ln(FP_t / FP_{t-1})$ is multiplied by (-100).

Diagnostic tests indicate the returns for each cash price series CR_{ijt} (separately identified by commodity, location and event time) and futures returns FR_{it} are stochastic and not serially correlated, but that historical distributions of Memphis corn and soybean cash returns for certain days within the event window and in particular for day t=0 (the first trading day after the new information in the report was released) are leptokurtic (distribution is peaked with fat tails). In other words both small and large price changes are more likely – than under the assumption of normally distributed returns – following report release. To a lesser extent small departures from normality were also observed for North Central Illinois cash returns and futures returns for certain days across the event window. To accommodate this finding and to account for the higher than "normal" possibility of extreme price changes, simulated cash and futures returns CR_{ijt}^{s} and FR_{it}^{s} are generated by drawing 1000 iterations from a Multivariate Empirical distribution (MVE), where the shape of this distribution is defined by the historical return data. For comparison purposes simulated cash and futures returns are also generated by drawing 1000 iterations from a Multivariate Normal distribution (MVN) with the first two moments estimated from the historical returns series. Simulations using both the MVE and MVN maintain and impose historical correlation structure between CR_{ijt} and FR_{it}. Simulated daily short-futures hedged returns HR^{s}_{ijt} are then simply the arithmetic sum of CR_{ijt} and FR_{it}.

(3) $HR_{ijt} = CR_{ijt} + FR_{it}$

Where it is assumed hedgers match the size of cash positions (in terms of quantity of bushels) with equal sized futures positions[3].

All simulated returns were then ranked from the most negative (lowest) to the most positive (highest) value. In this study we were interested in the risk of return measure at the 95% and 99% confidence levels. This practically means that for the 95 % confidence level VAR is the 50^{th} worst outcome out of 1,000 simulated outcomes (Fig. 1). The VAR at the 99% confidence is the 10^{th} worst realized return out of 1,000 simulated returns. These represent the possible losses that will be exceeded only 5% of the time and 1% of the time, respectively. Thus, these VAR measures provides us with a risk assessment of cash (un-hedged storage positions) against short-futures hedged positions for two commodities, two market locations, and across each day in the event window.

Analysis of Variance

In this study Analysis of Variance models were used to quantify the relative influence of commodity type, market location, event day, and marketing/storage strategy on the risk levels (VAR measures).

Specifically, four separate Analysis of Variance models were estimated for VAR measures generated from MVN and MVE distributions at the 5% and 1% confidence levels. These VAR measures were regressed upon indicator (dummy) variables and interaction variables representing commodity type, market location, event day, and marketing/storage strategy.

(4) $$VAR_{k,l} = \tilde{\alpha} + \sum_{i=1}^{5} \alpha_{2i} D_i + \alpha_3 D_6 + \alpha_4 D_7 + \alpha_5 D_8 + \alpha_6 D_9 + u_{k,l}$$

Where: k denotes assumed probability distribution, MVN or MVE; l denotes confidence level, 1% or 5%.

D_i represents 5 indicator variables D_1 through D_5.

D_1 represents indicator variable for event window day.

D_2 and D_3 represent indicator variables for marketing strategy, where

$D_2 = \begin{cases} 1 \ if \ cash \\ 0 \ otherwise \end{cases}$, $D_3 = \begin{cases} 1 \ if \ speculative \ short \ futures \\ 0 \ otherwise \end{cases}$

D_4 and D_5 represent indicator variables for location and commodity type respectively, where

$$D_4 = \begin{cases} 1 \text{ if Memphis} \\ 0 \text{ if NC Illinois} \end{cases}, D_5 = \begin{cases} 1 \text{ if soybeans} \\ 0 \text{ if corn} \end{cases}$$

$D_{6,}$ $D_{7,}$ D_8 and D_9 represent indicator interaction variables for location-Event day (MemED) ,Cash-Event day (CashED), Futures-Event day (FuturesED) and Commodity-Event day (SoyED) respectively, where

$$D_6 = \begin{cases} 1 \text{ if Memphis and Event day} \\ 0 \text{ if otherwise} \end{cases}, D_7 = \begin{cases} 1 \text{ if Cash Strategy and Event Day} \\ 0 \text{ if otherwise} \end{cases}$$

$$D_8 = \begin{cases} 1 \text{ if Futures Strategy and Event day} \\ 0 \text{ if otherwise} \end{cases}, D_9 = \begin{cases} 1 \text{ if Soybean and Event Day} \\ 0 \text{ if otherwise} \end{cases}$$

$\tilde{\alpha}$ is the intercept parameter that captures the base case where estimated VAR measures are observed for short-futures hedged corn positions in North Central Illinois on non event days of the event window.

