Hedging Effectiveness Around U.S. Department of Agriculture Crop Reports

Andrew McKenzie and Navinderpal Singh

It is well documented that "unanticipated" information contained in United States Department of Agriculture (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.

Key Words: analysis of variance, storage hedging, United States Department of Agriculture Crop Reports, value at risk

JEL Classifications: Q13, D81

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, 2006; McKenzie, 2008). In addition, Milonas (1987) 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 more volatile basis levels than their mid-west (surplus) counterparts. In fact, in extreme circumstances,

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if cash and futures prices become disconnected and basis variability increases, it is not inconceivable that unhedged positions could generate smaller losses than their hedged counterparts.

The theory of storage or cost-of-carry model and spatial integration models provide theoretical reasons as to why geographical basis differences, both in terms of basis levels and basis changes, may exist (McKenzie, 2005). In addition to variations in local supply and demand for grain, basis will differ substantially across cash market locations based upon factors such as the marginal convenience yield from storing an additional unit of inventory, the marginal physical cost of storage, the physical delivery cost associated with fulfilling the terms of the futures contract, interest rate cost associated with storage, and the transportation cost between markets.

Fortenbery and Zapata (1993) also shed some light on why the link between cash prices and futures prices may differ across locations. They examined cointegration between North Carolina corn and soybean cash markets and their respective futures markets, and found that markets were not consistently cointegrated across their sample period, which would have implications with respect to basis dynamics in these markets. They noted by considering small local markets outside of the primary grain producing states information flow may be unidirectional (i.e., from futures markets to North Carolina markets), and that this may have implications for the degree of cointegration. Fortenbery and Zapata (1993) also attributed different price responses in North Carolina soybean markets to market power factors (i.e., buyer concentration levels). Most importantly for our study, Fortenbery and Zapata's results show that cash price responses and basis dynamics may differ across market locations.

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 – unhedged cash or hedged storage positions – 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 downward price swings and hence negatively impacts their stored cash grain positions. Traditionally most elevators automatically hedge their stored grain to mitigate such large price movements. However, if basis becomes more volatile around the release of USDA crop reports, elevators' hedged positions could also be susceptible to large losses. 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". So in a similar vein to elevators, these grain buyers, even if hedged, could be susceptible to increased levels of price risk if basis volatility also increases around release of USDA reports.

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 11 day event window surrounding report release dates. Specifically, hedging effectiveness around reports is quantified in two ways. First, hedging effectiveness is measured by comparing the variance of returns of unhedged cash versus hedged positions. Second, hedging effectiveness is measured by calculating Value at Risk (VAR), which is used to quantify and compare the potential of large losses – observed in extreme left tail of returns distribution – for hedged versus unhedged 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 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 2008, yielding 68 historical events and 748 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) were obtained from the USDA Agricultural Marketing Service for Memphis, Tennessee, and North Central Illinois.

Cash prices in surplus areas with excess supplies (e.g., North Central Illinois) are typically at a lower level than those in deficit areas, which grow less bushels of grain and have a higher concentration of users (e.g., Memphis). This fact is reflected in average basis levels presented in Tables 1 and 2, where it can be seen that North Central Illinois corn and soybean basis is lower (more negative) across the event

window in comparison with average Memphis corn and soybean basis. In addition, corn cash prices in North Central Illinois market tend to be more closely aligned (correlated) to futures prices than their Memphis counterparts, as shown in Table 1. Higher correlations between North Central Illinois cash and futures returns are also consistent with a less variable basis, when compared with the Memphis market. Figure 1 shows that standard deviation of corn daily basis changes across the event window is typically larger in Memphis market.

Modeling Approach

First historical cash (North Central Illinois and Memphis) and futures returns were calculated for the 11 day event window surrounding report release dates.[3] More specifically, returns were calculated: 5 days before announcement, starting from the day $t = -5$ through day $t = -1$, and 6 days after announcement, from day $t = 0$ through day $t = 5$. It was determined that using 5 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 market prices and decreasing our ability to measure the response of the market, and hence quantify hedging effectiveness, to the event in question. Day $t = 0$ represents the first trading day after the new information in the report was released, and day

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[1] "Crop Production" http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1046.

[2] Given that grain elevators roll over nearby futures contracts during expiration months, the nearby corn price series used in this study comprised 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] McKenzie (2008) advocates using a Hamilton type model approach to more accurately discern market expectations and futures prices reactions to market events. However, we choose not to follow this approach for two reasons. First, from a practical standpoint, we do not have private corn and soybean production forecast data for our whole sample period, which is needed to implement the approach. Second, McKenzie's results show, at least with respect to corn markets, that actual futures price movements following report release dates accurately reflect market price expectations. Therefore, we assume that using actual futures price returns around USDA reports provides us with a reasonable estimate of price and basis risk associated with these reports.

Table 1. Historical Corn Cash and Futures Returns Relationships across Event Days

| | North Central Illinois Corn | | | | | | | | | | |
	−5	−4	−3	−2	−1	0	1	2	3	4	5
Cash futures correlations	0.89	0.87	0.94	0.93	0.84	0.95	0.88	0.84	0.94	0.85	0.90
Hedging effectiveness	79	76	89	86	70	89	77	70	87	73	81
Average basis	−19	−18	−18	−18	−18	−18	−18	−18	−18	−18	−17
	Memphis Corn										
	−5	−4	−3	−2	−1	0	1	2	3	4	5
Cash futures correlations	0.61	0.63	0.89	0.79	0.59	0.89	0.87	0.76	0.89	0.82	0.78
Hedging effectiveness	38	39	78	62	35	78	76	58	79	67	60
Average basis	−6	−6	−5	−6	−5	−5	−4	−2	−3	−3	−2

Note: Hedging effectiveness is measured as percentage reduction in variance of holding a hedged position versus an unhedged cash position.

$t = -1$ the last trading day before the report was released.

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

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

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 any value from t = −5 to t = 5.

Similarly, daily short-futures returns 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.

