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

Do USDA Announcements Affect the Correlations Across Commodity Futures Returns?

by

Berna Karali and ChangKeun Park

Suggested citation format:

Karali, B., and ChangKeun Park. 2010. "Do USDA Announcements Affect the Correlations Across Commodity Futures Returns?" Proceedings of the NCCC-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management. St. Louis, MO. [http://www.farmdoc.illinois.edu/nccc134].

Do USDA Announcements Affect the Correlations Across Commodity Futures Returns?

Berna Karali

and

ChangKeun Park*

Paper presented at the NCCC-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management
St. Louis, Missouri, April 19-20, 2010

*Berna Karali (bkarali@uga.edu) is an Assistant Professor and ChangKeun Park is a Ph.D. student in the Department of Agricultural and Applied Economics at the University of Georgia.

Do USDA Announcements Affect the Correlations Across Commodity Futures Returns?

The value of USDA reports has long been a question of interest for researchers and practitioners. Many economists have investigated whether the scheduled public report releases have any impact on commodity prices. In general, it is shown that markets are efficient; that is, prices move only when the reports contain "news". However, the impact of announcements on the correlations among related commodity prices has not been explored outside of financial asset markets. The purpose of this study is to simultaneously measure the impact of selected USDA reports on the conditional variances and covariances of returns on related commodity futures contracts using a bivariate GARCH model. It is shown that several of the reports considered contain new information for the market participants as futures return volatilities and correlations between the returns are found to move on announcement days. The largest movements in return volatilities are observed on days with Grain Stocks, Hogs and Pigs, Livestock, Dairy, and Poultry Outlook, and WASDE releases.

Key words: announcement effects, bivariate GARCH, futures markets, market efficiency, soybeans, USDA reports

Introduction

Understanding market structure and the underlying dynamics is an important issue in financial economics. There is a large literature on market forces, price discovery, equilibrium conditions and its dynamics. Market efficiency, which explains how well-functioning markets process new information, plays a major role in explaining price formation.

The efficient markets hypothesis asserts that asset prices move only when new information arrives to the market. Following Fama et al. (1969), many economists have conducted event studies to analyze the impact of economic announcements on asset prices as well as the speed of their adjustment following new information. See Binder (1998) for a review of event study methodologies and previous work on the topic. If an announcement conveys new information about an asset then the asset price in an efficient market should be affected. However, if the announcement does not convey new information, that is, if the information is already known or expected by market participants, no price change should occur.

Event studies primarily have been used to determine the impact of macroeconomic announcements on financial asset prices and exchange rates. For example, Hakkio and Pearce (1985) study the responses of spot exchange rates to several types of economic news using survey data from Money Market Services to break down the announcements into expected and unexpected components. They find that exchange rates respond to unexpected changes in the money stock and the response is completed in twenty minutes. Ederington and Lee (1995) measure the impact of 18 scheduled macroeconomic news releases on the T-bond, Eurodollar, and Deutschemark futures markets by using 10-second returns and tick-by-tick data. The authors report that for all three markets the major price adjustment occurs in the first minute, but prices continue to adjust for at least 10 minutes. Balduzzi, Elton, and Green (2001) analyze changes in price, volume, bid-ask spread, and volatility of the U.S. Treasury bonds with varying maturities in response to public economic announcements. They find that announcements affect bond prices, their volatility, and spreads, and that adjustments occur quickly. Andersen et al. (2003) examine the impact of macroeconomic announcements on the real-time U.S. dollar spot exchange-rate quotations. Their results show that the unexpected components of the announcements cause jumps in the conditional means and variances, with the adjustment speed of the latter being more gradual. More recently, Pearce and Solakoglu (2007) show that news indicating strong U.S. economy result in appreciation of the U.S. dollar against the Deutsche Mark and Japanese Yen, with responses being completed within six hours of five-minute intervals.

In agricultural economics, researchers have investigated the impact of various USDA reports on commodity futures prices. For example, Sumner and Mueller (1989) report that releases of USDA harvest forecasts, especially in August, September, and October, have an impact on the daily price changes in corn and soybean futures markets. Colling and Irwin (1990), using market survey data, show that live hog futures prices react significantly to the unanticipated components of the Hogs and Pigs reports. Fortenbery and Sumner (1993), on the other hand, examine the effects of Crop Production reports and World Agricultural Supply and Demand Estimates (WASDE) on corn and soybean futures and options markets and find that from 1985 through 1989 the impact of USDA reports has diminished relative to earlier periods. Mann and Dowen (1996) show that the release of the Hogs and Pigs reports increased price variability and trade volume in live hog and pork belly futures markets. Schaefer, Myers, and Koontz (2004) investigate the role of proprietary information on price discovery within the U.S. live cattle futures market using unique private data collected by Professional Cattle Consultants. They conclude that the information contained in this proprietary data source has explanatory power for forecasting final revised numbers in Cattle on Feed reports and for predicting short-term price movements of futures contracts. They also report that the initial estimates in the Cattle on Feed reports still have new information that moves prices even after accounting for the proprietary data. Similar to the current study, Isengildina, Irwin, and Good (2006) analyze the impact of selected USDA reports on the volatility of live/lean hog and live cattle futures returns by using a univariate TARCH-in-mean model. More recently, McKenzie (2008) concludes that USDA crop reports still convey new information to the corn futures market by showing that the reports would improve market participants' price expectations if released a day early.

