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* Nathan Kauffman is an economist at the Federal Reserve Bank of Kansas City, Omaha Branch. 2201 Farnam Street, Omaha, NE 68102. Email: nathan.kauffman@kc.frb.org. Phone: 402-221-5702.

Have Extended Trading Hours Made Agricultural Commodity Markets More Risky?

Abstract

In May 2012, the Chicago Mercantile Exchange extended trading hours for several agricultural commodities, including corn. Since then, trading during the release of a key U.S. Department of Agriculture report known as the World Agricultural Supply and Demand Estimate has been possible. Some concerns have been expressed that trading through the release of important market information might generate higher price volatility in agricultural commodity markets. The purpose of this paper is to examine the effect of extended trading hours on intraday price volatility in corn futures markets. The results suggest that trading during the information releases in 2012 has led to brief periods of excessive volatility immediately after the reports were released, but the higher volatility did not persist much beyond 60 minutes. The paper also highlights the role of higher liquidity in absorbing potential market shocks.

Keywords: Chicago Mercantile Exchange, commodity price volatility, corn futures, trading hours, World Agricultural Supply and Demand Estimates

Introduction

Volatility affects agricultural commodity market participants differently depending on their objectives. Producers generally dislike uncertainty and often use futures markets to mitigate risk associated with potential changes in prices. Unlike producers, traders with no physical connection to the underlying commodity, nonproducers, seek to profit from uncertainty by predicting which direction prices are headed. Volatile futures prices, therefore, present nonproducers with a profit opportunity. However, greater price volatility may lead producers to question the use of futures markets to mitigate risk if futures markets themselves have become more risky.

Commodity exchanges have undergone recent structural changes, leading to concerns about price volatility and risk management. In May 2012, the Chicago Mercantile Exchange (CME) stirred debate by extending its electronic trading hours. Since then, CME and other exchanges have been open for trading during the release of key government supply and demand reports. Producers are concerned that trading during the release of U.S. Department of Agriculture (USDA) reports will generate excessive price volatility, thus distorting markets and making risk management strategies more difficult. Proponents of extended trading hours, though, have argued for greater flexibility and modernization in commodity trading.

This paper examines the effect of extended trading hours on intraday volatility patterns in corn futures markets. Section I discusses how price volatility affects agricultural producers and concerns about extended trading hours. Section II analyzes the effects of extended trading hours on the magnitude and persistence of volatility spikes following the release of monthly USDA reports. Recognizing that volatility patterns are not constant across years, Section III offers possible explanations for the shifts. The paper concludes that trading during USDA supply and demand reports has led to brief periods of excessive volatility that could present challenges for producers seeking to manage risk. Greater market participation, however, has been a beneficial factor in helping to absorb volatility shocks generated from the release of new information. In particular, nonproducer participation appears to lessen the magnitude and persistence of volatility in corn futures markets, which would be beneficial for risk-averse producers.

I. Differing perspectives on price volatility

Agricultural producers typically prefer stable markets. Farmers and rural advocacy groups claim recent structural changes in commodity markets have negatively affected agricultural profitability through increased volatility. In 2012, commodity exchanges expanded their trading hours and now allow trades during the release of key government reports. Producers are concerned that extended trading hours may benefit nonproducers at the expense of producers. If producers believe that commodity futures markets are of little use in managing risk, and begin to withdraw from futures markets altogether, the valuable stabilizing effect of futures markets on commodity and food prices could be in jeopardy.

Risk management

Price volatility is often considered a measure of risk. Volatility tends to be high when uncertainty is high in a specific market or when markets are surprised by new information. Higher uncertainty causes an individual's beliefs about market fundamentals to change, sometimes sharply. As beliefs about market fundamentals change, prices tend to swing more widely. Prices may be considered volatile even if they change only several times within a growing season but are fairly stable from day to day or within a day. Conversely, prices might be extremely volatile within a day, but generally remain stable over a longer time horizon.

Volatile prices have the potential to affect the risk management decisions of agricultural producers. Farming has two basic forms of risk—price risk and production risk. Price risk is the exposure to potential price fluctuations between planting—when decisions are made—and harvest. These decisions include, for example, which crops to plant, choice of seeds, or potential fertilizer applications. Grain producers often rely on futures markets to manage price risk, a strategy known as hedging. Production risk, arising from uncertainty in crop yields, is typically addressed through federal crop insurance.[1]

When production risk and price risk are correlated, producers' hedging decisions depend on futures prices (Lapan and Moschini 1994). In managing price risk, producers decide how much to hedge in futures markets based on their expected crop production. If production and harvest prices are correlated, a change in futures prices would lead to a change in the optimal futures hedge. Price and production risk are negatively correlated. Using Iowa as an example, a local drought that reduces expected corn yields only in Iowa will raise futures prices because Iowa accounts for nearly 20 percent of U.S. production. If futures prices change, a producer in Iowa may want to revise his hedged position because of the relationship between his expected production and prices.

[1] When hedging with futures markets, there is a third form of risk known as basis risk. Basis risk is the risk that the local cash price may differ from the futures price at harvest.

If production and price risk are uncorrelated, the theoretically optimal hedging decision would be unaffected by changes in futures prices. A hedging decision made by a small farming operation in Mississippi, a state that accounts for less than 1.0 percent of U.S. corn production, would differ from the Iowa example. A local drought that reduces corn yields in Mississippi would be unlikely to affect futures prices significantly because there is little corn grown in the Southeast. A change in futures prices would be unlikely to affect the hedging decision of a farmer in Mississippi because of the lack of a connection between his expected production and prices.

In practice, though, producers employ many different types of hedging strategies that may be affected by price volatility. One example is a stop-loss order. Stop-loss orders limit losses caused by adverse price movements beyond a trader-defined price level, or threshold. Suppose that the futures price for corn is $5.40 per bushel. A producer might seek to limit his losses by setting a threshold of $5.00 per bushel that would automatically trigger a sell order if prices dip to that level. Extreme price volatility, even if brief, could push prices to $5.00—triggering the trade—but subsequently push prices as high as $5.80 and potentially back to $5.40.[2] In this case, price volatility would cost the farmer 40 cents per bushel relative to simply selling at $5.40. For a small farming operation of 300 acres with an average yield of 200 bushels per acre that sought to hedge a third of its expected output, volatility would result in a loss of $8,000.

Although volatility often affects risk management decisions, a greater concern is that heightened volatility could diminish the perceived usefulness of futures markets. Historically, futures markets have played a valuable role in price discovery and stability. In fact, the Chicago Board of Trade (CBOT) was established principally to stabilize prices. If producers perceive futures markets as excessively volatile—and of disproportionate benefit to nonproducers—they may choose to avoid futures markets altogether, reducing liquidity. If trading volume on agricultural futures markets declined, prices could become even more volatile. Volatile commodity prices could then translate into volatile food prices.

