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

Information Content of USDA Rice Reports and Price Reactions of Rice Futures

by

Jessica L. Darby and Andrew M. McKenzie

Suggested citation format:

Darby, J. L., and A. M. McKenzie. 2015. "Information Content of USDA Rice Reports and Price Reactions of Rice Futures." 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].

Information Content of USDA Rice Reports and Price Reactions of Rice Futures

Jessica L. Darby[1] and Andrew M. McKenzie[2]

Paper presented at the 2015 NCCC-134 Committee on Applied Commodity Price Analysis, Forecasting, and Market Risk Management

(1) Walton Accelerated MBA Candidate and (2) Professor in the Department of Agricultural Economics and Agricultural Business at the University of Arkansas

Abstract

Rice is a predominant food staple in many regions of the world, and international rice markets play a vital role in ensuring the food security needs of developing countries. It is important to develop economic tools and market-based instruments to aid in the price discovery process, mitigate the effects of price instability, and make rice markets more responsive to the needs of both consumers and producers. The purpose of this study is to estimate the economic value of USDA supply and demand forecasts, specifically WASDE and NASS, with respect to rice futures markets. Two event study approaches are utilized in this study: (1) examine variability in returns on report-release days as compared to returns on pre- and post-report days, and (2) regress price reactions on changes in usage and production information. It is found that the USDA provides the rice futures markets with valuable information, and rice futures respond to the information in an economically consistent manner.

Key Words: Rice, WASDE, USDA, market reactions, information content, futures

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1. Background

Rice is a predominant food staple in many regions of the world, and international rice markets play a vital role in ensuring the food security needs of developing countries. However, rice is sensitive to a variety of factors that can adversely impact production and market efficiency, including weather variability, inter-seasonal volatility, water resources, and risk management decisions. It is important to develop economic tools and market-based instruments to aid in the price discovery process, mitigate the effects of price instability, and make rice markets more responsive to the needs of both consumers and producers. As Milo Hamilton explained in his book, “When Rice Shakes the World”, it is not about the price of rice, but its ability to move in a market that is open and responsive to the global economy. As compared to other crops, a large portion – approximately 45% – of rice produced in the United States is exported. In the United States’ laissez faire environment, the invisible hand of the market guides the private sector to provide commodities when needed, thus avoiding problems associated with large shortages and surpluses (McKenzie 2012).

The main source of economic trading information used to guide production and marketing decisions for the U.S. rice industry is the monthly releases of U.S. and World Agricultural Supply and Demand Estimates (WASDE) reports provided by the United States Department of Agriculture (USDA). Beginning in May, the National Agricultural Statistics Service (NASS) provides monthly forecasts of expected U.S. rice acreage, and beginning in August, provides monthly forecasts of U.S. harvest time rice production based upon acreage and yield estimates. These estimates are considered to be among the most important sources of information affecting trade in farm commodities (Sumner and Mueller 1989). This information is particularly important in rice markets, as there is a lack of private forecasts in rice as compared to other crops.

Trading information (i.e. “news”) is vital to attract necessary speculative interest to futures markets and aid in the price discovery process. The primary source of price discovery for the U.S. rice industry is the U.S. rice futures market. Futures are a tool used to manage or hedge risk, reduce volatility, improve food security, and maximize efficiency and profit on the open market (McKenzie 2012). Liquid futures markets adjust quickly to supply and demand information and provide important pricing signals to the U.S. rice industry. These signals are important for all participants in the supply chain – from farmers to exporters to retailers to consumers. It is important to note that futures markets cannot discover price in an information vacuum – futures markets need to trade based on comprehensive and frequently published supply and demand information (McKenzie 2012).

Currently, the monthly WASDE and NASS Crop Production reports are the main source of trading information for the U.S. rice futures market. Per the Efficient Markets Hypothesis (EMH), futures prices should immediately adjust to new unanticipated information included in USDA reports to reflect the change in traders’ price expectations. The economic value of USDA reports in corn and soybean markets has been explored in a number of studies (e.g. Sumner and Mueller, 1989; Garcia, et.al, 1997; Isengildina-Massa, Irwin, Good, and Gomez, 2008a; Isengildina-Massa, Irwin, Good and Gomez, 2008b; McKenzie, 2008; Adjemian, 2012). It is found that if futures prices adjust to a new equilibrium level based on USDA reports, then the reports are considered to have contributed to the price discovery role played by commodity futures markets. However, the economic value of USDA forecasts with respect to rice markets remains unexplored.

The objective of this study is to determine whether USDA reports, specifically WASDE, NASS Crop Production, and March Prospective Plantings reports reveal valuable “news” information to the U.S. rice industry. While WASDE reports are released every month, NASS

Crop Production reports are released for the first time in August, then released in subsequent September, October, and November months simultaneously with WASDE reports. In effect, this study measures the impact of both WASDE and NASS information for the August through November period. Two event study approaches are utilized in this study: one approach examines variability in returns on report-release days as compared to returns on pre- and post-report days (i.e. Sumner and Mueller, 1989; Isgeldina-Massa et al., 2008), and the other approach regresses price reactions on changes in usage and production information (i.e. Good and Irwin, 2006; Lehecka, 2014; Fortenbery and Sumner, 1993).