All studies mentioned above consider only the movement of an asset's price following an announcement. However, we believe that understanding co-movement across different assets following an announcement is also important for minimizing risk through portfolio diversification. In the financial assets literature, Christiansen and Ranaldo (2007) analyze the news impact of macroeconomic announcements on realized variance and realized correlation of bond and stock returns and show that macroeconomic announcements have a significant impact on the realized stock-bond correlation. Similarly, Thomakos et al. (2008) analyze the effects of macroeconomic announcements on return volatilities, covariances, and correlations between Eurodollar futures and U.S. Treasury bond futures and show that all three react to information content of the announcements.

Our goal is to understand how correlations across commodity prices evolve around announcement days. Understanding how commodity prices are related to each other would help producers, commodity traders, and policy makers to make better informed decisions. From an econometric perspective, we propose the use of a bivariate GARCH model to simultaneously estimate the effects of USDA announcements on both conditional variances and covariances of commodity futures returns. We believe that this should result in more efficient estimates compared to the ones obtained from separate OLS or GARCH estimations.

Results show that several of the USDA reports considered convey new information to market participants. The return volatilities of soybeans, soybean oil, and soybean meal futures move on report release days, especially on the days with Grain Stocks, Hogs and Pigs, Livestock, Dairy, and Poultry Outlook, and WASDE releases. The covariances, and therefore the correlations, between soybeans and soybean oil returns and between soybeans and soybean meal returns also move on announcement days. The movement in the covariance between soybeans and soybean oil returns on announcement days ranges from -0.75 percentage points to 0.97 percentage points, while for soybeans and soybean meal it ranges from -0.50 to 0.88 percentage points. Seasonality and some day-of-the-week effects are also found to explain return variances and covariances.

Futures Returns and USDA Reports

We analyze soybeans, soybean oil, and soybean meal futures contracts traded at the Chicago Board of Trade from January 1990 through December 2007. Delivery months for soybeans futures are January, March, May, July, August, September, and November. Prices are quoted as cents per bushel and the contract size is 5,000 bushels. For soybean oil and soybean meal, delivery months are January, March, May, July, August, September, October, and December. Soybean oil futures are quoted as cents per pound and the contract size is 60,000 pounds. Soybean meal prices are stated in dollars and cents per short ton and the contract size is 100 short ton. To construct continuous price series, March contracts are rolled over at the end of the month preceding delivery, that is, at the end of April each year.

We measure approximate percentage change in daily return on grain futures as

$$\%\Delta\text{Return} \equiv R_{it} = 100 \times (\ln F_{it} - \ln F_{i,t-1}), \tag{1}$$

where $\ln F_{it}$ is the natural logarithm of the closing price of commodity i's futures contract on day t. Table 1 presents summary statistics for both percentage change in daily return and its absolute value. The average size of the movements in daily returns of soybeans, soybean oil, and soybean meal futures are 0.94, 0.97, and 1.02 percentage points, respectively.

We consider eleven USDA reports related to the futures markets studied. These are Acreage, Prospective Plantings, Cattle, Cattle on Feed, Crop Progress, Feed Outlook, Grain Stocks, Hogs and Pigs, Livestock, Dairy, and Poultry Outlook (LDPO), Oil Crops Outlook, and World Agricultural and Supply Estimates (WASDE). After taking into consideration the report release times, dummy variables for the release dates are created. More specifically, Acreage, Feed Outlook, Grain Stocks, and LDPO reports are released before trading starts, whereas the remaining reports (except Prospective Plantings and WASDE) are released after trading ends. For reports released before trading starts, dummy variables take the value of one on the exact release date. Because we measure the change in closing price from one day to the other, for reports released after the end of trading, dummy variables take the value of one on the day following the release. There has been a change in the release times for Prospective Plantings and WASDE reports during our sample period. Before 1996, Prospective Planting reports were released after trading hours. For those years, its dummy variable is set to one on the days after the release, and starting from 1996 to one on the release days. Due to the small number of observations, we combine Acreage and Prospective Plantings reports (APP) after all date adjustments have been made. WASDE reports were scheduled to be released after trading hours before May, 1994, after which its release time was switched to before trading hours. The same adjustment as the one for Prospective Plantings is made for the WASDE dummy variable. Further, following Fortenbery and Sumner (1993) and Irwin, Good, and Gomez (2001) the WASDE dummy variable is divided into two categories: one that coincides with the NASS production reports during August through November (WASDE Mix) and one that conveys only outlook information during December through July (WASDE Pure).

Table 1 reports summary statistics for the announcement dummy variables using all trading days (both announcement and non-announcement days). In total, there were 1,517 report releases in our 4,460 trading-days sample from January 1, 1990 to December 31, 2007. Some of the report releases overlap, leaving a total of 1,226 release days. As seen in the table, APP reports were released 33 times, Cattle 36 times, Cattle on Feed 195 times, Crop Progress 448 times, Feed Outlook 146 times, Grain Stocks 69 times, Hogs and Pigs 84 times, LDPO 151 times, Oil Crops Outlook 144 times, WASDE Mix 72 times, and WASDE Pure 139 times.

Table 2 compares various price movement measures across announcement and non-announcement days. When converted to contract size units, it can be seen that the average price movement (ΔPrice) of soybeans contracts on non-announcement days is \$9.70 per contract, whereas it is -\$4.00 per contract on announcement days. Thus, the soybeans futures price decreases, on average, by \$4 from the previous day's closing price on report release days. Similarly, the average price movement of soybean oil futures on non-announcement days is \$6.60 compared to -\$1.80 on announcement days. Again, the soybean oil futures prices fall, on average, on the release days. Finally, soybean meal futures prices increase on average by \$6.70 per contract on non-announcement days and fall by \$5.10 on announcement days. Table 2 shows that the size of the percentage change in soybean returns increases from 0.898 percentage points on non-announcement days to 1.045 percentage points on announcement days. Likewise, the magnitude of the change increases from 0.945 to 1.023 percentage points for soybean oil and from 0.973 to 1.131 percentage points for soybean meal. This demonstrates that daily futures return volatility, which can be proxied with $|\%\Delta\text{Return}|$, increases on report release days. Further, except for the absolute percentage change measure for soybean-soybean oil case, correlations between a commodity pair's price movement measures increases on announcement days.