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

where FP_{it} is the futures price for commodity i, and t represents the day in event time around

Table 2. Historical Soybean Cash and Futures Returns Relationships across Event Days

| | North Central Illinois Soybean | | | | | | | | | | |
	−5	−4	−3	−2	−1	0	1	2	3	4	5
Cash futures correlations	0.94	0.96	0.97	0.98	0.84	0.95	0.88	0.93	0.98	0.97	0.94
Hedging effectiveness	88	92	93	96	63	89	77	87	96	94	89
Average basis	−19	−18	−18	−18	−18	−19	−18	−18	−18	−19	−19
	Memphis Soybean										
	−5	−4	−3	−2	−1	0	1	2	3	4	5
Cash futures correlations	0.93	0.90	0.94	0.94	0.89	0.96	0.96	0.86	0.94	0.91	0.83
Hedging effectiveness	87	80	89	88	78	92	93	74	89	82	69
Average basis	0	2	0	1	1	1	3	4	2	3	3

Note: Hedging effectiveness is measured as percentage reduction in variance of holding a hedged position versus an unhedged cash position.
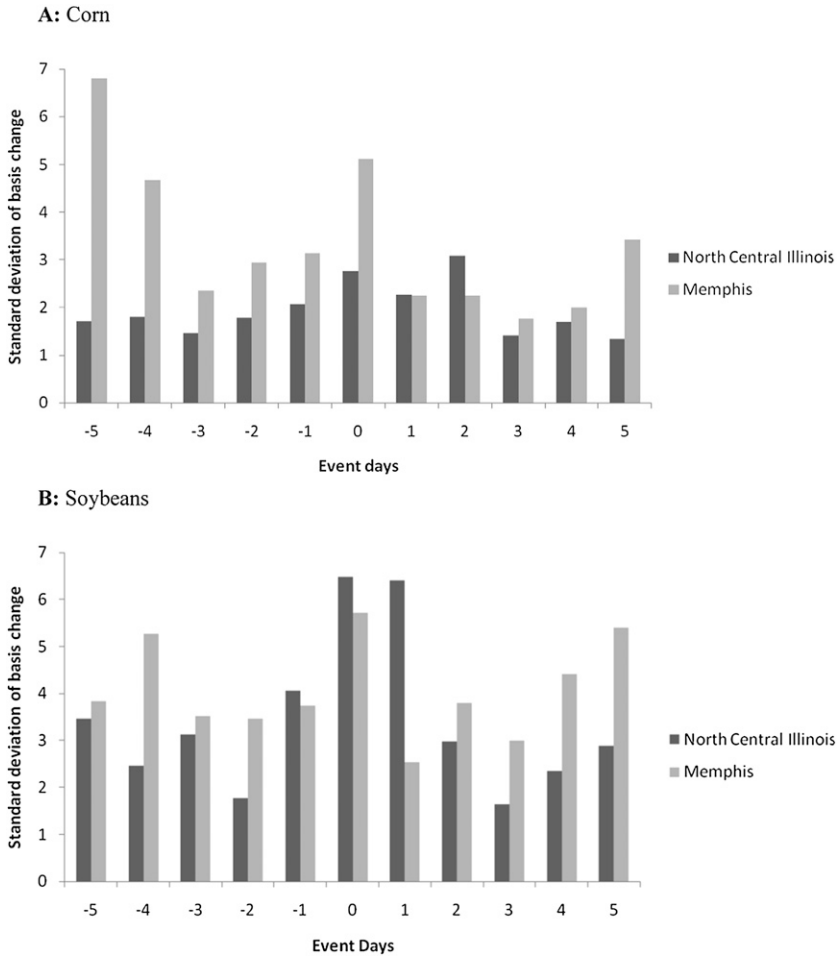
A: Corn

B: Soybeans

Figure 1. Standard Deviation of Basis Change Across Event Days in Cents/Bushel; Panel A – Corn; Panel B – Soybeans

the report's release that can take any value from $t = -5$ to $t = 5$. "Short-futures" position implies that a hedger or futures trader has initially sold futures contracts and will earn a positive return if prices fall the following day. This is why the term $\ln(FP_t / FP_{t-1})$ multiplied by (-100). Diagnostic tests indicated 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.

Finally, daily short-futures hedged returns are simply the arithmetic sum of CR_{ijt} and FR_{it}.

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

where it is assumed hedgers match the size of cash positions (in terms of quantity of bushels) with equal sized futures positions.[4]

Traditional Measures of Hedging Effectiveness

We employ a variety of different hedging effectiveness measures that have frequently been used in literature. Following Fackler and

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[4] 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.

McNew (1993), our primary measure of hedging effectiveness calculates the percentage reduction in variance of hedged position relative to unhedged position:

$$(4) \qquad HE = 1 - \left(\frac{Variance\ HR_{ijt}}{Variance\ CR_{ijt}} \right),$$

where HE is the hedging effectiveness measure. Note that this measure is very similar to the coefficient of determination (R^2) from an ordinary least squares (OLS) regression of cash returns on futures returns. Such a regression has been widely used to obtain minimum variance hedge ratios, where R^2 measures the risk reduction achieved from hedging cash grain in proportion to the optimal ratio. We choose to present results in terms of $HE,$ rather than $R^2,$ because as already mentioned we assume hedgers match the size of cash positions (in terms of quantity of bushels) with equal sized futures positions, rather than hedging using minimum variance ratios. However, for completeness, we also present results in terms of linear correlation coefficient between cash returns and futures returns, which is of course simply the square root of R^2 from a simple OLS regression with one explanatory variable. To analyze if HE measures are statistically different across event time, we first calculated HE measures for all non-event days (i.e., event window days other than the event day itself), for pre event window days (days -5 through -1), and for post event window days (days 1 through 5), by pooling observations within their respective categories. Second, we calculated the difference between HE measures for event days versus all other event window days, and between HE measures for pre event window days versus post event window days. Then, 90% bootstrapped confidence intervals were estimated around these HE differences to determine if HE difference measures are statistically significant.[5]

We also investigated, using standard F-tests, whether basis risk differs significantly across event time. Specifically, we test to see if basis change variance is greater on event days compared with other event window days, and if basis change variance is larger in the pre or post event window period. To calculate basis change variance for all non-event window days, pre event window days, and post event window days observations were pooled within their respective categories. In addition, for comparison purposes we present figures of standard deviations of historical cash, futures and hedged returns, and standard deviations of basis changes, for North Central Illinois and Memphis corn and soybean markets.