2. Literature Review: Informational Content of WASDE Reports

2.1 USDA Methods and Procedures

USDA reports use a number of sources. Per Aaronson and Childs (2000), the rice Interagency Commodity Estimates Committee (ICEC), chaired by the World Agricultural Outlook Board (WAOB), develops the supply and utilization tables released in the USDA's monthly reports. Each month, the ICEC develops estimates for beginning stocks, imports, production, domestic food, industrial, and seed use, residual use, exports, and ending stocks. The National Agricultural Statistics Service (NASS), the Foreign Agricultural Service (FAS), and the Economic Research Service (ERS) are also involved in the estimates. NASS provides estimates of domestic Crop Production, beginning and ending stocks, and monthly farm prices. The FAS provides information on commodities and foreign market developments. The FSA provides information on farm programs and their influence on domestic production. The ERS provides the basic economic analysis for domestic and global supply and demand conditions.

The first USDA supply and utilization forecasts for the following market year are released in May, when no actual data pertaining to this future period is available. However, ICEC makes statistically-based model forecasts based upon historical and expected data. Planted area data from

NASS' March *Prospective Plantings* report is combined with an ICEC yield projection (typically a 5-year Olympic average yield weighted by expected plantings) to forecast production. The estimate for planted area is based on a survey of producers (representative stratified sample) completed during the first two weeks of March. Harvested area data is estimated from planted area data in the *Prospective Plantings* report using a 5-year average of harvested-to-planted ratio.

In July, production forecasts are revised based on the June *Acreage* report. State-level area estimates using a representative area frame sample combined with a list frame that identifies producers by farm size comprise the first survey-based estimate of actual price plantings in the June *Acreage* report. In August, NASS reports its first Crop Production forecast, based upon a survey-based yield forecast and a revised area forecast. The survey-based yield forecast is typically gathered by mail and asks a representative sample of producers what they expect their yields will be. In September, milled rice stock estimates reported in the August *Rice Stocks* are converted to a rough rice basis and added to the current rough rice stocks provided by NASS to yield total stocks. In September, October, and November, ICEC adopts the revised yield forecasts provided by NASS. In January, NASS reports year-end area, yield, and production estimates.

Import forecasts are developed via short-term and long-term trends using historical import data from the Bureau of the Census. Data from the USA Rice Federation and per-capita consumption are used to forecast food, industrial, and residual use. NASS' per-acre seeding rate is multiplied by the expected planted acres next season to forecast the seed use. The FAS' weekly *U.S. Export Sales* report is used in conjunction with other factors, including U.S. competiveness in the global market, U.S. export assistance programs, and global supply and demand, to forecast exports. Export forecasts are revised based on shipment data from the Bureau of the Census.

The food, industrial, and residual use category is calculated to balance total use and total supply at the end of the year. All other elements of the supply and utilization table are based on actual reported data. Final estimates for acreage, yield, production, and stocks are provided by NASS. Estimates for total imports and exports are provided by the Bureau of the Census, but there is a 2-month lag in the reporting of U.S. trade data.

2.2 Event Study Approach

A vast literature has explored if various USDA Crop Production reports contain new and unanticipated information. Typically, an event-study framework is utilized to test whether significant changes in market prices occur following the release of a report. Event studies are based on the premise that information is valuable to the market if prices react to the release of reports (Campbell, Lo, and MacKinlay 1997). If reports contain only anticipated information at the time of release, then futures prices will not react and the report does not provide “news” to the market. The underlying assumption is that markets are not strong-form efficient, only semi-strong efficient, as futures prices would reflect both public and private information in a strong-form efficient market (Fama 1970). Thus, markets would already anticipate the information contained in the USDA reports. The concept of futures market efficiency and informational content of USDA reports are intrinsically linked in the event-study approach (McKenzie 2008).

Sumner and Mueller (1989) examined the informational content of USDA reports and its impact on corn and soybean futures prices. The impact was measured by the absolute mean differences between futures price changes following the report release and futures price changes on non-report release days. Sumner and Mueller concluded that USDA reports provided news to the market, as the absolute mean price change following the release of the report was higher than that of non-report release days. Similarly, Isengildina-Massa et al. (2008) examined the impact of WASDE reports using close-to-open returns of nearby corn and soybean futures contracts over the period 1985-2006. The results of the event study found that WASDE reports have a substantial impact on corn and soybean futures markets, as illustrated by a return variance on report releases almost three times that of pre- and post-report return variances. Thus, there is information provided in WASDE reports that is unanticipated in corn and soybean markets. Fortenbery and Sumner (1993) employed a similar methodology and compared close-to-close futures price and option premium returns on report release days to returns on non-report release days. The results of their analysis, however, found that the report releases from 1985-1989 did not result in larger average returns. "One cannot rule out that USDA reports still provide news, but that the news can no longer be measured by a simple price change variable" (Fortenbery and Sumner p.172).