Unlike producers, nonproducers often prefer markets with higher volatility. Called speculators by some market analysts, nonproducers seek to profit from commodity futures investments by correctly anticipating price movements. If prices stay constant, nonproducers have no way to profit in futures markets.[3] In addition to providing liquidity that allows potential market shocks to be more easily absorbed, nonproducers play another important role in agricultural commodity markets. By allowing producers to lock in a price for their crop in advance, they accept the price risk that producers prefer to avoid.

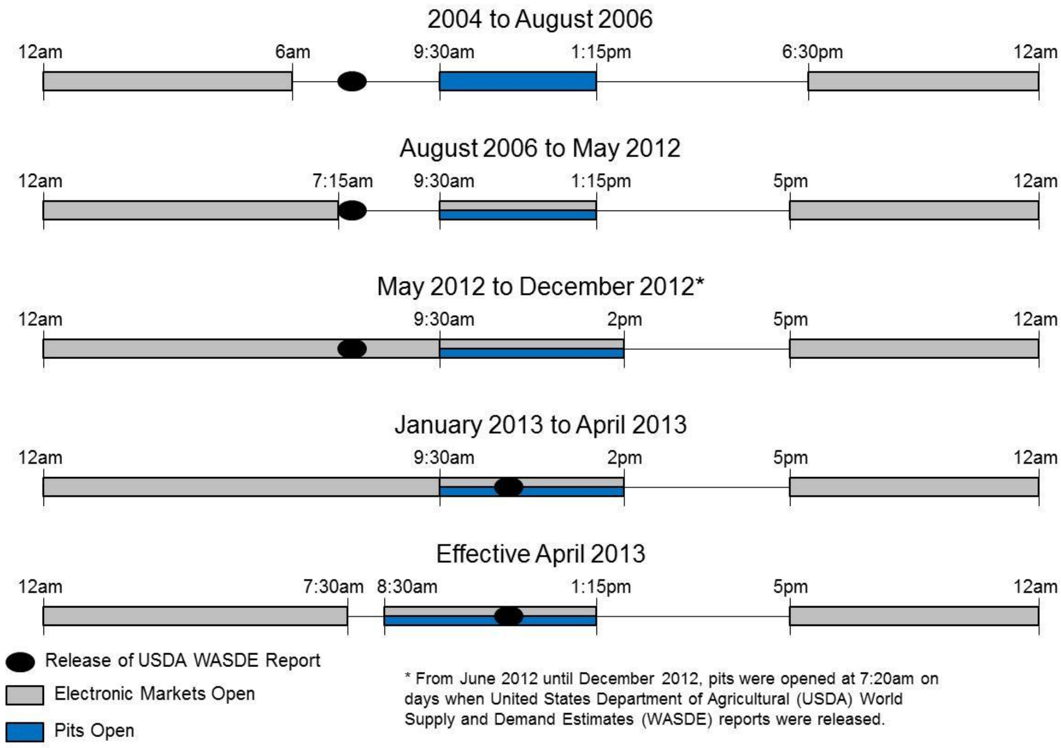
Structural changes at commodity market exchanges

Structural changes at commodity exchanges have sparked recent concerns about price volatility. In May 2012, the Intercontinental Exchange (ICE) began offering futures contracts in corn, wheat, soybeans, soybean oil, and soybean meal in addition to its other commodity offerings. At the same time, ICE announced that trading in agricultural commodities would be open for 22

[2] At the CBOT, corn futures prices are limited to daily price movements of 40 centsper bushel in either direction of the previous day's close.
[3] Nonproducers could, however, still profit when there is no price volatility by using options. One example is a short straddle, which might involve selling both an at-the-money call and an at-the-money put.

hours per day. The CME then responded by extending its trading hours as well. Since May 2012, agricultural commodity futures contracts have been traded at CME for 21 consecutive hours, from 5 p.m. to 2 p.m. the next day (Chart 1).[4]

Chart 1: CBOT/CME Hours of Operation



Since May 2012, markets have been open during the release of important government agricultural reports. For the rest of 2012, the CME was open for trading during the USDA's monthly release of the World Agricultural Supply and Demand Estimates (WASDE) at 7:30 a.m. CST.[5] Kept highly confidential prior to its release, WASDE provides agricultural commodity markets with important information about current and projected agricultural market fundamentals.

Some traders have supported the extension of trading hours. Proponents of around-the-clock trading say other markets have sufficiently adapted to the change, citing energy markets as an

[4] In March 2013, CME announced that it would again revise its trading hours. Effective April 8, 2013, a pause in electronic trading is observed from 7:45 a.m. to 8:30 a.m. Both pit and electronic platforms now close at 1:15 p.m. with electronic markets reopening at 7 p.m.

[5] After considerable debate, the USDA began releasing WASDE at 11 a.m. CST in January 2013. The justification for the change was to release the report at a time when liquidity was likely to be highest. Prior to the change, the CME had expanded pit trading hours on WASDE release days to increase liquidity beyond that of only electronic markets.

example. They also say the globalization of commodity markets has created a need for extended hours as a way to deal with different time zones across countries.

Agricultural stakeholders who have criticized the extension of trading hours express two general concerns (USDA 2012). Because USDA reports are released while markets are open, the first concern is that small agricultural enterprises may not have the resources to process new information and subsequently place a trade quickly enough to compete with large trading firms. The second concern is that active trading during the release of extensive new information may exacerbate price volatility and impinge the ability of producers to manage risk.

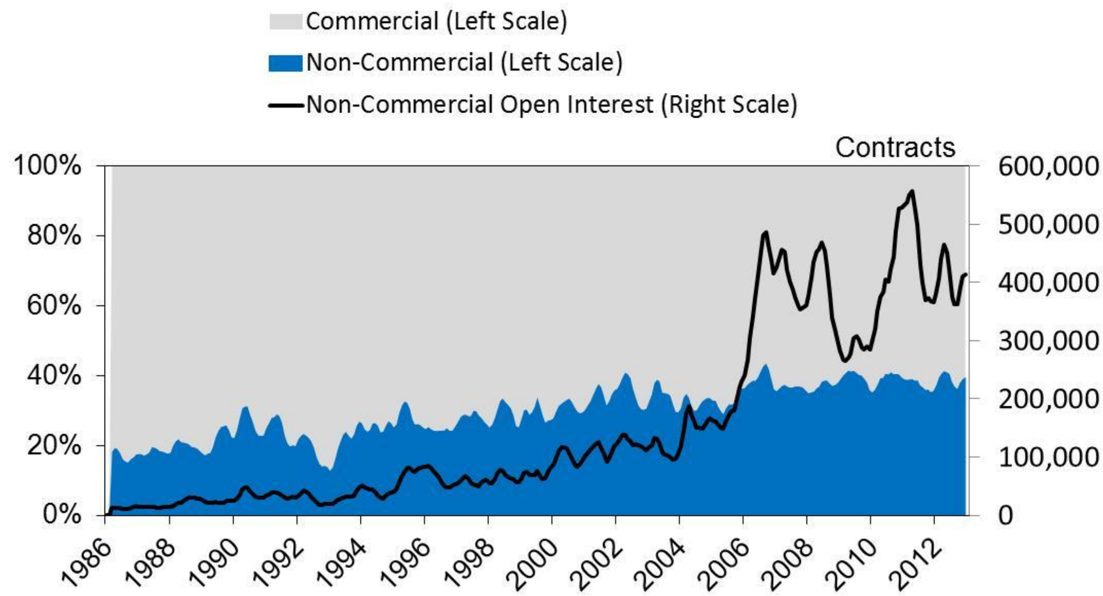
The first concern is that extended trading hours will disproportionately benefit traders with a comparative advantage in collecting information and processing trades quickly. Whereas producers specialize in commodity production, nonproducers typically have a comparative advantage in information technology. Large hedge funds often specialize in gathering information. Other commodity traders make huge investments to process trades faster than the competition. In the data center that houses the CME's GLOBEX electronic trading platform, traders pay up to $25,000 per month to have computers co-located next to the CME's servers so they can process trades faster (Bowley 2011). In 2010, $300 million was spent to install fiber-optic cables between Chicago and New York just to cut order transmission times by 3 milliseconds (Troianovski 2012). Because of their comparative advantage, it may be true that hedge funds and high-frequency traders earn consistently better returns than smaller traders (Baron, Brogaard, and Kirilenko 2012). It is much more difficult to argue that they should not be permitted to do so.