Value at Risk

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, 1997). Value at risk provides users with a summary measure of potential market risk. It is a risk management concept by which market agents can be informed, via single number, of the short term risk of potential losses. VAR has 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. Recently VAR as a risk management concept has come under attack because of its apparent inability to accurately measure risk levels associated with portfolios of mortgage-backed derivatives and other so called toxic securities. An excellent review of the issues surrounding VAR and the recent financial crisis by Nocera (2009) was published in the January 4, 2009 edition of the *New York Times* Magazine. However, as noted in the *New York Times* article, it is not that VAR as a risk management tool is flawed, but that financial market agents either forgot or ignored the fact that the VAR number was only meant to describe what happened 95% or 99% of the time. A given dollar loss wasn't just the most you could lose 99% of the time; it was the least you could lose

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[5] The bootstrapped confidence intervals were obtained by employing 1,000 replications of a nonparametric bootstrap simulation using the percentile method.

1% of the time. With this in mind, we believe that VAR remains an excellent risk management tool and in the context of this paper provides valuable insights as to potential losses associated with storing grain around USDA crop reports.

There are several accepted methods to compute VAR. In this study we used Monte Carlo simulation approach. Simulated cash and futures returns CR_{ijt}^{s} and FR_{it}^{s} were generated by drawing 1000 iterations from a bivariate normal distribution (BVN) with the first two moments estimated from the historical returns series. The BVN simulations maintain and impose historical correlation structure between CR_{ijt} and FR_{it}. Simulated daily short-futures hedged returns HR_{ijt}^{s} are then simply the arithmetic sum of CR_{ijt}^{s} and FR_{it}^{s}.

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 50th worst outcome out of 1,000 simulated outcomes. The VAR at the 99% confidence is the 10th 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 unhedged cash storage positions against short-futures hedged positions for two commodities, two market locations, and across each day in the event window.

Analysis of Variance

Analysis of Variance (ANOVA) is used to quantify the relative influence of commodity type, market location, event day, and marketing/storage strategy on the risk levels (VAR measures). Specifically, two separate ANOVA models were estimated for VAR measures generated from BVN 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.

$$(5) \quad Var_l = \alpha + \sum_{i=1}^{4} \beta_i D_i + \beta_5 (D_2 D_3) + \beta_7 (D_3 D_4) + \beta_8 (D_2 D_1) + u,$$

where l denotes 1% or 5% confidence level. $D_1 - D_4$ are indicator variables, with the terms $(D_2 D_2)$, $(D_3 D_4)$, and $(D_2\ D_1)$ representing interaction terms.

$$D_1 = \begin{cases} 1 & \text{if Event Day, t=0 (the first trading} \\ & \text{day after report was released)} \\ 0 & \text{otherwise} \end{cases}$$

$$D_2 = \begin{cases} 1 & \text{if cash position} \\ 0 & \text{otherwise} \end{cases}$$

$$D_3 = \begin{cases} 1 & \text{if Memphis} \\ 0 & \text{if North Central Illinois} \end{cases}$$

$$D_4 = \begin{cases} 1 & \text{if soybeans} \\ 0 & \text{if corn} \end{cases}$$

$$D_2 D_3 = \begin{cases} 1 & \text{if cash position in Memphis} \\ 0 & \text{if otherwise} \end{cases}$$

$$D_3 D_4 = \begin{cases} 1 & \text{if soybeans in Memphis} \\ 0 & \text{if otherwise} \end{cases}$$

$$D_2 D_1 = \begin{cases} 1 & \text{if cash position on Event day} \\ 0 & \text{if otherwise} \end{cases}$$

Finally, α is an intercept parameter that captures the base case where estimated VAR measures are observed for hedged corn positions in North Central Illinois on non-event days of the event window.

Hedging Effectiveness Results for Historical Data

North Central Illinois. First, we consider results using traditional hedging effectiveness measures with respect to historical returns data for North Central Illinois market. Hedging effectiveness measures presented in Tables 1 and 2 shows that hedging is effective with respect to both corn and soybeans, and across event-window days. Even on the event day itself (day 0), hedging reduces the risk associated with storing unhedged grain by 89%. This is consistent with the high cash and futures returns correlations presented in the first row of Tables 1 and 2. In fact with respect to

corn, Table 3 results show that hedging effectiveness is statistically higher on the event day than on other event window days. Table 3 results also indicate there is no statistical difference between corn and soybean hedging effectiveness in the pre versus the post event period.

Similarly, Figures 2 and 3 indicate that standard deviation (risk) of hedge returns are lower than standard deviations of cash returns irrespective of day or commodity. Standard deviation of cash returns and futures returns are highest on event day. This is consistent with Isengildina-Massa et al. (2008) who find futures return variance to be greatest on first trading day session (close-to-open) following World Agricultural Supply and Demand Estimates release dates, and shows that USDA reports contain price sensitive information. As one would expect, patterns of basis change risk, presented in Figure 1, mirror hedge return risk patterns. However, it is of interest to present both types of statistics as standard deviation of basis change is measured in cents per bushel, while returns measure the percentage price change. Given that soybeans are always priced at least 2–3 times higher than corn (in cents per bushel) over our sample period, although the variation in hedge returns of corn and soybeans are of similar magnitude, the basis results show that relative cents per bushel variation in soybean cash and futures prices are greater than that for corn; soybeans are more risky in terms of cents per bushel price moves.

Results presented in the top half of Table 3 show that corn and soybean basis risk (the variance of daily basis changes) is statistically highest on event days. This indicates that reports induce an immediate disconnect between cash and futures prices, and thus the largest hedging losses are most likely to occur on event days. However, as our hedging effectiveness results indicate these losses would be much higher for non-hedged cash positions. Table 3 results also illustrate that post event basis risk is statistically higher than pre event basis risk for both corn and soybeans. Thus, although the disconnect between cash and futures prices observed on event days, is less pronounced in the post event period, reports continue to impact basis volatility over the week following report release dates. This

pattern coupled with the fact that hedging effectiveness does not deteriorate in the post event period is consistent with relatively large cash price movements in the week following report release date. Evidence of this cash price effect can be seen in Figure 2 (panel A), where cash price return volatility on days 1, 2, and 3 is high and relatively greater than futures return volatility over the same days. This is consistent with the idea that cash and futures markets may respond differently to report information in terms of magnitude and speed of adjustment.