2.3 Private Forecasts and Regression Analysis

Regression analysis can also be utilized to determine if various USDA Crop Production reports contain new and unanticipated information. Typically, the regression model involves regressing futures price changes on a dummy variable for report release dates as well as other explanatory variables (Fortenbery and Sumner 1993). The regression-based event study model is typically estimated using Ordinary Least Squares (OLS), or using Weight Least Squares (WLS) in the presence of heteroskedasticity, Fortenbery and Sumner (1993). The estimated regression coefficient measures the average price response to a change in the news provided in USDA reports. (Fortenbery and Sumner 1993) regressed the futures price change against loan prices, U.S. share of the world markets, and availability of option markets.

In order to compute the magnitude of news included in USDA reports, an estimate of market expectations measured just prior to USDA report release dates is necessary to capture the anticipated versus unanticipated component of USDA reports. As noted earlier, and according to EMH, futures markets should only react to new unanticipated information. Due to the growth of private firms providing information on agricultural markets, a number of studies (Garcia et al.

2007; Egelkraut et al. 2003; Good and Irwin 2006) have utilized private information to proxy the amount of anticipated information in the market. Theoretically, the price impact of USDA production forecasts should be determined by how well the market anticipates the forecasts (Good and Irwin 2007). Good and Irwin (2007) found that, on average, USDA corn production forecasts were more accurate than private market forecasts for most of the 1970-2003 time period. However, production forecast errors for USDA and private firms were highly correlated, suggesting that at least some information in USDA reports is anticipated by the private market. Thus, unanticipated information is measured as the difference between private information and information contained in USDA reports.

Alternatively, Lehecka (2014) assumed that the crop-condition information in Crop Progress reports serves as a proxy for anticipated information, thus the unanticipated information component is reflected in a change in crop-condition information from one report to the next. The study examined the relationship between changes in information provided in USDA Crop Progress and immediate price reactions. A WLS procedure was utilized, and close-to-open returns on report release sessions were regressed against the difference in the percentages of the crop in excellent or good condition from week to week. The results of the study indicated that there are price impacts from unanticipated information, and that Crop Progress reports provide significant informational value to corn and soybean markets.

There is a distinct lack of rice forecasts and information supplied by private analytical firms. This is in stark contrast to the large amount of private forecasts and information provided to other grain markets. Thus, in our analysis, the production and usage information included in the previous (at the time of release) USDA reports are used as a proxy for anticipated information. So, similar to Lehecka (2014), the news or unanticipated information is measured as the difference in production and usage numbers from one USDA report to the next. This measure of "news" allows us to empirically test if there is a private information gap in rice markets between the releases of public USDA numbers. If rice futures prices react to changes in month to month changes in USDA numbers this would indicate that (1) any interim private information does not fully replace or adjust market expectations based upon previous month USDA numbers; and that (2) any interim private information does not fully foreshadow the information contained in newly released USDA numbers.

3. Data and Methodology

3.1 Data

The data for the study was collected from USDA reports. The years selected were from 1990 to 2014, given that data is available prior to 1986, butWASDE releases were not subject to the same security measures as domestic reports until the two were combined in 1985 (Fortenbery and Sumner). The releases of all monthly WASDE reports for rice from January 1990 to December 2014 were analyzed in this study. Within this time period, a total of 287 WASDE reports were released; October 2013 is the only month without a report release due to the government shutdown. The WASDE report is typically released between the 9th and 12th of the month, but the time of release varies across the sample period. From January 1985 to April 1994, monthly reports were released at 3:30 p.m. EST, following the close of the Chicago Board of Trade (CBOT) trading session. From May 1994 to December 2012, with the exception of December 1994, monthly reports were released at 8:30 a.m. EST, prior to the start of CBOT trading session. From January 2013 to current, monthly reports were released at 12:00 p.m. EST, during the CBOT trading session. Additionally, March Prospective Plantings reports, which are released typically between the 28th and 31st of March, were analyzed for the same time period and had the same change in release time.

For futures prices, Chicago Board of Trade opening and closing futures prices for current (at the time of release) year rough rice November contracts were collected for six trading days prior and five trading days following the release of the WASDE, NASS Crop Production, and Prospective Plantings reports. While previous studies have used the nearest-to-maturity contracts for each release to measure price reactions to information about current market year information, November contracts were used in this study to capture price reactions to forthcoming market year information. November futures contract is the harvest-time new-crop contract in rice markets. As such, it is the first contract to cover the forthcoming market year and should be sensitive to market expectations about harvest production and beginning stock levels for the forthcoming market year. In addition, the November contract is highly liquid, both in terms of volume and open interest, as it is used to hedge future levels of expected production over the pre-harvest period.

Limit moves can pose an issue when measuring the price reaction in futures markets. This is due to the fact that futures prices do not reflect the “full” or “true” market reaction to new information on limit move days (Isengildina-Massa et al. 2008). Prior to October 1994, the daily price limit for CBOT rough rice futures was $0.30/hundredweight (cwt), expandable to $0.45/cwt and $0.65/cwt. After October 1994, the daily price limit for CBOT rough rice futures was $0.30/cwt, expandable to $0.45/cwt. From late August 2000 to late March 2008, the daily price limit was $0.50/cwt and was no longer expandable. After late March 2008, the daily price limit remained at $0.50/cwt, expandable to $0.75 and $1.15/cwt. For the sample period analyzed, rice futures prices did not reach a daily trading limit during the event windows surrounding the release of the reports.