The second concern, however, that extended trading hours could impact price volatility, calls for careful consideration. The criticism may be warranted if trading during the release of important information imposes an external cost on producers—or society—through higher price volatility. This concern justifies closer examination of how structural change has affected price volatility.

In addition to extended trading hours, nonproducer trading has increased and exchanges have shifted to electronic markets in recent years. Producers suggest these changes will compound the effects of extended trading hours on price volatility. Defined by the Commodity Futures Trading Commission (CFTC) as "non-commercial traders," nonproducers' held more than three times as many corn futures contracts from 2006 to 2010 as compared with 2000-04 (Chart 2). Meanwhile, electronic trading at the CME now accounts for about 95 percent of daily trading volume for agricultural futures contracts (Chart 3).

An agricultural boom has sparked investor interest in agricultural commodities. Crop prices, which doubled from 2005 to 2007, have nearly doubled again since then (Chart 4). A surge in prices has caused the volume of futures contracts traded on exchanges to soar in recent years. At the CME, corn futures volume has jumped by roughly 300 percent over the past decade (Chart 5). Demand for agricultural commodities is also surging across the world. From 2005 to 2006, the volume of corn futures contracts traded at China's Dalian Commodity Exchange, which began trading corn futures in September 2004, grew threefold before softening after the global financial crisis. Commodity exchanges in South America and Europe have seen higher trading volumes as well.

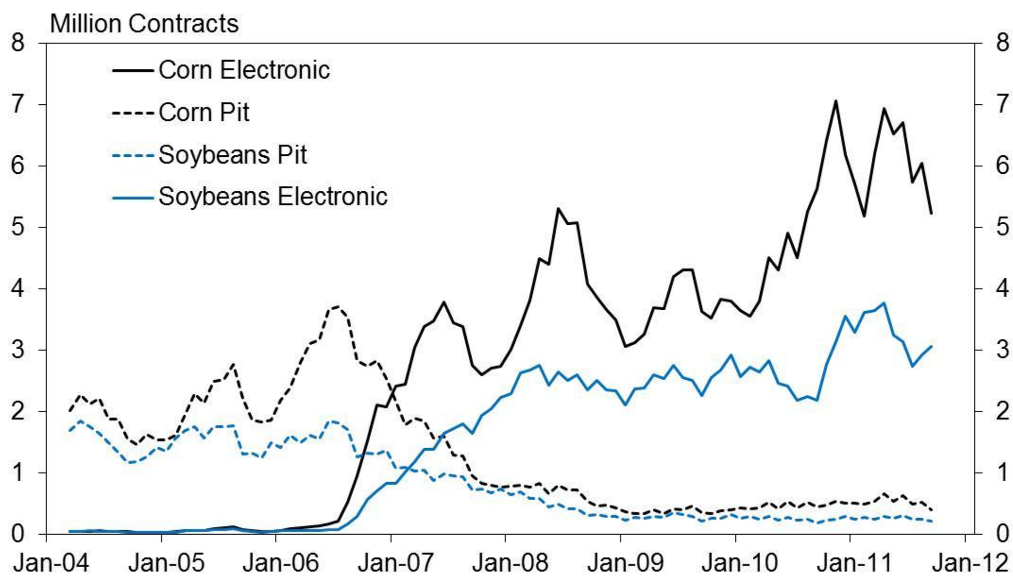
Chart 2: Traders' Share of Open Interest



Source: Commodity Futures Trading Commission
* Includes open interest from both futures contracts and futures-equivalent options.

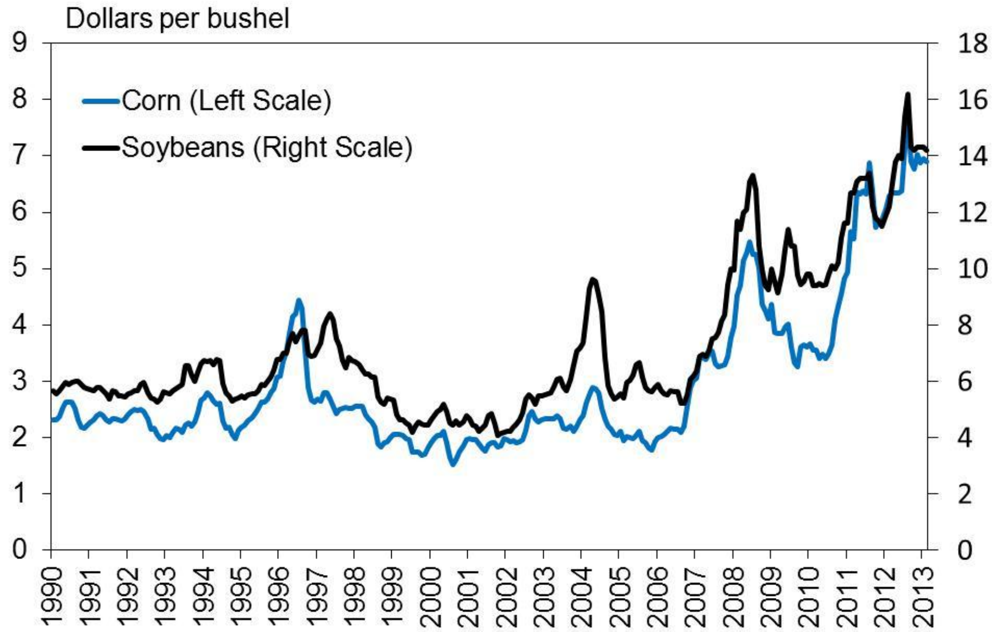
Chart 3: CME Monthly Futures Contract Volume by Platform