In sum, hedging in North Central Illinois corn and soybean markets is effective for all days across the event window. Most notably, although the greatest variability of cash returns, futures returns, hedge returns, and basis changes occurs on event days, hedging in North Central Illinois greatly reduces event induced price risk. In addition, we find a statistically significant response in basis volatility to release of reports, which continues for several days thereafter.

Memphis. Our historical returns results for Memphis market suggests that hedging corn is not as consistently effective in Memphis as in North Central Illinois. Table 1 shows that hedging effectiveness measures and cash/futures returns correlations are much lower for most days in the event window. This is particularly evident in the pre event window, and results presented in Table 4 shows that corn hedging effectiveness is statistically lower in the pre event period compared with the post event period. Results also show that corn hedging effectiveness is statistically greatest on the event day itself.

In contrast, Table 2 results indicate that hedging soybeans in Memphis is probably as equally effective as hedging soybeans in North Central Illinois. For most days in the event window Memphis and North Central Illinois hedging effectiveness measures and cash/futures returns correlations are of a similar magnitude. Table 4 results indicate that soybean hedging effectiveness is again statistically at its highest level on the event day, but that there is no statistical difference in hedging effectiveness between pre and post event periods.

Figure 2 shows that the standard deviation of hedged corn returns is typically higher in Memphis than in North Central Illinois. Several

Table 3. Historical North Central Illinois Basis Volatility and Hedging Effectiveness Tests

	Corn				Soybeans			
	Difference in Day 0 and All Other Event Days	F-Statistic	Difference in Pre and Post Event Days	F-Statistic	Difference in Day 0 and All Other Event Days	F-Statistic	Difference in Pre and Post Event Days	F-Statistic
Basis Change Volatility	3.88	2.04 (0.000)	−1.06	1.33 (0.004)	30.71	3.71 (0.000)	−9.29	1.98 (0.000)
	Difference in Day 0 and All Other Event Days	90% Confidence Interval	Difference in Pre and Post Event Days	90% Confidence Interval	Difference in Day 0 and All Other Event Days	90% Confidence Interval	Difference in Pre and Post Event Days	90% Confidence Interval
Percentage Hedging Effectiveness	10.32	(6.5, 16.4)	3.30	(−2.7, 11.1)	0.76	(−5.2, 7.0)	1.48	(−5.2, 7.4)

Notes: For basis change volatility, difference in day 0 and all other event days = variance of basis changes on day 0 − variance of basis changes pooled on all other event days. Therefore if this is a positive number, basis volatility is higher on event days.
Difference in pre and post event days = variance of pooled basis changes on pre event days − variance of pooled basis changes on post event days. Therefore if this is a positive number, basis volatility is higher on pre event days.
F-statistic ratios are always presented with the larger variance as numerator and the smaller variance as denominator.
For percentage hedging effectiveness, difference in day 0 and all other event days = percentage hedging effectiveness measure on day 0 − percentage hedging effectiveness measure pooled on all other event days. Therefore, if this is a positive number, percentage hedging effectiveness is higher on event days.
Difference in pre and post event days = percentage hedging effectiveness measure pooled on pre event days − percentage hedging effectiveness measure pooled on post event days. Therefore, if this is a positive number, hedging effectiveness is higher on pre event days.
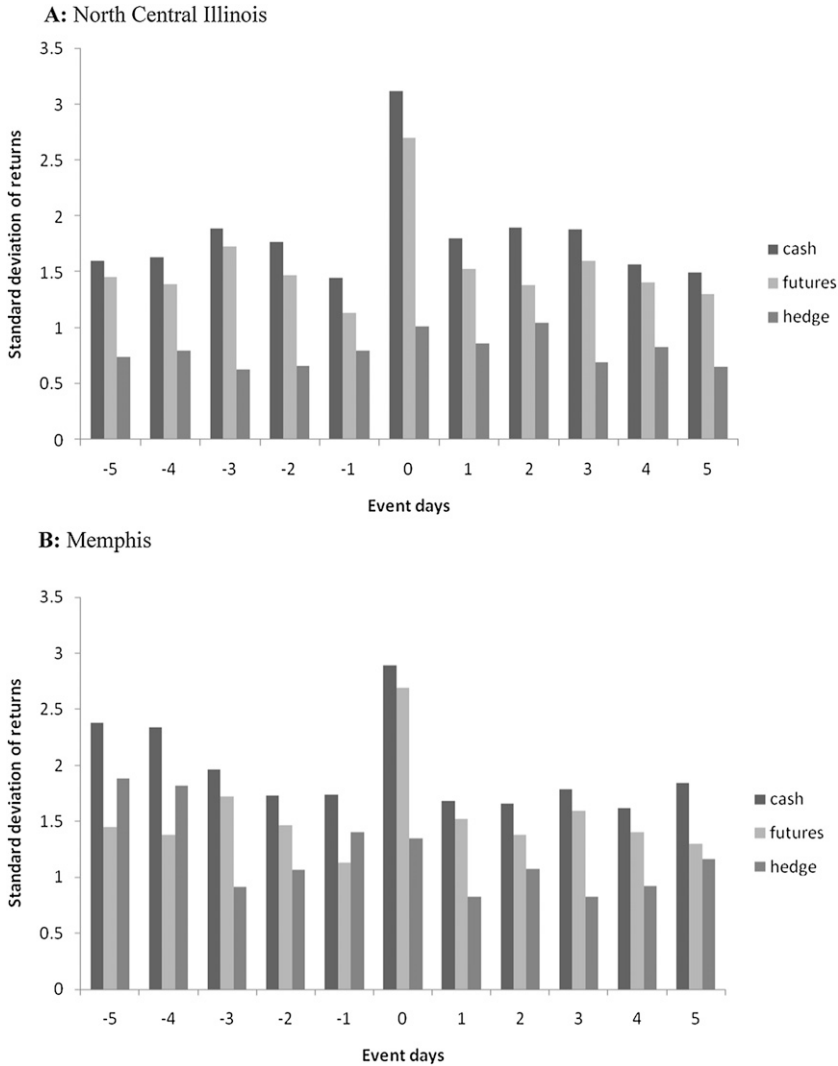90% confidence intervals are estimated around the differences in hedging effectiveness.