Included in the WASDE report is data on projected yield, acres harvested, acres planted, production, ending and begging stocks, total usage, and average farm price for the forthcoming market year. The market year for rice referenced in USDA reports is August to July (Aaronson and Childs 2000). This data was collected for the forthcoming (at the time of the release) market year for short-grain rice, medium-grain and long-grain rice, and aggregate totals across all rice varieties. Acres planted for short-grain rice, medium-grain and long-grain rice, and aggregate totals were collected for the forthcoming (at the time of release) market year from the Prospective Plantings reports. Although information across all rice-varieties was collected, only data pertaining to long-grain rice was used in the empirical analysis, as the U.S. rice futures contract specifies long-grain rice as the underlying deliverable commodity. As such, rice futures prices are likely to be most sensitive to information about long-grain rice. Other rice varieties (e.g. short and medium grain) are not perfect substitutes for long grain, and rice futures may not be very sensitive to information about these other rice types.

3.2 Event Return Analysis

If traders' perceptions of supply and demand are altered by the release of a WASDE report, then this new information should be reflected in a change in futures prices (Fortenbery and Sumner). As such, November rough rice futures prices represent the market's expectation of rice prices at harvest time. Variability of futures prices around report releases including market news should "spike" upon announcement and return to normal variability for days prior to and following the announcement. The "spike" reflects a change in the market's expectation of prices due to the news included in the announcement.

Following an event return approach (Isengildina-Massa et al. 2008), the time index for this event study is t = -6,…, -1, 0, +1, …, +5. In order to account for the change in release times over the course of this sample period, t = 0 indicates the trading session at the CBOT immediately following the release of a WASDE (or equivalently NASS Crop Production report), or Prospective Plantings report. Prior to 1994, the date of release is t = -1 due to release time following the close of trading. After 1994, the date of release is t = 0 due to release time prior to or during trading. Negative t values are days prior to the release of the report, and positive t values are days following the release of the report. For WASDE reports, the event index is i = 1, … , 287, where i = 1 represents the January 1990 release of the WASDE report and i = 287 represents the December 2014 release of the WASDE report. For Prospective Plantings reports, the event index is i = 1, …, 24, where i = 1 represents the March 1990 Prospective Plantings report and i = 24 represents the March 2014 Prospective Plantings report.

If WASDE, NASS Crop Production, or Prospective Plantings reports include news, the information should be reflected in futures price movements immediately following the release of the report. For the statistical tests in this study, variances of both close-to-close returns and close-to-open returns were analyzed to investigate the reaction of rough rice futures prices. The close-to-open returns for a given WASDE (NASS Crop Production) or Prospective Plantings report release date were calculated as:

$$(1)\ r_{t,i} = \ln(p^{o}_{t,i}/p^{c}_{t-1,i}) \times 100 \qquad t = -6, \ldots, 0, \ldots, +5$$

In a similar fashion, the close-to-close returns for a given WASDE (NASS Crop Production) or Prospective Plantings report were calculated as:

$$(2)\ r_{t,i} = \ln(p^{c}_{t,i}/p^{c}_{t-1,i}) \times 100 \qquad t = -5, \ldots, 0, \ldots, +6$$

$p^{o}_{t,i}$ is the opening price of the current (at time of release) year November rough rice futures contract for session t and event i, $p^{c}_{t-1,i}$ is the closing price of the current (at time of release) year November rough rice futures contract for session t – 1 and event i, and ln is the natural logarithm. The natural logarithm is used to measure daily percentage returns, which allows us to estimate and compare price reactions across years when rice traded at vastly different price levels.

For both close-to-close and close-to-open, a total event window of 11 trading days was used. There are five returns prior to the release of the report, one return for the release of the report (t=0), and five returns after the release of the report. This is consistent with the event window lengths used by Isengildina-Massa et al., Sumner and Mueller, and Fortenbery and Sumner.

A one-tailed F-test was applied to both the close-to-close and close-to-open returns. The null hypothesis is that the return variability for the report release session is less than or equal to the variability of the pre-report and post-report sessions. The alternative hypothesis is that the return variability for the report release session is greater than the variability of the pre-report and post-report sessions. Pre and post-report session returns were aggregated or combined to obtain a single estimate of non-release day session variances across the different reporting months. This is referred to as Pre/Post session variance in subsequent results section. All statistical tests were computed using Data Analysis Toolpak included in Excel software.

3.3 Regression Analysis – Price Reactions to Month to Month Pre-Harvest Information

A typical event study model can be written as an Ordinary Least Squares (OLS) regression:

$$(3)\ f_{+1} - f_{-1} = \tilde{a} + \tilde{b}\left(F_{ijt}^{USDA} - F_{ijt}^{Private}\right) + z_t,$$

where $f_{+1} - f_{-1}$ represents the price change from the closing futures price on the day prior to the report release to the closing futures price on the first trading day after the report release. The term, $(F_{ijt}^{USDA} - F_{ijt}^{Private})$ represents the "news" element of USDA reports, where F_{ijt}^{USDA} represents the USDA forecast of either usage or production *i*, observed in month *j* and year *t*, and

$F_{ijt}^{Private}$ represents the private market consensus forecast of either usage or production *i*, observed in month *j* and year *t*.