3-Month Moving Average



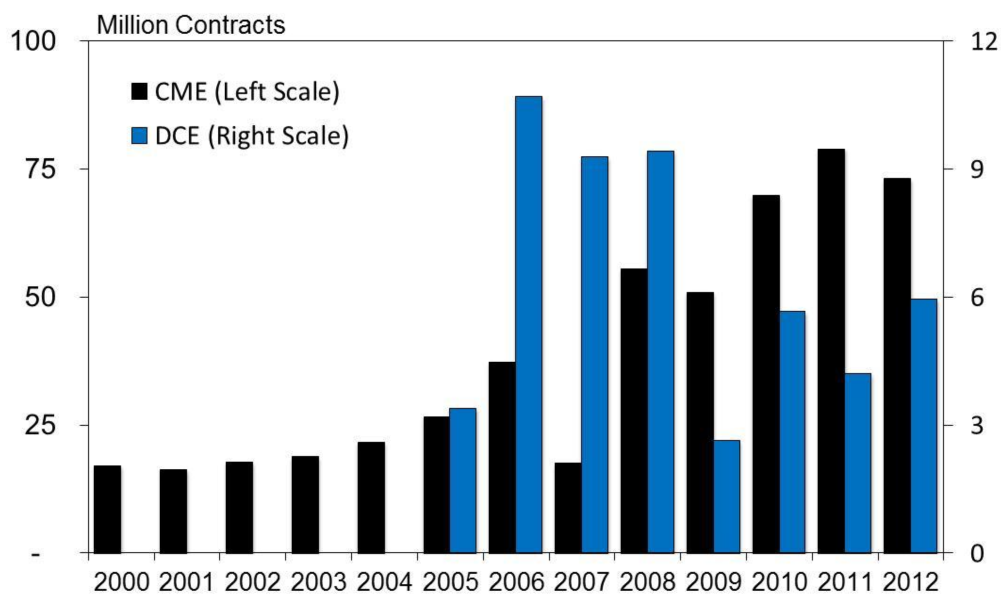
Source: CME Group

Chart 4: Historical Crop Prices



Source: USDA, prices received by farmers

Chart 5: Corn Futures Volume by Year



Source: Barchart.com Advanced Commodities Service

II. Effects of extended trading hours on price volatility

The extension of trading hours at commodity exchanges has changed market dynamics. Regression analysis shows that the release of WASDE reports while markets are open has led to brief spikes in corn futures price volatility. Price volatility, which was slightly higher in the minutes preceding WASDE releases, jumped sharply upon release and persisted for a short time afterward. Producers employing risk management strategies that are impacted by short bursts of high volatility could be affected by extended trading hours. There is, however, little indication that higher price volatility following a WASDE release persisted throughout the remainder of the trading day. In general, producers impacted by price fluctuations only over longer time horizons are unlikely to be should not be affected by extended trading hours with respect to volatility.

Volatility measurements

Price volatility can be measured in various ways. One difficulty in modeling volatility, though, is that it is not directly observable; it can only be estimated from past information. Some researchers employ statistical models of varying complexity to estimate volatility (Tsay 2005). Volatility can also be determined as “implied” by observable option prices. This paper uses a simple way to measure volatility by calculating realized volatility as the variance of price changes over a given time period.

Daily settlement prices for options have typically been used to measure the effect of WASDE releases on commodity price volatility (Sumner and Mueller 1989, Fortenberry and Sumner 1993, Isengildina-Massa et al. 2008, Adjemian 2012). In general, the studies have found that WASDE reports contain significant information that is transmitted to futures markets in varying speeds and intensities. However, using daily prices to determine the effect of the information release on volatility misses intraday effects. Isengildina-Massa et al. conclude that WASDE releases reduce volatility, which may be true when using end-of-day prices to determine volatility. Yet, the data show a definitive spike in volatility at the instant the reports are released. Intraday volatility can be important because many traders actively track market prices throughout the day when making trading decisions. Even brief periods of high volatility can impact risk management strategies. Moreover, if the release of WASDE reports while markets are open has impacted volatility, the impact is likely to be most noticeable immediately after the release.

Advancements in computing resources and data processing have allowed researchers to obtain high-frequency estimates of volatility. In this paper, realized volatility was calculated using corn futures price tick data obtained from CME Group for trades placed on its electronic platform, GLOBEX. Corn is used in the analysis because it is often interpreted as the leading agricultural commodity. Using second-by-second data, a series of intraday price volatility was calculated as a 60 second moving average of squared returns.[6] This intraday volatility series was calculated from the December futures prices for each trading day of June to November from 2008 to 2012.

[6] A full description of the data and regression methods used in this paper can be found in the Appendix.

Estimating volatility from non-WASDE-release days

The effect of WASDE releases on price volatility was measured using days when WASDE reports were not released. Regression analysis on non-WASDE days provides a baseline estimate of intraday price volatility. This baseline was compared to days when WASDE reports were released to measure the intraday effect of WASDE releases on volatility. The regression accounts for differences in month of year, hour of day, and the first three minutes of open outcry trading.[7] The results suggest that markets are adapting relatively quickly to the release of information, although there are periods of high volatility that could impact producers' risk management decisions.

There is little evidence that opening exchanges for trading prior to WASDE releases has contributed significantly to excess volatility. Volatility can be considered excessive when the resulting estimate exceeds what might be reasonably predicted by the regressions.[8] Volatility was somewhat excessive in the minutes immediately preceding a WASDE release, as traders took positions in advance of the reports; volatility was substantially less in the minutes following a release (Charts 6 and 7). Volatility was excessive for more than half of the five minutes preceding a WASDE release only in 2008 and 2012 (Chart 8). In 2012, volatility was excessive more than 80 percent of the time in the 15-minute minute period prior to a WASDE release. However, since 2008 there was little evidence of excessive volatility more than 15 minutes before a WASDE release.

An extension of trading hours appears to have led to a more pronounced period of excess volatility in the minutes following WASDE releases. Higher volatility persisted significantly longer following WASDE releases in 2012 than in previous years. Although excess volatility lasted more than five minutes after WASDE releases in 2008 and 2009, it lingered considerably longer in 2012. In 2012, volatility was excessive for 30 consecutive minutes following WASDE releases. In the 30-to-60-minute window after WASDE releases, excess volatility was evident 84 percent of the time.

Although the results point to higher volatility for up to 60 minutes following WASDE releases, the information was largely incorporated thereafter. There was only slight evidence that excess volatility persisted more than 2.5 hours after WASDE releases. Spikes in intraday volatility may be expected when new information is released, especially if the information is surprising. However, the higher volatility resulting from WASDE releases did not appear to persist to the end of the trading day. It is unlikely, then, that extended trading hours have significantly impacted producers' risk management practices if the decisions are not dependent on intraday price movements. However, risk management strategies affected by intraday fluctuations are likely to be impacted by the period of higher volatility following report releases.