Bivariate GARCH Model

To simultaneously estimate the impact of external factors, including USDA reports, on daily returns of related commodity futures and their variances, we employ a bivariate GARCH model by incorporating dummy variables into mean and variance equations for those external factors. Lagged values of the dependent variables are included as regressors in the mean equations to account for the autocorrelation in futures returns. The day-of-the-week dummy variables are included in both mean and variance equations, whereas monthly dummy variables, accounting for seasonality, and announcement day dummy variables are included only in the variance equations (see Isengildina, Irwin, and Good, 2006). Denoting the percentage change in the i^{th} commodity's return on day t by R_{it}, the bivariate case is given by:

$$R_{1t} = \delta_1 + \sum_{p=1}^{5} \psi_{1p} R_{1,t-p} + \sum_{d=1}^{4} \theta_{1d} W_{dt} + \varepsilon_{1t}, \tag{2}$$

$$R_{2t} = \delta_2 + \sum_{p=1}^{5} \psi_{2p} R_{2,t-p} + \sum_{d=1}^{4} \theta_{2d} W_{dt} + \varepsilon_{2t}, \tag{3}$$

where

$$\begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} \sim N \left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} h_{1t} & h_{12t} \\ h_{12t} & h_{2t} \end{bmatrix} \right),$$

and

$$h_{1t} = \mu_1 + \alpha_1 \varepsilon^2_{1,t-1} + \beta_1 h_{1,t-1} + \sum_{d=1}^{4} \phi_{1d} W_{dt} + \sum_{m=1}^{11} \varphi_{1m} M_{mt} + \sum_{k=1}^{11} \psi_{1k} A_{kt}, \quad (4)$$

$$h_{2t} = \mu_2 + \alpha_2 \varepsilon^2_{2,t-1} + \beta_2 h_{2,t-1} + \sum_{d=1}^{4} \phi_{2d} W_{dt} + \sum_{m=1}^{11} \varphi_{2m} M_{mt} + \sum_{k=1}^{11} \psi_{2k} A_{kt}, \quad (5)$$

$$h_{12t} = \mu_{12} + \alpha_{12} \varepsilon_{1,t-1} \varepsilon_{2,t-1} + \beta_{12} h_{12,t-1} + \sum_{d=1}^{4} \phi_{12d} W_{dt} + \sum_{m=1}^{11} \varphi_{12m} M_{mt} + \sum_{k=1}^{11} \psi_{12k} A_{kt}. \quad (6)$$

The variable W_{dt} represents the day-of-the-week dummy variables with $W_{1t} = 1$ if t is Monday and zero otherwise, $W_{2t} = 1$ if Tuesday and zero otherwise, and so on for $d = 1, \cdots, 4$. Similarly, the variable M_{mt} represents monthly dummy variables with $M_{1t} = 1$ if t is in January and zero otherwise, $M_{2t} = 1$ if February and zero otherwise, and so on for $m = 1, \cdots, 11$. The dummy variables for each USDA report are $A_{kt} = 1$ if report k is released on day t and zero otherwise for $k = 1, \cdots, 11$. Thus, the reference category for the mean equations is a Friday, and for the variance and covariance equations a Friday in December without any scheduled announcements. Equations (2) through (6) are estimated simultaneously for each commodity pair. Thus, this system of equations are estimated once for soybeans and soybean oil and once for soybeans and soybean meal. We implement the diagonal BEKK method presented in Engle and Kroner (1995) to ensure positive semi-definite variance-covariance matrix. Estimations are carried out using E-Views software.

Empirical Results

Coefficient estimates and their p-values from the bivariate GARCH model for both commodity pairs are presented in table 3. The predicted conditional variances, covariances, and correlations are illustrated graphically in figures 1 and 2. We first discuss the soybeans-soybean oil commodity pair and then the soybeans-soybean meal pair.

Soybeans-Soybean Oil

Autocorrelation is found in the fifth lag for soybeans, and in the first and the fifth lags for soybean oil. Day-of-the-week dummy variables have no statistical power in explaining changes in the means of soybean and soybean oil returns. Likewise, neither conditional variances nor conditional covariance estimates show evidence for day-of-the-week effects. Thus, there is no statistical difference in the return and return volatility of soybean and soybean oil futures on any day of the week. Both ARCH and GARCH estimates are statistically significant in both commodities' return volatility.

Compared to its December level, soybeans return volatility is statistically lower by 0.04 percentage points in January, by 0.07 percentage points in March and September, by 0.03 percentage points in April, and by 0.06 percentage points in October. In contrast, it is statistically greater than its December level by 0.33 percentage points in February, by 0.04 percentage points in May, by 0.10 and percentage points in June, and by 0.11 percentage points in July. Soybean oil return volatility, on the other hand, is statistically lower than its December level in March, August, September, and October, and higher in February, May, June, and July. Conditional covariance of soybeans and soybean oil follows a similar pattern with lower than December covariances in March, September, and October, and higher in February, May, June, and July. Thus, seasonality is mostly present in the conditional variances and covariance.