In the traditional event study approach, the estimated regression coefficient $\tilde{b}$ measures the average price response to a one-percentage point change in the "news" element of USDA reports. Thus, it is assumed that futures prices only react to the element of USDA production forecasts that was not anticipated by the private sector.

For this study, the previous month USDA reports serve as a proxy for private production forecasts, as it is assumed that the private production forecasts contain no additional information compared to previous month USDA forecasts. In this case, equation (3) can be rewritten as:

$$(4)\ f_{+1} - f_{-1} = \tilde{a} + \tilde{b}\left(F_{ijt}^{USDA} - F_{ij-nt}^{USDA}\right) + z_t,$$

where the private forecast is replaced with the previous USDA forecast observed at time *j-n*. This would be the USDA forecast observed in the previous month and the term $F_{ijt}^{USDA} - F_{ij-nt}^{USDA}$ would measure the monthly revision in USDA forecasts as in (Isengildina, Irwin, and Good, 2006).

3.4 Regression Analysis – Price Reaction to Information Changes from Pre-Harvest Time Periods to Harvest Time

$$(5)\quad f_{\text{Novt}} - f_{\text{jt}} = \tilde{a} + \tilde{b}\left(F_{iNovt}^{USDA} - F_{ijt}^{USDA}\right) + z_t$$

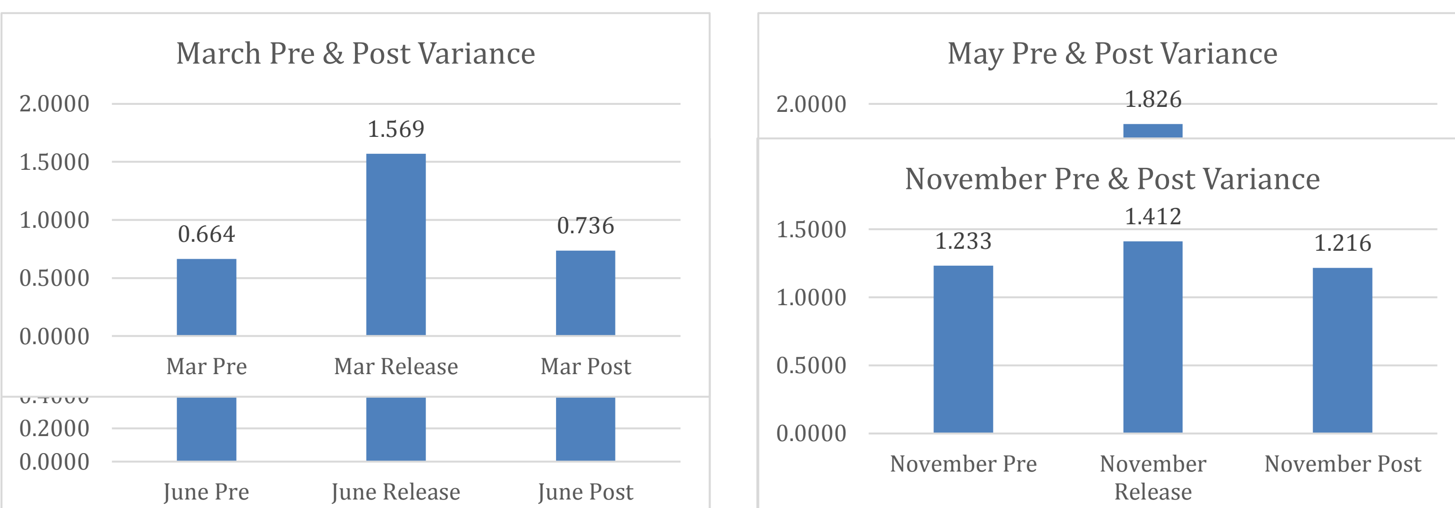
Equation (5) above was used to analyze the previous USDA forecast observed at time *j* as compared to the USDA forecast observed in November, which has final numbers for production and usage. In this case, the term $F_{iNovt}^{USDA} - F_{ijt}^{USDA}$ would measure the revision in USDA forecasts from current (at the time of the report) to final estimates in November.

4. Results

4.1 Event Window Returns

The impact of USDA reports on event returns is illustrated graphically in **Figure 1** below for close-to-open return variances for March, May, June, July, August, September, October and November. The close-to-close return variances by month are included in **Figure 2** in **Appendix A**. With the exception of September, the overall pattern of return variances for each of the months is consistent with the prediction that the return variance "spikes" on release days. This is reflected in both close-to-close and close-to-open return variances. The most notable statistically significant release "spikes" occur in July and October. For July, close-to-close report return session variance is approximately 2.5 times larger than pre- and post-report return variances; close-to-open report return variance is approximately 2.2 times larger than the pre- and post-report return variances. For October, the close-to-open report session return variance is approximately 3.6 times greater than the pre- and post-report return variances; close-to-close report session return variance is approximately 1.6 times greater than the pre- and post-report return variances.