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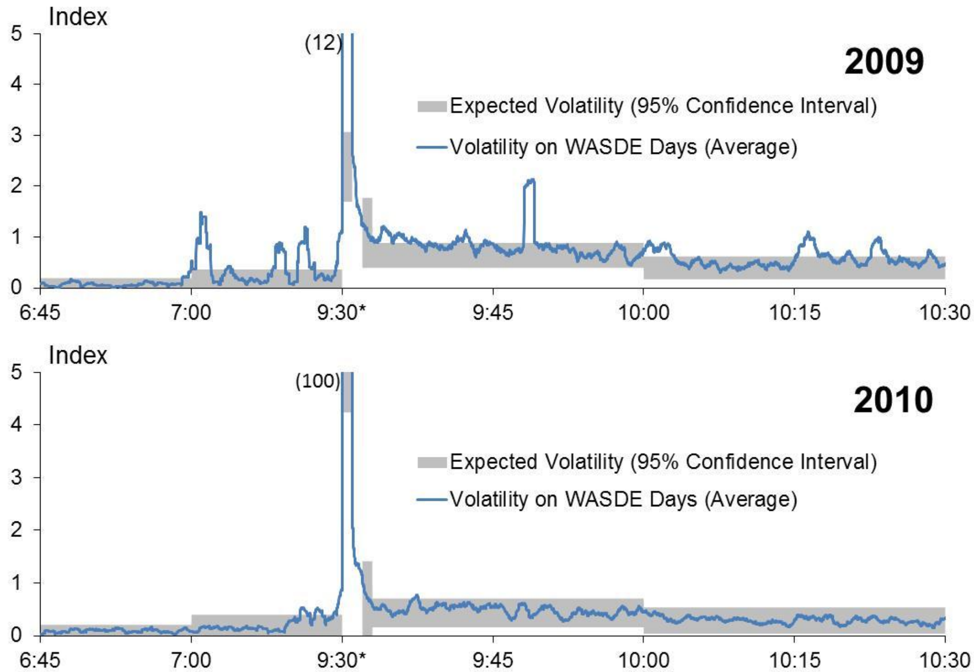
[7] Prior to May 2012, there was a gap in trading when both electronic markets and pits were closed (Chart 1). As a result, there was a daily spike in volatility at 9:30 a.m. as pits reopened from the previous day's close and electronic markets reopened after a morning pause. Because WASDE was released at 7:30 a.m., markets were first able to process the information at 9:30 a.m. Only the first three minutes were significant in the regression on non-WASDE days. Hourly dummy variables are included from 7 a.m. to 1 p.m. to capture hour-specific intraday effects.

[8] Volatility is interpreted as excessive when the estimate lies outside the 95 percent confidence interval determined by the regressions in the analysis.

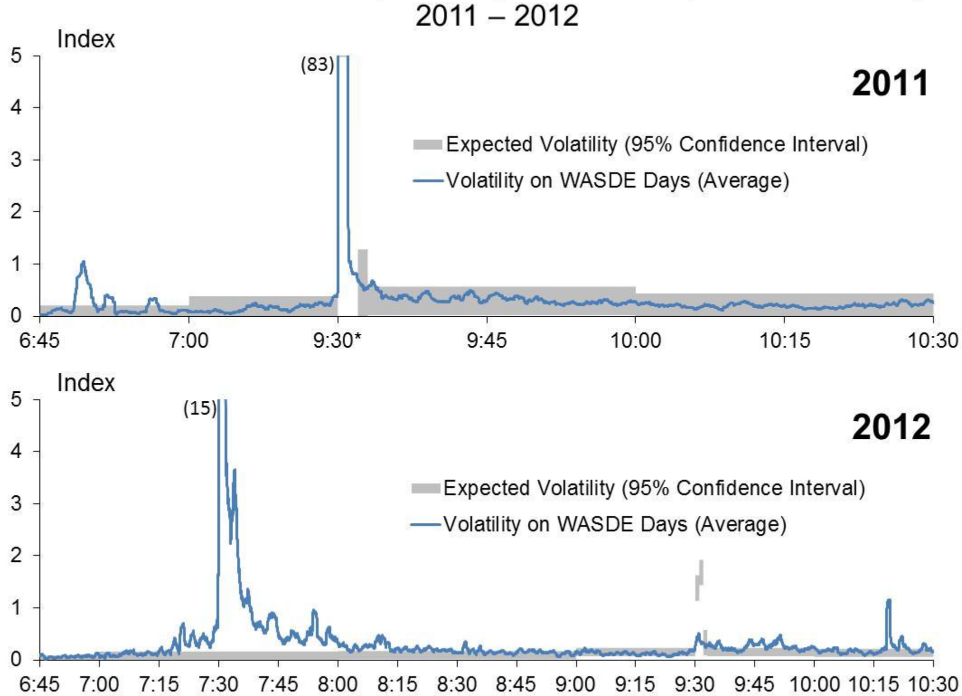
Chart 6: Realized Volatility and Expected Volatility for WASDE Days: 2009 – 2010



* The time gap between 7:15am and 9:30am when markets were closed, is omitted from the charts.

Note: Volatility is indexed between 0 and 100 with a value of 100 corresponding to the maximum in the data between 2008 and 2012, which corresponds to 9:31am in 2010. Numbers in parentheses indicate the peak in volatility, exceeding the chart's scale.

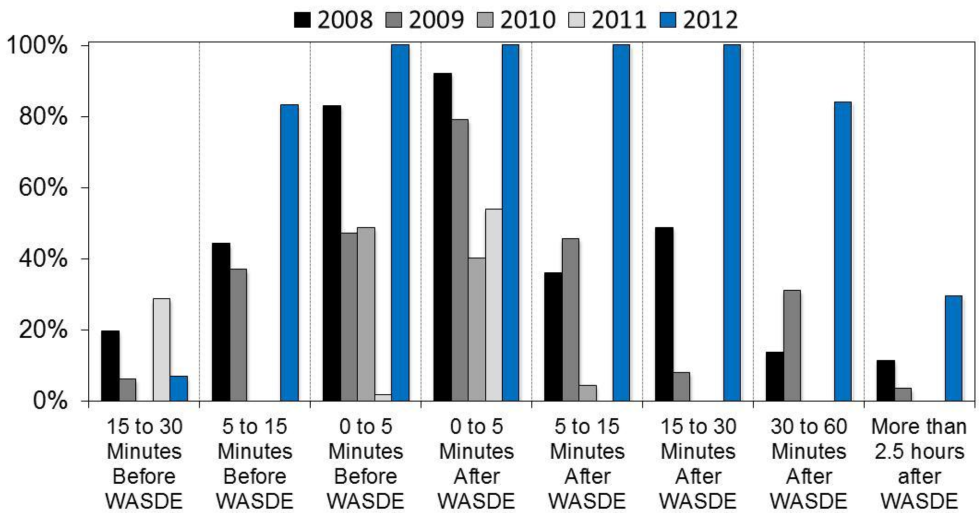
Chart 7: Realized Volatility and Expected Volatility for WASDE Days: 2011 – 2012



* The time gap between 7:15am and 9:30am when markets were closed, is omitted from the charts.