Figure 2. Standard Deviation of Corn Cash, Futures, and Hedge Percentage Returns; Panel A – North Central Illinois; Panel B – Memphis

days in the pre-event window (−5, −4, and −1) exhibit higher hedged returns standard deviations than futures returns standard deviations. More reassuringly – from a risk management per-spective – standard deviations of cash returns are greater than standard deviations of hedged returns across the entire event window. In con-trast, standard deviation of Memphis soybean returns (hedged and unhedged), presented in Figure 3, show a similar pattern to North Central Illinois returns. This provides additional evi-dence that hedging soybeans is as equally ef-fective in Memphis as in North Central Illinois.

Standard deviation of basis changes illus-trated in Figure 1 confirms that hedging corn in Memphis is relatively less effective than in North Central Illinois, while hedging soybeans in Memphis is as equally effective in Memphis as in North Central Illinois. Standard deviations of Memphis corn basis changes, presented in panel A, are much higher for most days (most notably day −5 and day 0). In contrast, stan-dard deviations of soybean basis changes, presented in panel B, show that basis changes of a similar magnitude can occur in both mar-kets. In fact, North Central Illinois soybean

Table 4. Historical Memphis Basis Volatility and Hedging Effectiveness Tests

	Corn				Soybeans			
	Difference in Day 0 and All Other Event Days	F-Statistic	Difference in Pre and Post Event Days	F-Statistic	Difference in Day 0 and All Other Event Days	F-Statistic	Difference in Pre and Post Event Days	F-Statistic
	Difference in Day 0 and All Other Event Days	90% Confidence Interval	Difference in Pre and Post Event Days	90% Confidence Interval	Difference in Day 0 and All Other Event Days	90% Confidence Interval	Difference in Pre and Post Event Days	90% Confidence Interval
Basis Change Volatility	14.08	2.16 (0.000)	12.66	3.18 (0.000)	16.67	2.05 (0.000)	0.29	1.02 (0.434)
Percentage Hedging Effectiveness	21.71	(6.0, 34.2)	−19.39	(−33.1, −2.2)	8.57	(1.1, 14.6)	2.90	(−2.5, 14.1)

Notes: For basis change volatility, difference in day 0 and all other event days = variance of basis changes on day 0 − variance of basis changes pooled on all other event days. Therefore if this is a positive number, basis volatility is higher on event days.
Difference in pre and post event days = variance of pooled basis changes on pre event days − variance of pooled basis changes on post event days. Therefore if this is a positive number, basis volatility is higher on pre event days.
F-statistic ratios are always presented with the larger variance as numerator and the smaller variance as denominator.
For percentage hedging effectiveness, difference in day 0 and all other event days = percentage hedging effectiveness measure on day 0 − percentage hedging effectiveness measure pooled on all other event days. Therefore, if this is a positive number, percentage hedging effectiveness is higher on event days.
Difference in pre and post event days = percentage hedging effectiveness measure pooled on pre event days − percentage hedging effectiveness measure pooled on post event days. Therefore, if this is a positive number, hedging effectiveness is higher on pre event days.
90% confidence intervals are estimated around the differences in hedging effectiveness.
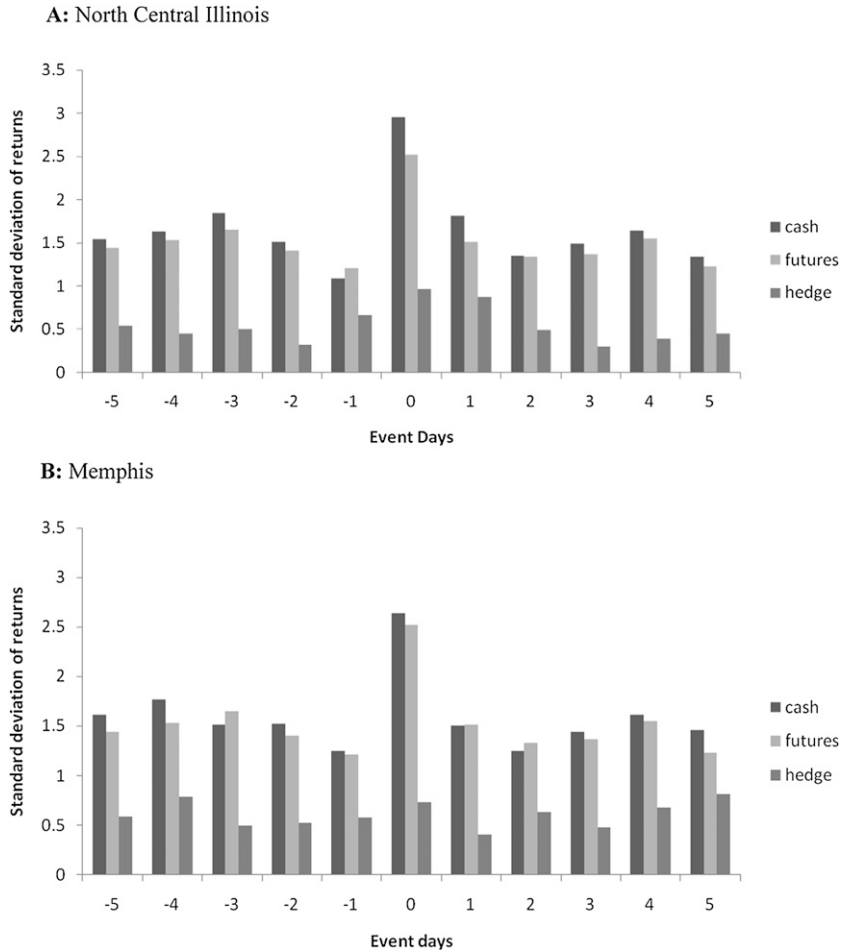
A: North Central Illinois

B: Memphis

Figure 3.   Standard Deviation of Soybean Cash, Futures, and Hedge Percentage Returns; Panel A – North Central Illinois; Panel B – Memphis

basis experiences the greatest variation on day 0 and day 1.

Results presented in the top half of Table 4 show that corn and soybean basis risk is statistically highest on event days. This result, as in North Central Illinois case, indicates a significant and immediate basis response (increase in basis risk) to release of reports. Also, we find that corn basis risk is significantly higher in the pre event period compared with the post event period, although there is no statistical difference between pre and post event soybean basis risk. Our results indicate the potential for large basis movements in Memphis corn market in both pre event period and on event day itself. The patterns of corn basis volatility are consistent with information contained in reports inducing a different initial

response in Memphis corn cash market to corn futures market, but subsequently reducing market uncertainty by helping to better align futures and cash price movements.