In the Preliminary model specifications individual effects of the days were analyzed in the event window by specifying dummy variables for each of the 11 days, market location, and marketing/storage strategy on risk levels. The results from the model revealed that there was no significant statistical difference among the non event days on the VAR measure. To address that concern the returns from all the non event days were incorporated into a single dummy variable, non event day (NED) and for the Event day new dummy variable event day (ED) was specified.

The new model was better in terms of the statistical significance of the variables .But the results of this model were very general. For example the variable for the location (Memphis) had not explained whether any marketing strategy performed better or worse specifically on the event day. In the same way variable for the commodity (soybeans) could have been interpreted in a general context of all the days, for both the locations and for all the marketing strategies. Therefore further analysis is done (taking into account possible interaction effects between marketing location, marketing strategy and event window days)

1) To determine if hedging reduces risk on the event day itself (day $t=0$) compared to a simple cash strategy.

2) To determine if hedging reduces risk on the event day itself (day $t=0$) compared to a short futures strategy.

3) To determine the performance of hedging strategy in Memphis market as compared to North Central Illinois market on the event day itself (day $t=0$) .

4) To determine the performance of hedging strategy for soybeans as compared to corn market on the event day itself (day $t=0$).

To analyze interaction effects between the location-Event day, Cash Strategy-Event day, Futures Strategy-Event day, Commodity-Event day, Location-Strategy, Commodity-Cash Strategy, Strategy and Commodity-Location seven more dummy variables were specified. The results of the model confirmed that the interaction between Location-Strategy, Commodity-Strategy and Commodity-Location were not statistically significant. Different combinations of independent dummy variables were undertaken, and then interaction variables for location-Event day (MemED) , Cash-Event day (CashED), Futures-Event day and Commodity-Event day (SoyED) were included in the final model.

Results

Overall, the results suggest that around USDA crop report release dates both in the corn and soybean markets, naïve hedging is more effective than the cash and future strategies as a risk of returns management tool. The VAR losses are more in the Memphis location than the NCI for both hedged and un hedged positions in general within the event window. Results with respect to the four Analysis of Variance models are summarized and presented in Tables 1-4.

A comparison of the performance of the naïve hedging strategy, cash strategy and the futures strategy across the event window consistently illustrate that a hedging marketing strategy would on an average, across the event window, result in significantly lower losses (irrespective of the assumed distribution) than those associated with other two strategies. In Table 1 for MVN 5% model D_2 (Cash) and D_3 (Futures) are significantly more negative than $\tilde{\propto}$. For example, D_2 is -1.12% and D_3 is -0.93% for MVN 5%, and significantly different from $\tilde{\propto}$ at 1% confidence level. Similarly in Table 2 for MVE 5% model D_2 is more than $\tilde{\propto}$ by - 0.97% and D_3 is more than $\tilde{\propto}$ by - 0.85% at 1% confidence level. Therefore 5% VAR short-hedged corn losses in North Central Illinois average around 1.15% for the non event days, while 5%VAR cash corn losses and futures corn losses average around 2.2% and 2% respectively for the non event window days. In Table 3 for MVN 1% model both the cash and futures strategy corn losses are around 3% and short-hedged corn losses are around 1.7 % on the non event days. In the same way for MVE 1% model in Table 4 both the cash and futures strategy corn losses are around 3.5% and short-hedged corn losses are around 2% on the non event days. Thus on an average hedging is still preferred to a cash and futures marketing strategies for holding periods encompassing the whole event window.