Most of the USDA reports have statistically significant effects on the conditional variances and covariance. On days with Acreage & Prospective Plantings reports releases, the conditional variance of soybeans returns falls by 0.48 percentage points, while the conditional covariance between soybeans and soybean oil returns falls by 0.43 percentage points. Cattle report releases cause a 0.85, 0.96, and 0.75 percentage point decrease in soybeans return volatility, soybean oil return volatility, and covariance between soybeans and soybean oil returns, respectively. In contrast, Cattle on Feed report releases have positive impact on all three ranging from 0.15 to 0.23 percentage points. Soybeans return volatility decreases by 0.40 percentage points on the days with Feed Outlook releases while the conditional variance of soybean oil returns and the conditional covariance between soybeans and soybean oil returns falls by 0.31 percentage points. Grain Stocks has a greater impact on soybeans return volatility (an increase of 0.84 percentage points). Its effect on the conditional variance of soybean oil returns and the conditional covariance is 0.42 and 0.49 percentage points, respectively. Similarly, Hogs and and Pigs reports and Livestock, Dairy, and Poultry Outlook (LDPO) reports positively affect all three. The largest announcement effect is the release of WASDE Mix reports. Conditional variances increase by 0.96 and 1.27 percentage points and the conditional covariance by 0.97. WASDE Pure estimates are statistically insignificant. These findings on WASDE effects are consistent with those in Irwin, Good, and Gomez (2001). Crop Progress and Oil Crops Outlook reports also have no explanatory power in variance equations.

Soybeans-Soybean Meal

Only the fifth lag of soybeans and soybean meal returns shows evidence of autocorrelation. None of the day-of-the-week dummy variables are statistically significant in the mean equations. However, there is a Monday and Thursday effect in the variance equations. Compared to Fridays, the soybeans and soybean meal return volatilities are higher by 0.19 and 0.15 percentage points, respectively, on Mondays. The conditional covariance is also higher by 0.21 percentage points on Mondays compared to Fridays. As in the soybeans-soybean oil case, both ARCH and GARCH terms are statistically significant.

Seasonality is prominent in the soybeans-soybean meal variance equations as well. Compared to December, return volatilities and covariance are lower in January, March, April, August (except soybean meal variance), September, and October. In contrast, they are higher than their December counterparts in February, May, June, and July. The positive monthly effect ranges from 0.03 to 0.18 percentage points while the negative effect ranges from 0.02 to 0.11 percentage points in absolute value.

Like the soybeans-soybean oil case, APP and Cattle report releases have a negative impact on conditional variances and covariance. The APP effect is about a 0.5 percentage point decrease for all three. The Cattle report effect ranges from 0.28 to 0.62 percentage points in absolute value. Cattle on Feed report releases cause soybeans and soybean meal return volatilities to increase by 0.10 and 0.17 percentage points, respectively. Similarly, conditional covariance increases by 0.11 percentage point on release dates. Crop Progress reports have a negative impact on soybeans return volatility in this case. Unlike the soybeans-soybean oil case, none of the Feed Outlook parameter estimates are statistically significant. Grain Stocks reports positively affect both conditional variances and covariance. The effect on soybeans return volatility is 0.80 percentage points. Its effect on soybean meal return volatility and on the covariance between soybeans and soybean meal returns are greater than what is found for soybean oil. The effect of Hogs and Pigs report on soybean return volatility is decreased in this commodity pair estimation. LDPO reports positively affect both variance and the covariance, its impact ranging from 0.68 percentage points to 0.92. Oil Crops Outlook report now has statistically significant negative impact on the soybean return volatility with -0.37 percentage points. Again, all of the WASDE Mix estimates are statistically significant, while none of the WASDE Pure estimates are significant. The WASDE Mix effect is an increase of about 0.7 percentage points for both variances and covariance.

Conclusions

The impacts of USDA reports on commodity prices are well studied in literature. Extensive research has been conducted to determine if the information contained in the these reports has any value; that is, if they convey new information about the commodities to market participants. In general, empirical findings have been supportive for the continuation of the USDA reports.

While the price reaction of commodity futures following an announcement has been explored extensively in previous research, the impact of announcements on the comovement or correlation between related asset prices has not been investigated outside of financial asset markets. Our study fills this gap by simultaneously estimating the impact of several USDA reports on the conditional variances and covariances of returns on related commodity futures contracts by using a bivariate GARCH model.

Our results show that several of the reports considered have a statistically significant effect on both return volatilities and the conditional covariance. Announcement effects on soybeans return volatility range from -0.85 percentage points to 0.96 percentage points. The largest impact is seen on the days with WASDE releases during August through November (WASDE Mix). The range for soybean oil return variance is -0.96 to

1.27 percentage points, with the impact of WASDE Mix being the largest. Covariance between soybeans and soybean oil returns also react to announcements within the range (-0.75, 0.97). The range of the movement in soybean meal return variance due to report releases is (-0.62, 1.0), with Grain Stocks reports having the largest impact. Finally, the effects of report releases on the covariance between soybeans and soybean meal range from -0.50 to 0.88 percentage points. When the square roots of these announcement effects are compared to the average absolute percentage change in return ($|\%\Delta \text{Return}|$), these effects are sizeable.

Ignoring ARCH and GARCH terms, the estimated correlation between soybeans and soybean oil returns is -0.4 on Fridays in December when there are no report releases. The correlation becomes positive and greater in magnitude on release dates. It becomes 0.7 on the days with Grain Stocks and Hogs and Pigs report releases, and 0.8 on the days with LDPO and WASDE Mix releases. The estimated correlation between soybeans and soybean meal returns is 0.9 on days with Grain Stocks, LDPO, and WASDE Mix releases, and 0.6 on days with Hogs and Pigs report releases. Thus, the return on any portfolio consisting of soybeans, soybean oil, and/or soybean meal futures contracts will move on these announcement days. Other external factors that are found to affect conditional variance-covariance equations are seasonality and day of the week (only in soybeans-soybean meal case). In addition, autocorrelation is found in mean equations to some degree.