In sum, hedging is more effective at reducing risk in Memphis corn and soybean markets than choosing to store unhedged grain for all days across the event window. Indeed, hedging soybeans in Memphis is as equally effective as hedging soybeans in North Central Illinois. However, hedging corn in Memphis is relatively less effective than hedging corn in North Central Illinois. Also, release of report information appears to initially increase Memphis corn basis risk on event day, but in the following week basis volatility is significantly reduced below pre event levels.

Analysis of Variance Results

Empirical results with respect to the two Analysis of Variance models are presented in Tables 5 and 6. Table 5 reports parameter estimates for BVN 5% model, while Table 6 reports parameter estimates for BVN 1% model. Results presented in Tables 5 and 6 show that VAR losses are qualitatively similar in terms of treatment variables effects on losses. Parameter estimates are quantitatively larger but of the same sign and significance levels. This is consistent with the fact that we would expect to observe larger potential losses at the 1% VAR level.

North Central Illinois. First, we consider VAR results with respect to North Central Illinois market at the 5% level. Intercept estimate in Table 5, which captures our base case indicates that losses for hedged corn positions on non event days will be approximately 1.22% or greater, 5% of the time. Losses for hedged corn positions held over event days are marginally greater, at 1.61% (*Intercept + Event Day*) or more, 5% of the time.

In contrast, unhedged corn cash positions on non event days yield significantly larger losses of 2.89% (*Intercept + Cash*). Notably, unhedged corn cash losses of 6.18% are greatest on event day (*Intercept + Cash + Cash × Event Day*). The statistically significant interaction between cash and event day (−1.75%) reflects the fact that carrying unhedged grain around USDA reports is inherently more risky than storing hedged grain. This is consistent with literature, which has found large price reactions to USDA reports.

These results are also consistent with Figure 4 (panel A),[6] which illustrates BVN VAR losses at the 5% level for North Central Illinois corn market. It is immediately apparent that hedging corn over the event window in North Central Illinois is effective at reducing potential losses, at least 95% of the time. Even though

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[6] Other charts showing VAR losses for North Central Illinois and Memphis corn and soybean markets at the 1% level (not presented here to conserve space) are qualitatively similar to the 5% level Figures 4 and 5 in terms of patterns. Obviously, the 1% charts show larger losses for cash, futures, and hedged losses.

unhedged cash or speculative short-futures positions would tend to result in large potential losses on the event day, these event-day induced losses are to a large extent effectively constrained by hedging.

We also find a small but significantly positive effect associated with storing soybeans in North Central Illinois (*Soybeans* = 0.34%) rather than corn, irrespective of marketing strategy or day. This effect can be seen graphically by comparing VAR losses across days and strategies for corn in Figure 4 (panel A) with VAR losses for soybeans in Figure 5 (panel A). However, this result is tempered by the fact that although percentage losses are marginally smaller for soybeans positions, cents per bushel losses would in fact be higher for soybeans.

Next, we turn attention to VAR results at the 1% level, presented in Table 6. The BVN results presented in Table 5 are qualitatively similar to the 5% level results already discussed. Note that the base case (hedged corn positions on non event days) now results in losses of around 1.71% or more. Similarly, the worst case scenario (storing unhedged cash corn over the event day) now yields potential losses of 6.76% or greater.

In sum, hedging in North Central Illinois market is reasonably effective at reducing the risk of potential losses irrespective of commodity or day. In fact, hedging is only marginally less effective on event days compared with non event days, in the sense that hedged losses on event days are marginally (but significantly) larger than hedged losses on non event days. Even when cash and futures prices experience extreme moves (1% of the time), and there is a tendency for basis levels to widen, hedging losses are still significantly less than corresponding unhedged cash losses.

Memphis. Of particular interest is the extent to which stored grain positions held in Memphis market experience larger losses than their North Central Illinois counterparts. To answer this question we first turn to our 5% VAR results (Table 5) and focus attention on *Memphis*, *Memphis × Cash*, and *Memphis × Soy* parameter estimates. The *Memphis* estimate measures additional impact of storing grain in Memphis across the event window. Results indicate that storing hedged corn in Memphis

Table 5. Analysis of Variance VAR 5% Level

Parameters	Estimate	Standard Error	T-Value	*p*-Value
Intercept	−1.22	0.09	−13.20	<0.0001
Event Day	−0.39	0.18	−2.14	0.035
Cash	−1.61	0.11	−15.03	<0.0001
Memphis	−0.65	0.13	−5.07	<0.0001
Soybeans	0.34	0.10	3.24	0.002
Memphis × Cash	0.34	0.15	2.32	0.023
Memphis × Soy	0.46	0.15	3.09	0.003
Cash × Event Day	−1.75	0.26	−6.78	<0.0001
R-Square		0.89		

yields an additional 1.61% loss or greater, 5% of the time, compared with storing hedged corn in North Central Illinois. This is consistent with our hedging effectiveness results with respect to historical data — hedging corn in Memphis is less effective than hedging corn in North Central Illinois.

Interestingly, when considering unhedged cash positions, the positive signs on *Memphis × Cash* and *Memphis × Soy* parameter estimates counter this negative impact of storing grain in Memphis. For example, storing unhedged cash soybeans in Memphis on non-event days results in losses of 2.34% or greater 5% of the time, while storing unhedged cash soybeans in North Central Illinois on non-event days results in losses of 2.49% or greater 5% of the time. F-test reveals that these cash losses in the two markets are not significantly different from each other at the 5% level. Similarly, storing unhedged cash corn in Memphis on non-event days results in losses of 3.14% or greater 5% of the time, while storing unhedged cash corn in North Central Illinois on non-event days results in losses of

2.83% or greater 5% of the time. Again F-test reveals that these cash losses in the two markets are not significantly different from each other at the 5% level. Thus, storing unhedged cash grain (corn or soybeans), carries the same level of risk—in terms of extreme potential loss—irrespective of market. This fact is also borne out in Figures 4 and 5, where it can be seen that VAR 5% corn and soybean cash losses tend to be very similar for both markets.