Figure 1: Pre-Report, Release, Post-Report Session Close-to-Open Return Variances[1]
(January 1990-December 2014)



[1]*The following dates did not have available opening futures price data and were excluded from the event windows for the close-to-open return variance results: April 6, 2012; November 4, 2012; November 8, 2012; November 12, 2012; November 14, 2012; March 24, 2013; March 25, 2013; March 26, 2013; May 7, 2013; May 8, 2013; May 9, 2013; May 14, 2013; May 15, 2013, May 16, 2013; May 17, 2013; May 20, 2013; May 21, 2013; November 7, 2013; November 10, 2013; November 12, 2013; November 13, 2013; November 14, 2013.*

Table 1 presents the close-to-open F-test statistics for pre- and post-report return variances as compared to report session return variance. The F-test statistics for pre- and post-report return variances as compared to report session return variances for close-to-close prices are shown in **Table 4** in **Appendix A**. With the exception of September, there was substantially higher variance on report sessions than on pre- and post-report sessions when observing close-to-open prices. The statistical significance in the difference of report session and pre- and post-report session return variances observed in close-to-open prices disappears when using close-to-close prices. The return variance on report sessions was only statistically significantly different from pre- and post-report return variances for July and October when observing close-to-close prices. The difference in significance in close-to-open and close-to-close return variances could be due to market inefficiency; if markets overreact to the USDA report releases, then the close-to-open returns could overstate the "news" component included in the report (Isengildina 2008). However, close-to-open returns tend to best represent the instantaneous incorporation of new information into market prices, and other information events, observed over the course of the release date trading day, pertaining to rice markets may impact the close to close returns.

The incorporation of June Prospective Plantings data in the July WASDE report likely explains the larger "spike" in July report sessions than other months; the amount of unanticipated "news" is higher in the July report. One would expect to see large reactions to July and August information, as these represent the first release times of truly new production information. Subsequent USDA reports might contain less unanticipated supply information, hence less variability for September. October may be more variable as the market adjusts to final (i.e. "more certain") production numbers. Adverse weather events, such as too hot nighttime temperatures over summer months, which are known to adversely affect rice yields are over by October, and the effects are now realized and reflected in October production numbers for the first time. For this reason, the futures returns during the September period may be particularly noisy across the whole event window.

These explanations for the F-test results should be qualified by the fact that reports contain projected usage information as well as projected supply information. Usage shocks can be revealed at any time during the year, so the spike in October numbers could have also been the result of large unanticipated change in usage production numbers over the sample period. The regression analysis results in this study will be able to offer more discerning results as to the relative impacts of both supply (production) and demand (usage) shocks revealed in this report.

Table 1: Rice Futures Close-to-Open Return Variance Test Results for WASDE Reports (January 1990-December 2014)

Month	Report Session Return Variance	Pre/Post Report Return Variance	F-Statistic
March	1.569	0.701	2.240***
May	1.826	0.929	1.963***
June	1.256	0.975	1.288
July	1.763	0.803	2.195***
Aug	1.618	0.777	2.083***
Sep	0.885	0.815	1.086
Oct	2.953	0.814	3.630***
Nov	1.412	1.252	1.128

*Indicates significance at the 10% level, **Indicates significance at the 5% level, *** Indicates significance at the 1% level

4.2 Regression Analysis – Price Reactions to Month to Month Pre-Harvest Information

Regression results for immediate futures price reactions to production and usage "news" announced in USDA reports across the pre-harvest period from June to November are reported in **Table 2**. The coefficient b_1 corresponds to the production variable, and the coefficient b_2 corresponds to the usage variable. With the exception of the July usage coefficient, all of the estimated coefficients in **Table 2** are statistically significant and of the expected sign. An increase in production, a supply side factor, should elicit a price decrease – as indicated by the negative coefficient. An increase in usage, a demand factor, should elicit price increase – as indicated by the positive coefficient. The results illustrate that futures prices responses to supply and demand information across the pre-harvest period are consistent with a well-functioning and efficient market. Prices rise with respect to increased usage, or demand shocks, and fall with respect to increased production, or supply side shocks. Furthermore, as indicated by the R^2 in **Table 2**, changes in production and usage information account for a larger proportion of overall variation in futures prices movements later in the season. September and October have the highest R^2 as any changes in production and usage information account for more of the variation in futures prices movements as it gets closer to harvest.

The average rice futures price over the time period of January 1990 to December 2014 was $9.78/cwt. The results in **Table 2** show that, on average, a 1 percent unanticipated increase in production from the July to August period would elicit, on average, a 0.49 percent decrease in futures prices, a decrease of 5 cents/cwt. Conversely, a 1 percent unanticipated increase in usage from the July to August period would result in, on average, a 0.57 percent increase in futures prices, an increase of 6 cents/cwt. On average, unanticipated changes in production elicit the largest futures price responses from the September to October period at -0.71 percent, a decrease of 7 cents/cwt, while unanticipated changes in usage elicit the largest futures price responses from the October to November period at 0.94 percent, an increase of 9 cents/cwt.

On a month-to-month basis, the change in production and usage numbers announced in USDA reports elicits an immediate futures price response; public "news" drives futures prices in rice markets. Irwin et al. (2002) found that futures prices only respond to news unanticipated by private forecasts, which are released prior to the official public USDA numbers. The results in **Table 2** suggest that private rice forecasts released between monthly USDA reports are not viewed by rice futures markets as complete information updates on previous USDA report numbers. The fact that rice futures prices react to these changes in month to month changes in USDA numbers indicates that any interim private information does not fully foreshadow the information contained in newly released USDA reports.