Note: Volatility is indexed between 0 and 100 with a value of 100 corresponding to the maximum in the data between 2008 and 2012, which corresponds to 9:31am in 2010. Numbers in parentheses indicate the peak in volatility, exceeding the chart's scale.

Chart 8: Excess Volatility on WASDE Release Days

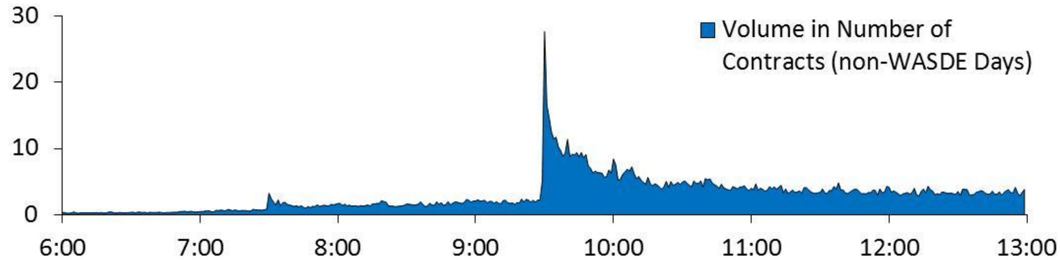


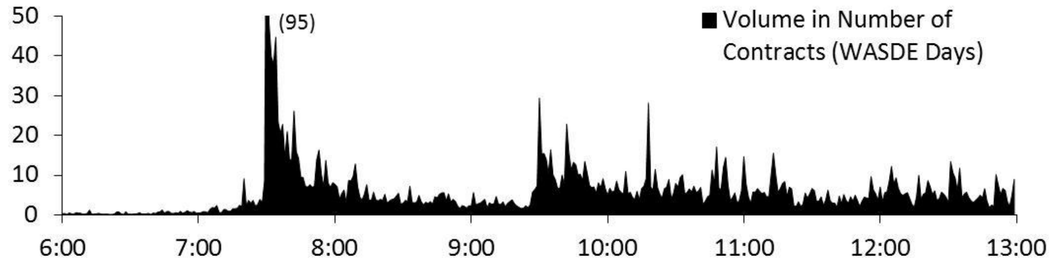
The results also highlight the value of liquidity. High levels of liquidity help markets absorb potential shocks and keep volatility from becoming excessive. Liquidity, as measured by the average volume of contracts traded in a given time frame, was generally at its highest from 9:30 a.m. to 10:30 a.m. (Chart 9). Trading volumes were significantly higher at 7:30 a.m. on days when WASDE reports were released. However, volumes were noticeably less from 8:30 a.m. to 9:30 a.m. Spikes in volatility quickly dissipated in years prior to 2012 when the first minutes of trading following WASDE releases (after 9:30 a.m.) were periods of high liquidity. Conversely, in 2012, the first minutes of trading following WASDE releases (after 7:30 a.m.) were periods of relatively low liquidity.[9] This result supports the USDA decision to move the WASDE release time to 11 a.m. in 2013.

The results suggest that extended trading hours have altered intraday price volatility patterns for corn futures. Differences in liquidity or trader participation strategies while markets are open, resulting from extended trading hours, may be one explanation. However, there is some anecdotal evidence that individuals attempting to download WASDE precisely when it is released have faced significant delays, likely due to server congestion.[10] Thus, it is possible that higher volatility has persisted longer since May 2012 if some groups of traders, wishing to place a trade only after accessing WASDE, are unable to access the information at the same time as others with faster access.

[9] Beginning in June 2012, the CME announced that open outcry hours would begin at 7:20 a.m. on days of a WASDE release in an attempt to increase liquidity. Pit trading opened at its usual time (9:30 a.m.) on all other days.
[10] This issue was discussed by participants at the NCCC-134 Applied Commodity Price Analysis, Forecasting, and Market Risk Management Conference held in St. Louis, MO on April 22, 2013.

Chart 9: Average Intraday Corn Futures Volume per Minute, 2012





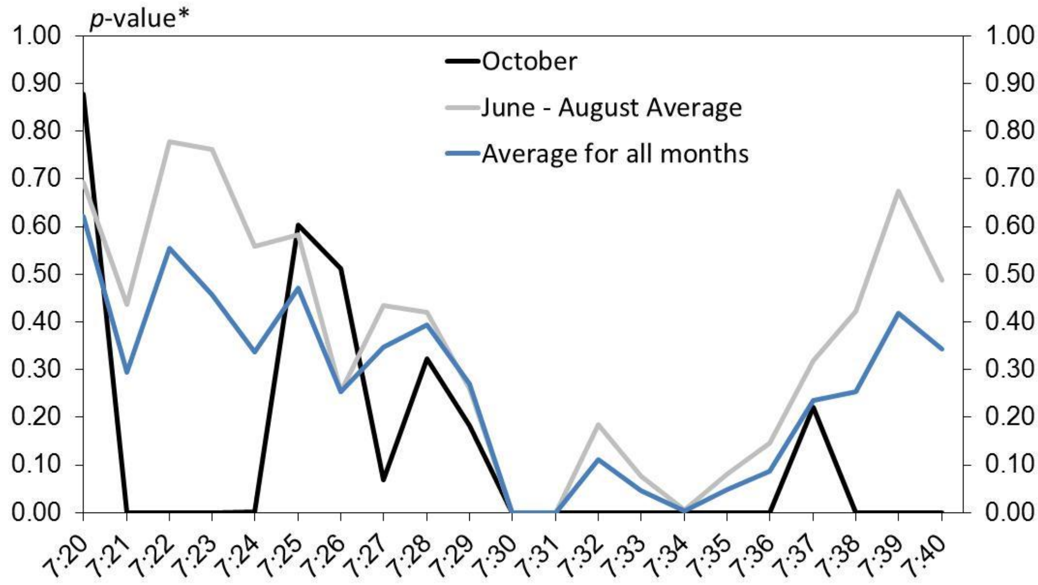
Estimating volatility from previous WASDE release days

Another way to interpret the effect of extended trading hours on intraday volatility is to use WASDE release days prior to 2012 as the baseline. As in the previous subsection, the persistence of excess volatility in 2012 relative to other years provides insight from an alternative perspective. This approach also highlights the potential difference in effects attributed to specific months of WASDE releases.

Realized volatility on previous-year WASDE days was used to estimate intraday volatility in 2012 from June to October using linear regression analysis. Intraday price volatility from 2008 to 2011 was averaged for each month and used to estimate intraday volatility for the corresponding WASDE-release month in 2012. For example, realized volatility on the WASDE-release day in June was calculated for 2008, 2009, 2010, and 2011. The minute-by-minute average of this realized volatility was used to estimate intraday volatility on the WASDE-release day for June 2012.