Current research will be extended to include other covariates in the mean and variance equations, such as commodity inventories and time to delivery. The analysis will also be applied to other related commodity pairs, such as corn-soybeans, corn-live cattle, corn-lean hogs, wheat-soybeans, and wheat-corn. Another useful extension in consideration is to model all three commodities studied here (soybeans, soybean oil, and soybean meal) together via trivariate GARCH.

References

Andersen, T.G., T. Bollerslev, F.X. Diebold, and C. Vega. 2003. "Micro Effects of Macro Announcements: Real-Time Price Discovery in Foreign Exchange." *The American Economic Review* 93:38–62.

Balduzzi, P., E.J. Elton, and T.C. Green. 2001. "The Effects of Macroeconomic News on High Frequency Exchange Rate Behavior." *Journal of Financial and Quantitative Analysis* 36:523–543.

Binder, J.J. 1998. "The Event Study Methodology Since 1969." *Review of Quantitative Finance and Accounting* 11:111–137.

Christiansen, C., and A. Ranaldo. 2007. "Realized Bond-Stock Correlation: Macroeconomuic Announcement Effects." *The Journal of Futures Markets* 27:439–469.

Colling, P.L., and S.H. Irwin. 1990. "The Reaction of Live Hog Futures Prices to USDA "Hogs and Pigs Reports"." *American Journal of Agricultural Economics* 72:84–94.

Ederington, L.H., and J.H. Lee. 1995. "The Short-Run Dynamics of the Price Adjustment to New Information." *The Journal of Financial and Quantitative Analysis* 30:117–134.

Engle, R.F., and K.F. Kroner. 1995. "Multivariate Simultaneous Generalized ARCH." *Econometric Theory* 11:122–150.

Fama, E.F., L. Fisher, M.C. Jensen, and R. Roll. 1969. "The Adjustment of Stock Prices to New Information." *International Economic Review* 10:1–21.

Fortenbery, T.R., and D.A. Sumner. 1993. "The Effects of USDA Reports in Futures and Options Markets." *The Journal of Futures Markets* 13:157–173.

Hakkio, C.S., and D.K. Pearce. 1985. "The Reaction of Exchange Rates to Economic News." *Economic Inquiry* 23:621–636.

Irwin, S.H., D.L. Good, and J.K. Gomez. 2001. "The Value of USDA Outlook Information: An Investigation Using Event Study Analysis." Proceedings of the 2001 NCR-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management. St. Louis, MO. [http://purl.umn.edu/18948].

Isengildina, O., S.H. Irwin, and D.L. Good. 2006. "The Value of USDA Situation and Outlook Information in Hog and Cattle Markets." *Journal of Agricultural and Resource Economics* 31:262–282.

Mann, T.L., and R.J. Dowen. 1996. "Are Hog and Pig Reports Informative?" *The Journal of Futures Markets* 16:273–287.

McKenzie, A.M. 2008. "Pre-Harvest Price Expectations for Corn: The Information Content of USDA Reports and New Crop Futures." *American Journal of Agricultural Economics* 90:351–366.

Pearce, D.K., and M.N. Solakoglu. 2007. "Macroeconomic News and Exchange Rates." *Journal of International Financial Markets, Institutions & Money* 17:307–325.

Schaefer, M.P., R.J. Myers, and S.R. Koontz. 2004. "Rational Expectations and Market Efficiency in the U.S. Live Cattle Futures Market: The Role of Proprietary Information." *The Journal of Futures Markets* 24:429–451.

Sumner, D.A., and R.A.E. Mueller. 1989. "Are Harvest Forecasts News? USDA Announcements and Futures Market Reactions." *American Journal of Agricultural Economics* 71:1–8.

Thomakos, D.D., T. Wnag, J. Wu, and R.P. Chuderewicz. 2008. "Macroeconomic Announcements, Intrady Covariance Structure and Asymmetry in the Interest Rate Futures Returns." *The Journal of Futures Markets* 28:815–844.

Table 1: Summary Statistics

$N = 4,460$	Mean	Min.	Max.	Std. Dev.
%ΔReturn$= 100 \times (\ln F_t - \ln F_{t-1})$				
Soybeans	0.012	-24.391	13.256	1.361
Soybean Oil	0.023	-21.412	13.402	1.390
Soybean Meal	0.014	-24.308	17.682	1.543
$\|$%ΔReturn$\| = \|100 \times (\ln F_t - \ln F_{t-1})\|$				
Soybeans	0.938	0	24.391	0.986
Soybean Oil	0.967	0	21.412	0.998
Soybean Meal	1.016	0	24.308	1.161
Announcement Day Dummy Variables				
Acreage & Prospective Plantings (33)	0.007	0	1	0.086
Cattle (36)	0.008	0	1	0.089
Cattle on Feed (195)	0.044	0	1	0.204
Crop Progress (448)	0.100	0	1	0.301
Feed Outlook (146)	0.033	0	1	0.178
Grain Stocks (69)	0.015	0	1	0.123
Hogs and Pigs (84)	0.019	0	1	0.136
Livestock, Dairy, and Poultry Outlook (151)	0.034	0	1	0.181
Oil Crops Outlook (144)	0.032	0	1	0.177
WASDE Mix (72)	0.016	0	1	0.126
WASDE Pure (139)	0.031	0	1	0.174

Notes: Rolled over March contracts from 01/01/1990 to 12/31/2007 are used. The summary statistics of announcement dummy variables are computed using both announcement and non-announcement days. The numbers in parentheses represent the total number of report releases in the sample period.