In general, potential un hedged cash strategy losses are larger on the event day. For example, losses average around 3.7% on event days for 5% VAR and 5.11% for 1% VAR MVN (Table 3). The interaction variable between cash strategy and event day is not statistically significant for 1% VAR MVE (Table 4). Largest potential losses occur for un hedged soybean cash positions on event Day. In the results these are 4.3 % for 5% VAR (Tables 1 and 2) and 6.15 % for 1% VAR (Table 3 and 4) on an average. Hedging is equally effective in the event window for both the event and non event days for MVN 5%, MVN 1% and MVE 1%, as the coefficient D_1 (ED) is statistically insignificant for all these cases. The results for MVE 5% show VAR losses are 0.53 % greater on the event day (Table 2) in general. The results indicate that VAR losses for cash strategy are more on the event days as compared to the non event days. Hedging is an effective strategy to counter risk within the event window around the USDA crop release dates. On the whole, event window results are consistent with the notion that cash and futures markets may experience a temporary disconnect with the influx of “news” that induces large price movements.

A comparison of the VAR loses among the locations i.e. Memphis and North Central Illinois are presented in Tables 1-4. Interestingly, in line with our *a-priori* expectations, results presented in Tables 1–4 consistently indicate that on an average across the event window hedging in Memphis market performs poorly compared to hedging in North Central Illinois market. In all four models D_4 (Memphis) is significantly more negative than $\tilde{\alpha}$ at 1% confidence level. In Table 1 for MVN 5%, D4 is -0.42 which means that short futures hedging for corn in Memphis on the event day results into -0.42 % more losses than NCI on the event day. The estimate for interaction variable D_6 (memED) is -1.382 (Table 1) indicate that losses are even more on the event day in the Memphis location. Similarly in Table 2 for MVE 5%, D_4 is -0.27 and D_6 (memED) is -0.75 and in Table 3 for MVN 1%, D_4 is -0.57 and D_6 (memED) is -1.69. In Table 4 for MVE 1% D_4 ,the variable for location is -1.127 but D_6 ,the variable explaining interaction effect between Memphis and event day is not statistically significant. Therefore the results indicate that potential losses for both hedged and un hedged positions, irrespective of day or commodity are greater in Memphis. The losses are still greater on the event day than the non event day for Memphis location for both the hedged and un hedged positions.

The commodity type also has an effect on the VAR losses. The output in Tables 1-2 indicate that D_5 (Soybeans) is 0.2 on an average. These results suggest that hedging strategy for soybeans on the non event days in general performs better than the corn. But the interaction variable between soybeans and event day, D_9 is -0.927 for MVN 5% in Table 1 and -1.18 for MVN 1% in Table 3, which explains that losses are more for hedging soybeans than corn on the event day itself. The interaction variable between soybeans and event day is statistically insignificant for other two models (Tables 2-4). It is clear from the output that storing soybeans in Memphis on the Event Day is the worst case scenario, yielding greatest potential loss on an average (6.5%) as compared to (1.5%) average loss for hedged corn in NCI on Non-Event day.

The results of the analysis (Table 2) clearly indicate that Hedging irrespective of commodity is less effective on Event Day in both markets. For example in MVE 5% (Table 2) the potential losses for hedging on the event day are 0.53 % greater the non event day. This difference is statistically significant at 6% confidence level.

The results presented in Table 4 for MVE 1% level illustrate that the Event Day interaction effects with commodity, strategy and location are statistically insignificant. Large potential losses are equally likely across all days, but un hedged cash losses will be greater (1.58%) than hedged losses.

Conclusion

The main objective of this study was to analyze the effectiveness of hedging as a marketing strategy to counter the risk in returns induced by the new information in the form of USDA crop reports. To explain that VAR levels were derived from simulated short-futures hedging returns, cash returns and speculative short-futures returns, and then examined using Analysis of Variance (ANOVA) to uncover underlying factors that contribute to hedging effectiveness.

Analysis of Variance (ANOVA) was used to investigate the impact of various factors on VAR levels. It is established that location, strategy and crop certainly has an impact on the VAR losses. The losses are more in case of the Memphis location than the NCI across the event window. Hedging is better than the un hedged cash and futures positions. The interaction effects between Memphis location and soybeans on the report release day formed the worst results. In general the losses for hedging as a marketing strategy are still lower than cash and futures strategy to counter the risk even in the event window.

On a final note, hedging strategy is better than the cash strategy in the event window. Also, hedging is less effective in Memphis compared to North Central Illinois market**.** Memphis market experiences a temporary disconnect between cash and futures prices on Event Day. However, even in Memphis market, hedging is on an average still better than not hedging. There is less evidence of a temporary disconnect between futures and North Central Illinois cash market.