The results of this approach point to somewhat shorter periods of excess volatility surrounding WASDE releases in 2012. Averaged across months, there was only slight evidence of excessive volatility prior to WASDE releases in 2012. There was very little evidence of heightened volatility more than one minute prior to WASDE releases (Chart 10). Consistent with the previous subsection, however, there was strong evidence of excessive volatility during the first five minutes following WASDE releases. Contrary to the earlier results, there was little evidence that excessive volatility persisted beyond five minutes after WASDE releases.

Chart 10: Excess Volatility on 2012 WASDE Release Days
Estimated from WASDE Days in 2008 – 2011



* A *p*-value close to 0 indicates strong evidence of excess volatility. A *p*-value close to 1 indicates weak evidence of excess volatility.

The results also suggest that excessive volatility persisted for a longer period of time both before and after WASDE releases in later months. In October 2012, volatility was excessive as much as nine minutes before the WASDE release and persisted for approximately 10 minutes afterward. In September 2012, the duration of excessive volatility was slightly shorter, beginning about seven minutes before the WASDE release and lingering for eight minutes. In June, July, and August 2012, however, excessive volatility persisted for only one to four minutes on average. Volatility was generally not excessive prior to WASDE releases.

The results of this subsection are qualitatively similar to those of the previous subsection. There was slight evidence of excessive volatility prior to WASDE releases, sharp jumps in excessive volatility when the reports were released, and slight persistence thereafter. One reason for a shorter duration of excessive volatility estimated in this subsection, however, is that prior to 2012, markets were unable to trade until 9:30 a.m., two hours after WASDE releases. Volatility that is typically higher at 9:30 a.m. cannot be disentangled from the effects of WASDE releases in those years using this approach. If the effects could be disentangled, the volatility attributed to WASDE releases prior to 2012 would be less both before and after 9:30 a.m., making volatility associated with WASDE releases in 2012 higher by comparison.

III. Explaining intraday volatility patterns across years

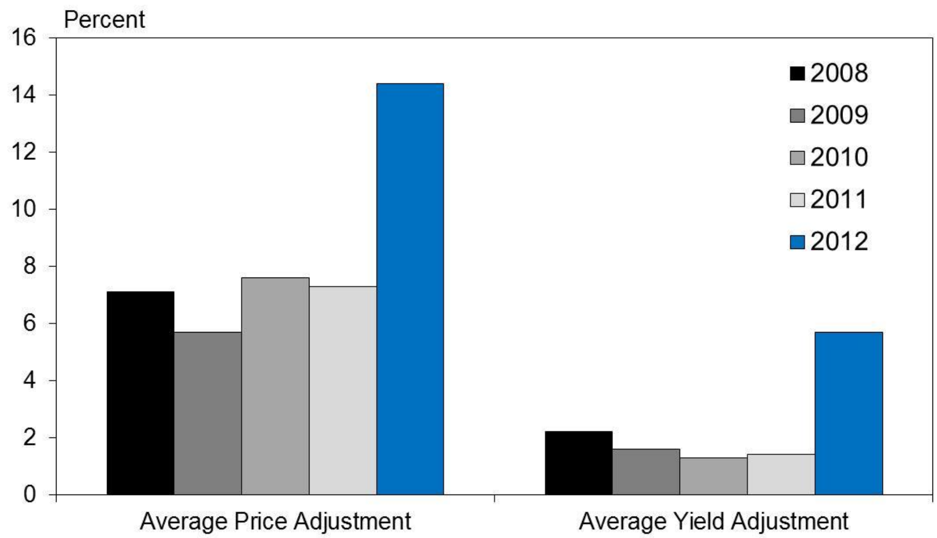
The analysis of the previous section reveals that intraday volatility patterns have not been constant across years. In some years, price volatility has been significantly higher and more persistent than in others (Chart 8). One possible explanation is that supply and demand fundamentals differed across years or that some WASDEs have contained larger information surprises than others. The number of market participants, including nonproducers, and volume of trading activity may also explain differences in volatility across years.

Unexpected information

The release of unexpected information in WASDEs may help explain why the duration of excess volatility was longer in some years. Every month, USDA updates its estimates of supply, demand, and a range of forecasted prices. Information on supply includes inventory estimates, projected crop yields, projections of harvested acreage, and imports. For corn, WASDEs provide projections of demand for domestic feed, food, seed, industrial use, and export demand. Larger-than-expected adjustments in price expectations or in individual supply and demand projections may generate longer periods of excess volatility as markets react to surprising information.

The size of adjustments in supply and demand estimates from one WASDE release to the next has varied significantly from 2008 to 2012. In 2012, the average adjustment to projected corn yields, a widely reported headline number, was 5.7 percent from May to November (Chart 11). In 2008, another year with relatively high intraday volatility, the average yield adjustment was 2.2 percent. Conversely, the average yield adjustment made from one WASDE release to the next was only 1.3 percent and 1.4 percent in 2010 and 2011, respectively. These years also coincided with relatively low intraday volatility. Although it is difficult to determine what markets may have expected prior to WASDE releases, this result provides some support for the notion that traders may be responding to unexpected changes in the headline crop yield projections.

Chart 11: Average Month-to-Month WASDE Adjustments (May to November)



Source: USDA

The month of WASDE releases, coupled with the size of adjustment may also explain intraday volatility patterns across years. In 2010, few adjustments were made to corn yield projections before October, when yields were revised down by 4.1 percent. For the majority of 2010, intraday volatility was relatively low before spiking sharply with the October adjustment. Conversely, yields were revised higher by 4.4 percent and 4.0 percent in August 2008 and 2009, respectively. The size of the intraday volatility spikes in those months paled in comparison to the spike in October 2010, although intraday volatility was generally higher throughout both 2008 and 2009. This result suggests that for adjustments made early in the year, spikes in intraday volatility may be smaller than when the adjustment is made later in the year. However, significant adjustments made earlier in the year have resulted in noticeably higher intraday volatility for the remainder of the growing season.

Intuitively, changes in season-average price projections from month to month could contribute to differences in intraday volatility across years. In addition to providing supply and demand estimates each month, the USDA also provides an estimated range of farm prices for the year for individual crops. Adjustments to this price projection capture elements of both supply and demand. However, there was no discernible pattern between the average size of price adjustments and intraday volatility across years. This loosely suggests that traders might place more emphasis on supply adjustments made by the USDA than general shifts in demand.

The size of inventories might be considered as another relevant factor contributing to differences in volatility. Although post-drought inventories were low in 2012, a year with higher intraday volatility, inventories were also 25 percent below average in September 2011, a year with relatively low intraday price volatility. While inventories may affect volatility over longer time horizons, their influence on intraday price volatility patterns appears limited.