Table 2: Price Movements and Their Correlations

	All Days ($N = 4,460$)			Announcement Days ($N = 1,226$)			Non-Announcement Days ($N = 3,234$)		
	ΔPrice	%ΔReturn	|%ΔReturn|	ΔPrice	%ΔReturn	|%ΔReturn|	ΔPrice	%ΔReturn	|%ΔReturn|
Soybeans (S)	0.118	0.012	0.938	-0.080	-0.009	1.045	0.194	0.021	0.898
Soybean Oil (BO)	0.007	0.023	0.968	-0.003	-0.022	1.023	0.011	0.040	0.945
Soybean Meal (SM)	0.035	0.014	1.016	-0.051	-0.024	1.131	0.067	0.028	0.973
Correlations									
S - BO	0.747	0.743	0.661	0.776	0.769	0.618	0.737	0.733	0.675
S - SM	0.900	0.885	0.825	0.923	0.914	0.843	0.890	0.874	0.818

Notes: ΔPrice=$F_t - F_{t-1}$, %ΔReturn=$100 \times (\ln F_t - \ln F_{t-1})$, and |%ΔReturn|= $|100 \times (\ln F_t - \ln F_{t-1})|$, where F_t is the price of the relevant futures contract on day t.

Table 3: Bivariate GARCH Estimation Results

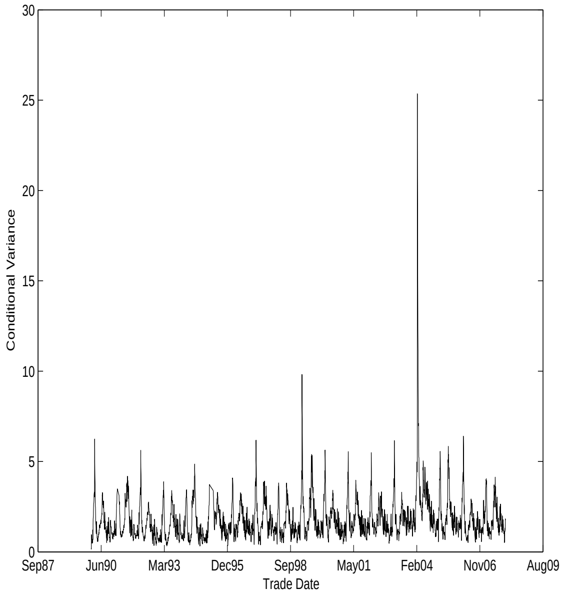
	Soybeans - Soybean Oil			Soybeans - Soybean Meal		
	S	BO	S-BO	S	SM	S-SM
Mean Equations						
Constant	-0.020	0.027		-0.009	-0.007	
	(0.637)	(0.538)		(0.816)	(0.859)	
R_{t-1}	0.005	0.026		-0.012	0.006	
	(0.701)	(0.032)		(0.266)	(0.604)	
R_{t-2}	-0.009	-0.018		-0.015	-0.028	
	(0.483)	(0.135)		(0.176)	(0.016)	
R_{t-3}	-0.021	-0.017		-0.012	-0.006	
	(0.106)	(0.172)		(0.284)	(0.567)	
R_{t-4}	-0.007	0.003		0.000	-0.014	
	(0.573)	(0.831)		(1.000)	(0.212)	
R_{t-5}	-0.029	-0.033		-0.033	-0.031	
	(0.023)	(0.008)		(0.002)	(0.007)	
Monday	-0.002	-0.089		0.010	0.006	
	(0.971)	(0.138)		(0.844)	(0.917)	
Tuesday	0.032	-0.008		0.043	0.023	
	(0.570)	(0.894)		(0.402)	(0.691)	
Wednesday	0.052	0.004		0.069	0.055	
	(0.365)	(0.944)		(0.177)	(0.327)	
Thursday	-0.044	-0.075		-0.053	-0.053	
	(0.444)	(0.209)		(0.321)	(0.373)	
Variance Equations						
Constant	0.093	0.050	-0.028	-0.080	0.008	-0.059
	(0.128)	(0.414)	(0.623)	(0.014)	(0.857)	(0.080)
ARCH(1)	0.190	0.147		0.117	0.149	
	(0.000)	(0.000)		(0.000)	(0.000)	
GARCH(1)	0.951	0.968		0.977	0.961	
	(0.000)	(0.000)		(0.000)	(0.000)	
Monday	-0.004	-0.075	0.081	0.195	0.148	0.212
	(0.966)	(0.436)	(0.371)	(0.000)	(0.017)	(0.000)
Tuesday	-0.112	-0.016	0.013	0.053	-0.057	0.036
	(0.225)	(0.869)	(0.880)	(0.297)	(0.430)	(0.504)
Wednesday	-0.086	-0.072	0.014	0.015	-0.081	-0.030
	(0.313)	(0.423)	(0.861)	(0.800)	(0.291)	(0.637)
Thursday	-0.023	0.087	0.090	0.213	0.153	0.193
	(0.818)	(0.381)	(0.332)	(0.000)	(0.013)	(0.000)

Continued on next page...