Similarly, if we just focus attention on any potential differences between storing hedged soybeans in Memphis versus North Central Illinois, our results indicate no significant difference exists. Storing hedged soybeans in Memphis on non-event days results in losses of 1.07% or greater 5% of the time. Storing hedged soybeans in North Central Illinois on non-event days results in losses of 0.88% or greater 5% of the time. F-test reveals that these hedged losses in the two markets are not significantly different from each other at the 5% level. Storing hedged soybeans carries the same level of risk, in terms of potential loss,

Table 6. Analysis of Variance VAR 1% Level

Parameters	Estimate	Standard Error	T-Value	*p*-Value
Intercept	−1.71	0.13	−12.87	<0.0001
Event Day	−0.57	0.26	−2.17	0.003
Cash	−2.22	0.15	−14.38	<0.0001
Memphis	−0.89	0.18	−4.82	<0.0001
Soybeans	0.47	0.15	3.09	0.003
Memphis × Cash	0.48	0.21	2.24	0.028
Memphis × Soy	0.66	0.21	3.09	0.003
Cash × Event Day	−2.26	0.37	−6.08	<0.0001
R-Square		0.88		

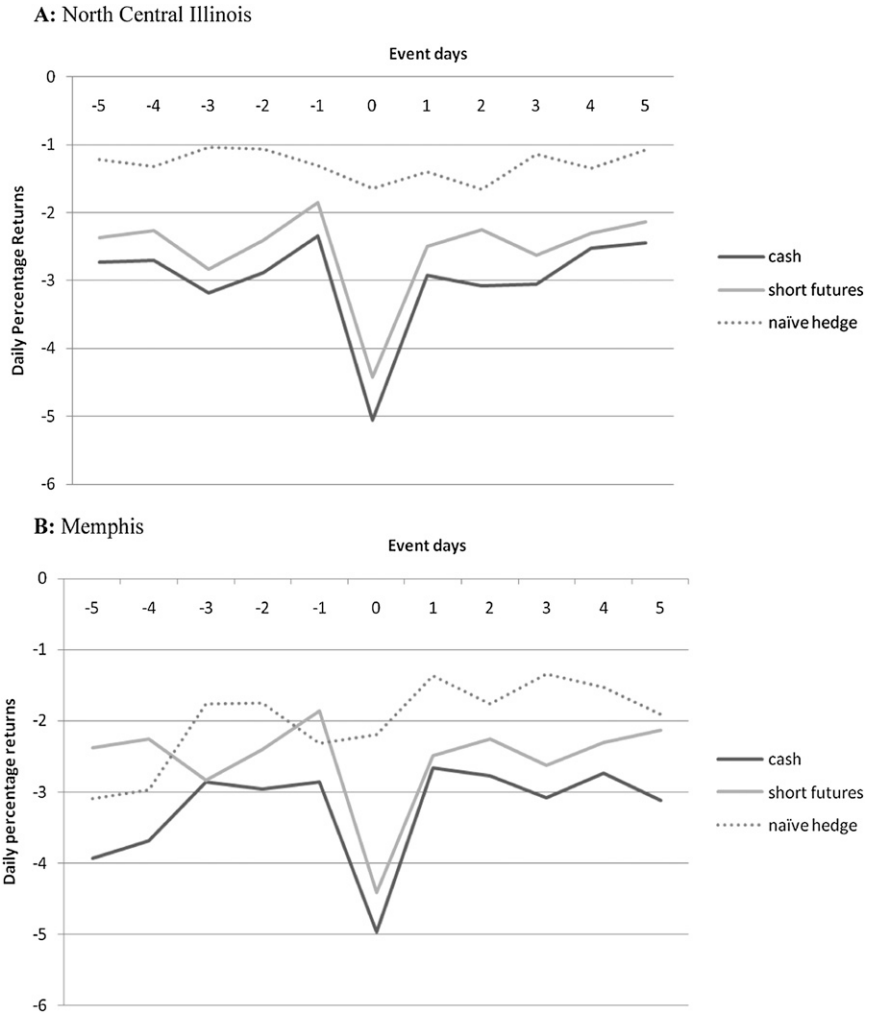**A:** North Central Illinois

B: Memphis

Figure 4. VAR Corn Losses 5%; Panel A – North Central Illinois; Panel B – Memphis

irrespective of market. This fact is also borne out in Figure 5, where it can be seen that VAR 5% hedged soybean losses tend to be very similar for both markets.

Importantly, it should also be emphasized that our results confirm that storing unhedged cash grain (corn or soybeans) across event window in Memphis, is more risky (results in larger potential losses) than storing hedged grain in Memphis. For example, F-test reveals that unhedged soybean cash losses on non-event days (2.34%) are significantly greater than hedged soybean losses on non-event days (1.07%). As is the case with North Central Illinois, the worst possible percentage losses of 5.28% or more occur when storing unhedged

cash corn on event days. Also, as is the case with North Central Illinois, at the 1% VAR level, additional losses attributed to storing in Memphis are correspondingly larger. However, all of the conclusions we reached with respect to our 5% VAR level results remain unchanged.