Table 2: Futures Price Reactions to Production and Usage "News" Announced in USDA Reports across the Pre-harvest Period

Parameters	June	July	Aug	Sep	Oct	Nov
Constant	0.29	0.19	0.20	-0.44	-0.17	-0.46
	(0.26)	(0.46)	(0.28)	(0.17)	(0.25)	(0.28)
Production	-0.38*	-0.20*	-0.49***	-0.44***	-0.71***	-0.43*
	(0.19)	(0.11)	(0.17)	(0.09)	(0.14)	(0.26)
Usage	0.87**	0.21	0.57**	0.27**	0.54***	0.94***
	(0.33)	(0.19)	(0.26)	(0.11)	(0.18)	(0.27)
R^2	0.19	0.07	0.21	0.51	0.50	0.30
Q (1)	0.37	3.96	1.55	0.24	0.00	0.00
	(0.55)	(0.05)	(0.21)	(0.62)	(0.91)	(0.97)
Q(2)	0.55	4.17	2.56	0.42	2.43	1.71
	(0.76)	(0.12)	(0.28)	(0.81)	(0.30)	(0.43)
LM(1)	0.39	3.64	1.49	0.38	0.01	0.10
	(0.53)	(0.06)	(0.22)	(0.54)	(0.91)	(0.76)
B-P	1.69*	1.12	1.32	3.40	1.16	0.75
	(0.43)	(0.57)	(0.52)	(0.18)	(0.56)	(0.69)
F Test	3.79*	1.91	4.27**	13.64***	12.51***	5.94***
	(0.04)	(0.17)	(0.03)	(0.00)	(0.00)	(0.01)

*Indicates significance at the 10% level, **Indicates significance at the 5% level, *** Indicates significance at the 1% level
White standard errors are presented for regressions with heteroskedasticity

4.3 Regression Analysis – Price Reaction to Information Changes from Pre-Harvest Time Periods to Harvest Time

Regression results for futures price changes regressed on harvest area, yield, and usage forecast errors of USDA reports across the pre-harvest period from June to November are reported in **Table 3**. The coefficient β_1 corresponds to the harvest area variable, the coefficient β_2 corresponds to the yield variable, and the coefficient β_3 corresponds to the usage variable. All of the estimated coefficients in **Table 3** are statistically significant and of the expected sign. An increase in harvest area and production, supply side factors, should elicit a price decrease – as indicated by the negative coefficient. An increase in usage, a demand factor, should elicit price increase – as indicated by the positive coefficient. Prices rise with respect to increased usage, or demand shocks, and fall with respect to increased harvest area and yield, or supply side shocks. Furthermore, as indicated by the R^2 in **Table 3**, changes in production and usage information account for a large proportion of overall variation in futures prices movements throughout the pre-harvest period. This is in contrast to the month-to-month results in **Table 2**, which indicated that the regression explains more as harvest approaches.

As mentioned previously, the average rice futures price over the time period of January 1990 to December 2014 was $9.78/cwt. The results in **Table 3** show that, on average, a 1 percent unanticipated increase in harvested area from the July to harvest period would elicit, on average, a 3.13 percent decrease in futures prices, a decrease of 31 cents/cwt. Additionally, a 1 percent unanticipated increase in yield from the July to harvest period would elicit, on average, a 3.33 percent decrease in futures prices, a decrease of 33 cents/cwt. Conversely, a 1 percent unanticipated increase in usage from the July to harvest period would result in, on average, a 2.63 percent increase in futures prices, an increase of 26 cents/cwt. On average, unanticipated changes in harvested area elicit the largest futures price responses from the September to harvest period at

-3.17 percent. On average, unanticipated changes in yield elicit the largest futures price responses from the June to harvest period at -3.34 percent, while unanticipated changes in usage elicit the largest futures price responses from the October to harvest period at 4.53 percent.

The price of U.S. rice is highly influenced by the export market, as almost half – about 45 percent - of domestic production is exported (Childs and Livezy 2006). The extent to which, if any, domestic supply influences futures prices is an open question. The results in **Table 3** suggest that domestic supply factors (i.e. yield and harvested area) do influence futures prices across the pre-harvest period.

Table 3: Futures Price Changes Regressed on USDA Forecast Error of Harvest Area, Yield and Usage Measured at USDA Report Times across the Pre-harvest Period

*Indicates significance at the 10% level, **Indicates significance at the 5% level, *** Indicates significance at the 1% level
White standard errors are presented for regressions with heteroskedasticity