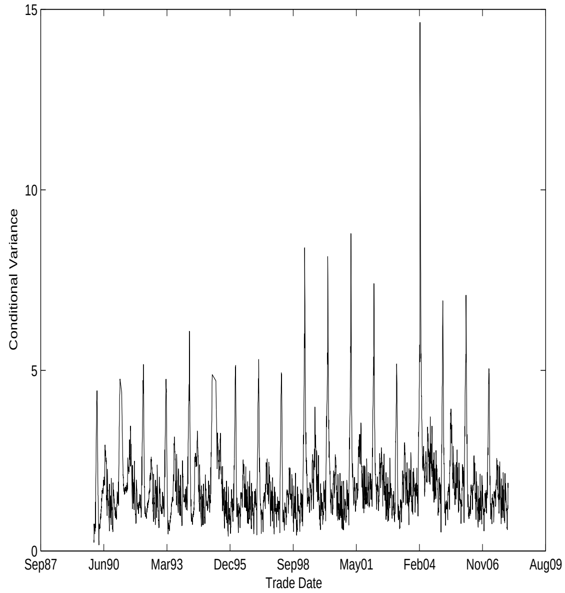
Table 3 – Continued

	Soybeans - Soybean Oil			Soybeans - Soybean Meal		
	S	BO	S-BO	S	SM	S-SM
Variance Equations (cont'd.)						
January	-0.043	-0.030	-0.018	-0.056	-0.075	-0.061
	(0.049)	(0.109)	(0.319)	(0.000)	(0.000)	(0.000)
February	0.335	0.353	0.251	0.074	0.182	0.104
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
March	-0.073	-0.152	-0.067	-0.058	-0.108	-0.074
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
April	-0.035	-0.007	-0.017	-0.022	-0.032	-0.026
	(0.028)	(0.660)	(0.251)	(0.041)	(0.021)	(0.025)
May	0.039	0.036	0.048	0.046	0.033	0.042
	(0.015)	(0.023)	(0.001)	(0.000)	(0.018)	(0.000)
June	0.102	0.051	0.080	0.083	0.089	0.092
	(0.000)	(0.003)	(0.000)	(0.000)	(0.000)	(0.000)
July	0.111	0.062	0.090	0.048	0.073	0.064
	(0.000)	(0.003)	(0.000)	(0.013)	(0.002)	(0.002)
August	-0.028	-0.045	-0.018	-0.046	-0.028	-0.033
	(0.206)	(0.016)	(0.322)	(0.002)	(0.142)	(0.042)
September	-0.075	-0.076	-0.046	-0.052	-0.074	-0.054
	(0.000)	(0.000)	(0.010)	(0.001)	(0.000)	(0.001)
October	-0.065	-0.081	-0.048	-0.048	-0.050	-0.041
	(0.000)	(0.000)	(0.003)	(0.000)	(0.002)	(0.003)
November	-0.033	-0.021	-0.006	-0.030	-0.030	-0.030
	(0.152)	(0.333)	(0.751)	(0.075)	(0.142)	(0.084)
APP	-0.480	-0.259	-0.426	-0.504	-0.498	-0.503
	(0.091)	(0.339)	(0.091)	(0.012)	(0.050)	(0.015)
Cattle	-0.853	-0.958	-0.753	-0.283	-0.622	-0.395
	(0.000)	(0.000)	(0.000)	(0.049)	(0.001)	(0.012)
Cattle on Feed	0.146	0.191	0.230	0.105	0.168	0.110
	(0.085)	(0.038)	(0.006)	(0.040)	(0.006)	(0.030)
Crop Progress	0.009	-0.053	-0.050	-0.040	0.020	-0.023
	(0.837)	(0.124)	(0.160)	(0.046)	(0.514)	(0.334)
Feed Outlook	-0.398	-0.310	-0.311	0.074	-0.082	-0.001
	(0.004)	(0.034)	(0.009)	(0.511)	(0.587)	(0.990)
Grain Stocks	0.854	0.420	0.491	0.804	1.011	0.884
	(0.000)	(0.026)	(0.005)	(0.000)	(0.000)	(0.000)
Hogs and Pigs	0.316	0.438	0.344	0.129	0.219	0.119
	(0.014)	(0.000)	(0.002)	(0.069)	(0.031)	(0.149)
LDPO	0.643	0.535	0.566	0.678	0.918	0.772
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Oil Crops Outlook	-0.001	-0.141	-0.080	-0.374	0.004	-0.180
	(0.997)	(0.294)	(0.487)	(0.000)	(0.977)	(0.131)
WASDE Mix	0.962	1.272	0.970	0.763	0.738	0.696
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
WASDE Pure	-0.112	-0.002	0.062	0.028	0.044	0.016
	(0.386)	(0.987)	(0.630)	(0.780)	(0.713)	(0.875)

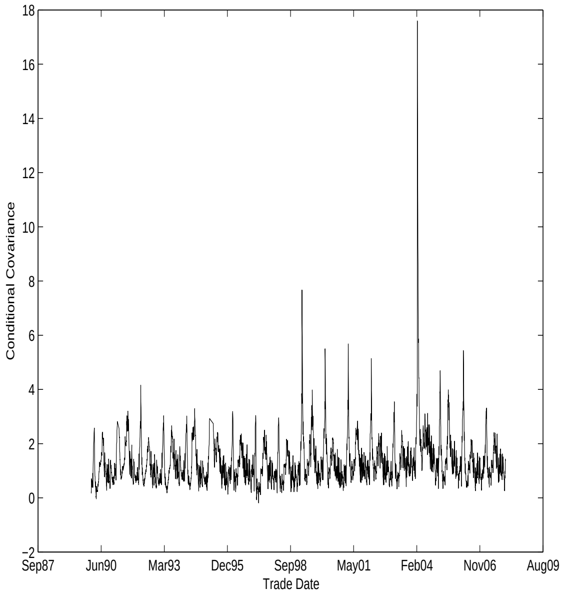
Notes. Mean equations are $\%\Delta\text{Return} \equiv R_{it} = 100 \times (\ln F_{it} - \ln F_{i,t-1}) = \delta_i + \sum_{p=1}^{5} \psi_{ip} R_{i,t-p} + \sum_{d=1}^{4} \theta_{id} W_{dt} + \varepsilon_{it}$, and variance equations are $h_{it} = \mu_i + \alpha_i \varepsilon_{i,t-1}^2 + \beta_i h_{i,t-1} + \sum_{d=1}^{4} \phi_{id} W_{dt} + \sum_{m=1}^{11} \varphi_{im} M_{mt} + \sum_{k=1}^{11} \psi_{ik} A_{kt}$.