Conclusions

The main objective of this study was to analyze the effectiveness of hedging as a marketing strategy to counter the risk of potential losses induced by large price spikes following the release of new information contained in USDA crop reports. Traditional hedging effectiveness measures were used to evaluate historical returns
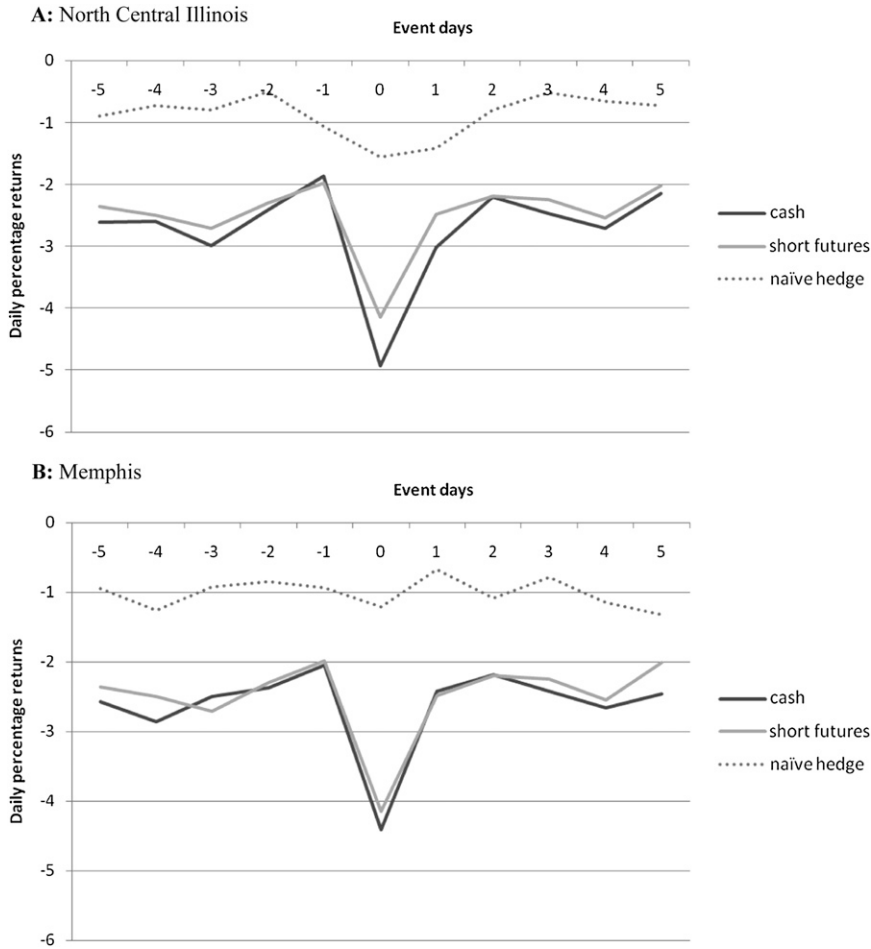
A: North Central Illinois

B: Memphis

Figure 5. VAR Soybean Losses 5%; Panel A – North Central Illinois; Panel B – Memphis

associated with hedged and unhedged cash positions for North Central Illinois and Memphis corn and soybean markets. Then, to evaluate the potential impact of extreme tail losses, VAR loss levels were derived from simulated hedged, speculative short futures, and unhedged cash positions. These losses were then examined using ANOVA to uncover underlying factors that impact losses and hence influence hedging effectiveness.

Our analysis reveals that hedging stored grain over USDA report days is extremely important and beneficial from a risk management perspective, irrespective of market location or crop. Unhedged corn and soybean losses can be extremely larger on event versus non-event days. Results presented in Tables 3 and 4 clearly show that in all but one case (storing

soybeans in North Central Illinois), hedging effectiveness is statistically greater on event days versus non-event days. Of course, if we consider hedging effectiveness purely in terms of basis risk, our results also indicate that in all cases basis volatility is statistically highest on event days. This, along with our hedging effectiveness results, highlights the fact that although potential losses irrespective of marketing strategy tend to be greatest on event days, hedging does lead to lower losses than storing unhedged cash grain.

While our finding that hedging corn is more effective in North Central Illinois than Memphis around USDA reports is perhaps not unexpected, the magnitude of the impact is surprising. For example, from Table 6 we can infer that storing unhedged corn over USDA report days in North Central Illinois results in potential losses of

6.76%, 1% of the time. In contrast, hedging corn over USDA report days in North Central Illinois results in potential losses of only 2.28% or greater, 1% of the time. Even in Memphis, where we found corn hedging to be less effective, hedging over these event days is still very beneficial. For example, storing unhedged corn over USDA report days in Memphis results in potential losses of 7.17%, 1% of the time. In contrast, hedging corn over USDA report days in Memphis results in potential losses of only 3.17% or greater, 1% of the time. To put this into perspective, it is informative to translate these potential percentage losses into monetary losses based upon current December corn futures price of $3.80 per bushel (CBOT closing price July 18, 2010). In this case, potential daily unhedged losses in Memphis would equal 27 cents per bushel, while potential daily hedging losses in Memphis would only amount to 12 cents per bushel. This clearly shows that hedging corn in Memphis, although not as effective as hedging corn in North Central Illinois, is still preferred to simply storing unhedged corn positions around USDA reports. Although our historical hedging effectiveness results indicate the Memphis market experiences relatively high levels of basis risk and volatility several days prior to and on USDA report release dates, hedging is still very effective because cash price risk and volatility is even greater.

In sum, we find that release of USDA crop reports, location, storage strategy, and crop type all have an impact on VAR losses. Our VAR results are consistent with our historical returns results. Notably, storing hedged corn positions across event window yields greater losses in Memphis than in North Central Illinois. Thus there is considerable evidence that hedging corn in Memphis is less effective than hedging corn in North Central Illinois. However, hedging corn compared with storing unhedged cash corn is still the preferred strategy in terms of risk reduction. In contrast, we find that hedging soybeans is as equally effective in Memphis as in North Central Illinois, and from a risk perspective is preferred to storing unhedged soybeans.

Given our empirical findings with respect to market location, a natural question to ask is: why in general is corn basis risk higher and corn hedging effectiveness lower in Memphis compared with North Central Illinois? First, one important reason is that CBOT corn futures prices better reflect local supply and demand in the midwest corn belt, and so futures prices tend to be more closely aligned to midwest corn cash prices. This explanation is consistent with the North Carolina grain market cointegration results of Fortenbery and Zapata (1993). Second, corn markets in the midsouth, where grain elevators trade corn in much lower volume with a higher concentration of users, tend to have much larger and more variable handling margins, which have a direct impact on corn basis volatility.

On a final note, perhaps our most significant result is that USDA crop reports have a substantial impact on basis variability in both North Central Illinois and Memphis. Basis volatility increases significantly on event day in all markets. This would be consistent with cash and futures markets responding to "new" information at different adjustment speeds and magnitudes. With respect to North Central Illinois, corn and soybean basis volatility tends to remain high for one or two days following report release, and is statistically higher in post versus pre event period. This would be consistent with cash and futures markets continuing to respond to report information at differing rates. In contrast, corn basis volatility in Memphis actually declines and hedging effectiveness increases in the week following report release days. This would be consistent with the notion that "news" contained in reports, although inducing an immediate increase in basis risk on day 0, may over the following week remove some uncertainty to this market and help to realign cash and futures prices to a greater degree than during the pre event period. In comparison with North Central Illinois, the immediate day 0 increase in corn basis risk is much larger in Memphis. However, over the course of the next several days, corn basis volatility adjusts to a similar level in both markets.

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