Parameters	May	June	July	Aug	Sep	Oct
Constant	1.23	2.07	5.28	3.48	2.23	1.11
	(4.62)	(5.28)	(3.22)	(2.39)	(2.64)	(1.77)
Harvest Area	-2.68***	-2.45**	-3.13***	-2.84***	-3.17***	-2.01***
	(0.78)	(1.00)	(0.91)	(0.70)	(0.80)	(0.77)
Yield	-3.21***	-3.34**	-3.33***	-3.29***	-2.85***	-2.07***
	(1.23)	(1.41)	(0.88)	(0.66)	(0.71)	(0.75)
Usage	2.99***	2.95**	2.63**	2.86***	3.07**	4.53***
	(1.03)	(1.16)	(0.94)	(0.82)	(0.03)	(1.55)
R^2	0.42	0.31	0.44	0.58	0.43	0.33
Q (1)	0.00	0.00	0.16	0.00	0.12	0.00
	(0.91)	(0.79)	(0.69)	(0.79)	(0.72)	(0.91)
Q(2)	0.79	0.94	0.72	1.78	3.11	1.06
	(0.68)	(0.62)	(0.70)	(0.41)	(0.21)	(0.59)
LM(1)	0.33	0.41	0.23	0.10	0.15	0.05
	(0.56)	(0.52)	(0.63)	(0.75)	(0.70)	(0.83)
B-P	10.75**	9.35**	4.92	8.50**	5.41	10.93**
	(0.01)	(0.03)	(0.18)	(0.04)	(0.14)	(0.01)
F Test	6.70***	4.54**	7.17***	11.98***	7.04***	4.83**
	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.01)

5. Summary and Conclusions

The purpose of this study was to determine whether USDA reports, specifically WASDE, NASS Crop Production, and March Prospective Plantings reports reveal valuable “news” information to the U.S. rice industry. If reports contain only anticipated information at the time of release, then futures prices will not react and the report does not provide “news” to the market. Two event study approaches are utilized: (1) examine variability in returns on report-release days as compared to returns on pre- and post-report days, and (2) regress price reactions on changes in usage and production information.

The most notable release “spikes” occur in July and October, as reflected in both close-to-open and close-to-close return variances. The regression analysis indicates that the supply (harvest area and yield) shocks have the largest impact on July variances. This is consistent with the fact that July is the first release time of truly new production information, as the June Prospective Plantings data is incorporated in the July WASDE report. By October, the market has adjusted to final production numbers with more certainty, but demand shocks can be revealed at any time. Thus, the regression analysis indicates that the impact of demand (usage) shocks have the largest impact on October variances.

From a practical standpoint, our regression results show that the USDA provides the futures market with important information, which is vital to the price discovery process. The pre-harvest information and futures price reactions are correlated, thus futures prices are driven by new information as it is released. Private rice forecasts released between monthly USDA reports are not viewed by rice futures markets as complete information updates on previous USDA report numbers due to the fact that rice futures prices react to these month-to-month changes in USDA numbers. Any interim private information does not fully foreshadow the information contained in newly released USDA reports, thus suggesting that there is an information gap between USDA reports. The information gap is an opportunity that could be profitably exploited by private firms that could provide accurate and timely forecasts of monthly USDA numbers.

This is the first event study to measure futures price reactions to USDA reports in rice markets, and the findings are significantly different than that of event studies on corn and soybeans. Studies (Good and Irwin 2006) in corn and soybeans find that futures prices only respond to news unanticipated by private forecasts. On a month-to-month basis, corn and soybeans futures prices do not react based solely on information provided in USDA reports. There is a large amount of private information that is incorporated in the reactions

Due to the lack of private forecasts, rice futures prices tend to react to information provided in USDA reports more than corn and soybeans futures prices. While rice is sensitive to many of the same market factors as corn and soybeans, rice markets have a number of idiosyncrasies and are very different from other grain markets. All rice is irrigated, thus yields are much less variable. Production is sensitive to availability of water resources and some weather variability, but overall production risks are lower. Furthermore, rice markets have thinly traded futures markets. In fact, the Risk Management Association is not providing 2015 Crop Year rice revenue protection coverage because there is not enough trading volume in November (harvest time) contracts.

Production and usage information is necessary to attract speculative interest in futures contracts and aid in the price discovery process. Pricing signals from the futures markets are important for all participants in the supply chain – from farmers to exporters to retailers to consumers. Futures markets cannot discover price in an information vacuum – futures markets need to trade based on comprehensive and frequently published supply and demand information (McKenzie 2012). If the production and usage information provided to the marketplace can be improved and the error in USDA's pre-harvest forecasts reduced, then movements in rice futures could be better predicted. Rice futures price realignments over the pre-harvest period indicate that more timely and accurate private forecast of production and usage could potentially be used to exploit trading strategies. Future research is needed to determine the extent of profitability of private forecasts in rice markets. Furthermore, future research could consider developing and testing trading strategies based upon advanced knowledge of information contained in USDA reports or upon private forecasts released prior to USDA reports.

Appendix A: Close-to-Close

Figure 2: Pre-Report, Release, Post-Report Session Close-to-Close Return Variances (January 1990 – December 2014)

Table 4: Rice Futures Close-to-Close Return Variance Test Results for WASDE Reports (January 1990-December 2014)

Month	Report Session Return Variance	Pre/Post Report Return Variance	F-Statistic
March	1.770	1.467	1.207
May	2.280	1.785	1.310
June	1.890	1.380	1.369
July	4.905	1.980	2.477***
Aug	2.121	1.878	1.129
Sep	1.445	1.984	0.728
Oct	3.014	1.899	1.588**
Nov	2.280	1.954	1.167

*Indicates significance at the 10% level, **Indicates significance at the 5% level, *** Indicates significance at the 1% level

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