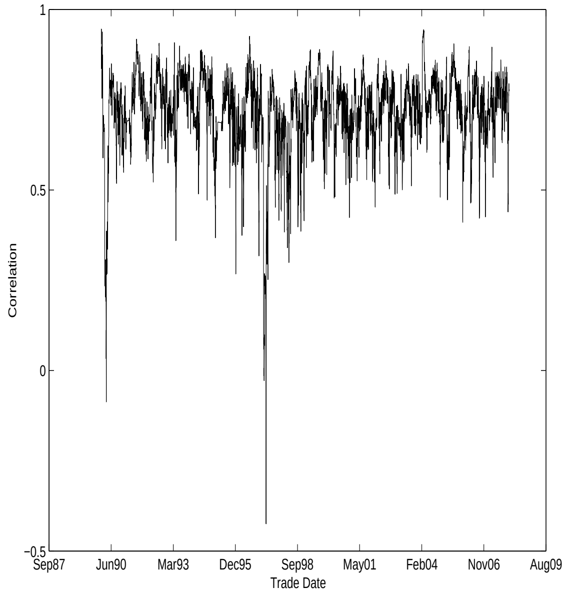
(a) Var(S)



(b) Var(BO)

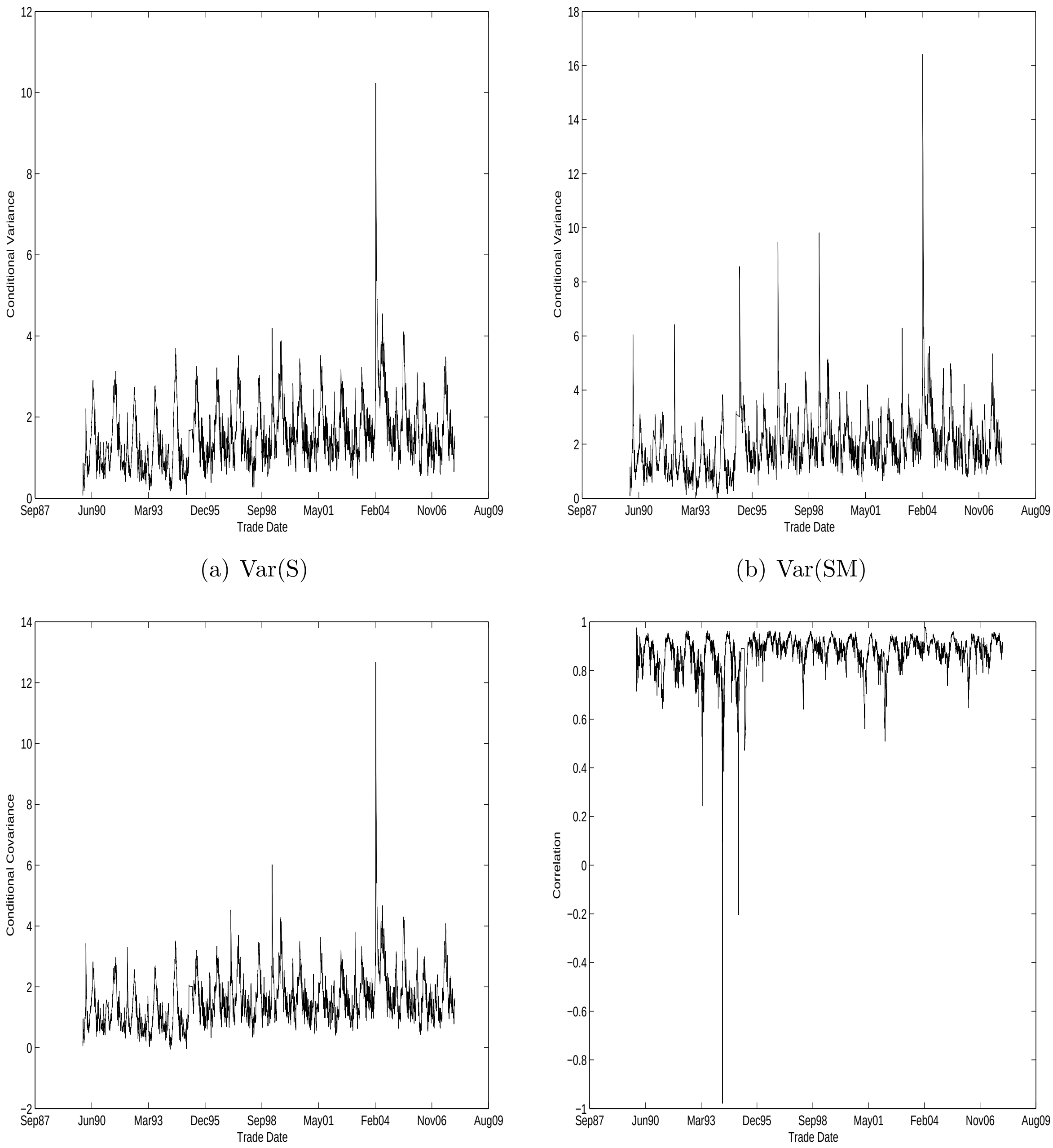


(c) Cov(S,BO)



(d) Corr(S,BO)

Figure 1: Conditional Variances, Covariances, and Correlations: Soybeans - Soybean Oil



(a) Var(S) (b) Var(SM)

(c) Cov(S,SM) (d) Corr(S,SM)

Figure 2: Conditional Variances, Covariances, and Correlations: Soybeans - Soybean Meal