This study can form the basis of further research. Various other possible events can be investigated in terms of the impact on risk of returns and efficiency of hedging. For example, we can analyze how well standard storage hedge protects against interest rate increases, oil price shocks, trade embargos, hurricanes, draughts, or other various possible sources of price risk.

The impact of events on other hedging strategies can be analyzed. For example, instead of naïve hedge, which is characterized by the 100% ratio, other hedge ratios could be used (e.g. 50%, 60%, 75%, etc) to figure out the optimum storage hedge ratio.

Finally, it could be valuable to examine the risk of returns and hedging efficiency of other agricultural commodities besides corn and soybean.

Endnotes

(1) http://usda.mannlib.cornell.edu/reports/nassr/field/pcp-bb/

(2) Given that grain elevators roll over nearby futures contracts during expiration months, the nearby corn price series used in this study comprise September contracts for August *Crop Production* reports, and December contracts for September, October and November reports. Similarly with respect to soybean prices series we use September contracts for August *Crop Production* reports, November contracts for September and October reports, and January contracts for November reports.

(3) This is not an unrealistic assumption as it is common industry practice for grain merchandisers and elevators to form naïve hedged positions where equal but opposite futures positions are held against cash positions.

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Table 1. Analysis of Variance (MVN VAR 5% Level)

Parameters	Estimate	Std. Error	T-Value	P-Value
Intercept	-1.210	0.111	-10.290	<.0001
ED	-0.068	0.389	0.180	0.861
Cash	-1.123	0.122	-9.170	<.0001
Futures	-0.930	0.136	-6.800	<.0001
Memphis	-0.420	0.122	-3.460	0.001
Soybeans	0.234	0.100	2.340	0.021
MemED	-1.382	0.406	-3.400	0.001
CashED	-1.350	0.406	-3.320	0.001
FuturesED	-1.641	0.454	-3.610	0.000
SoyED	-0.927	0.331	-2.790	0.006
R-Square		0.710		

Table 2. Analysis of Variance (MVE VAR 5% Level)

Parameters	Estimate	Std. Error	T-Value	P-Value
Intercept	-1.130	0.086	-13.140	<.0001
ED	-0.530	0.285	-1.870	0.063
Cash	-0.970	0.090	-10.900	<.0001
Futures	-0.850	0.093	-8.540	<.0001
Memphis	-0.270	0.090	-3.060	0.003
Soybeans	0.153	0.076	2.080	0.040
MemED	-0.750	0.298	-2.520	0.013
CashED	-1.266	0.298	-4.250	<.0001
FuturesED	-1.870	0.333	-5.630	<.0001
SoyED	-0.454	0.243	-1.870	0.643
R-Square		0.810		

Table 3. Analysis of Variance (MVN VAR 5% Level)

Parameters	Estimate	Std. Error	T-Value	P-Value
Intercept	-1.719	0.163	-10.52	<.0001
ED	-0.066	0.542	-0.12	0.903
Cash	-1.501	0.170	-8.80	<.0001
Futures	-1.286	0.190	-6.74	<.0001
Memphis	-0.577	0.170	-3.38	0.0010
Soybeans	0.294	0.139	2.11	0.0371
MemED	-1.694	0.566	-2.99	0.0033
CashED	-1.908	0.566	-3.37	0.0010
FuturesED	-2.223	0.633	-3.51	0.0006
SoyED	-1.180	0.462	-2.55	0.0119
R-Square		0.701		

Table 4. Analysis of Variance (MVE VAR 1% Level)

Parameters	Estimate	Std. Error	T-Value	P-Value
Intercept	-1.911	0.451	-4.230	<.0001
ED	-0.707	1.498	-0.470	0.638
Cash	-1.583	0.471	-3.350	0.001
Futures	-1.567	0.527	-2.970	0.004
Memphis	-1.127	0.471	-2.390	0.019
Soybeans	0.176	0.385	0.460	0.648
MemED	-0.074	1.565	-0.050	0.963
CashED	-2.089	1.565	-1.330	0.184
FuturesED	-0.616	1.750	-0.350	0.725
SoyED	-0.386	1.277	-0.300	0.763
R-Square		0.210		

Figure 1. CDF VAR 5%