Nonproducer participation

Nonproducers provide commodity markets with greater liquidity and depth. Market liquidity and market depth are closely related. High liquidity refers to the ability to sell assets in a market without affecting price. Depth refers to the ability to place large orders in a market without affecting price. Markets that are deep tend to also be liquid. In this paper, volume is used as a proxy for market liquidity (Datar, Naik, and Radcliffe 1998, Brennan, Chordia, and Subrahmanyam 1998). Open interest, the number of contracts outstanding at a given time, is used as a proxy for market depth (Bessembinder and Seguin 1993, Ragunathan and Peker 1997).

Nonproducers typically seek to profit in commodity markets only from price fluctuations. The aggregate positions and relative importance of nonproducers have changed over the years. In the early 1990s, nonproducers held as little as 6 percent of total open interest in corn futures contracts. Since 2000, the share of open interest held by nonproducers has ranged from 19 percent to 38 percent. Throughout 2012, the share has averaged 33 percent.

Nonproducers can be categorized in various ways. One category, whose activity is tracked by the CFTC, is managed money traders (MMTs). MMTs, often interpreted as large speculators, consist of hedge funds and commodity pool operators. MMTs seek profits from both price increases and decreases. Another category is commodity index traders (CITs). Unlike MMTs, CITs typically seek profits only from price increases through general commodity market exposure. Investing in popular indexes such as the Goldman Sachs Commodity Index (GSCI) or Dow Jones UBS Commodity Index (DJ-UBSCI) is often considered a passive form of commodity market speculation in which positions are mechanically rolled from an expiring contract to the next contract available.

Commodity market speculators have generated substantial debate surrounding their potential to influence food prices and volatility (Robles, Torero, and von Braun 2009, Irwin, Sanders, and Merrin 2009, Stoll and Whaley 2010, Baffes and Haniotis 2010). Although the effects of speculation on prices and volatility may be controversial, speculation has long been recognized as valuable in providing markets with additional depth and liquidity (Working 1953). Still, the CFTC continues to push for tighter speculative trading limits.

The CFTC regulates commodity futures and options markets. Weekly positions of commercial and non-commercial traders are disclosed through the CFTC large trader reporting program to provide some transparency in commodity derivative markets. The positions are reported as open interest. The CFTC aggregates daily positions of various trader groups in futures and options contracts and provides this information to the public weekly.[11]

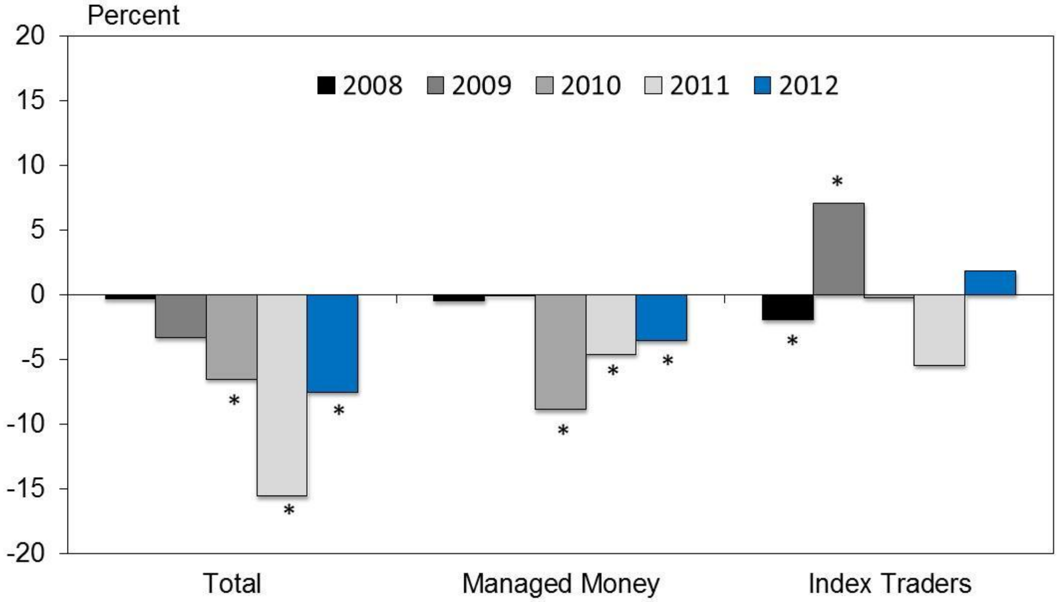
Open interest can be interpreted as a proxy for market depth, closely related to liquidity, over time. Total open interest, MMT open interest, and CIT open interest were each included separately as explanatory variables in the earlier regressions. As in the previous section, regressions were conducted for each individual year from 2008 to 2012.

Market depth may explain some differences in intraday volatility across years. The inclusion of trader positions in the regressions suggests that volatility is generally reduced with higher levels of open interest. The marginal effects of total open interest and MMT open interest were consistently negative and highly significant in the past three years (Chart 12). The two years with the least persistence of excessive volatility, 2010 and 2011, coincided with when the marginal effect of total open interest was its largest. The marginal effect of CIT open interest on realized volatility was not statistically significant in the last three years.

The results suggest that crop prices in 2012 may have been more volatile if not for the presence of nonproducers. With WASDEs released during a time of day with relatively low trading volumes, market participation might have been even less if nonproducers were restricted from participation. Thin markets could have caused excessive volatility to persist for a longer period of time and at higher levels following WASDE releases.

[11] See *http://www.cftc.gov/IndustryOversight/MarketSurveillance/LargeTraderReportingProgram/index.htm* for more information on the CFTC program, data, and trader groups.

Chart 12: Marginal Effects of Open Interest by Trader Group



Note: Marginal effects indicate the percentage change in estimated volatility associated with a 1 percent change in open interest when evaluated at the means of the data.
* Effect is significant at the 5% significance level.

Conclusion

Agricultural commodity producers are highly focused on managing risk. Producers typically disapprove of any change in market structure that impacts their ability to mitigate exposure to price volatility. Conversely, nonproducers often welcome price volatility because it provides them an opportunity to profit from changing prices. Producers have expressed concerns that extended trading hours at commodity exchanges could exacerbate price volatility. The extension of trading hours in May 2012 has allowed markets to trade during the release of fundamental supply and demand reports for the first time.

Extended trading hours have resulted in brief shocks in corn futures price volatility around the release of USDA market reports. Higher volatility due to extended trading hours is likely to impact producers' risk management strategies that are affected by intraday price swings. The heightened volatility, however, has not typically lasted more than 30 to 60 minutes. Producers whose risk management strategies are not affected by intraday price swings are not likely to be significantly affected by trading during the release of WASDEs.

With shifting market conditions, intraday price volatility patterns have varied significantly over the past five years. Fluctuations in supply and demand, particularly unexpected forecast adjustments, have partly shaped these differences. Information surprises have typically generated more intraday volatility, but the magnitude of the effect has depended on the time of year the information shocks have taken place. Despite the ongoing controversy of speculation in commodity markets, the presence of nonproducers has contributed to keeping price volatility subdued.

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Appendix

Second-by-second corn futures prices and traded quantities were obtained from CME Group covering the time period from June 1, 2008 to November 6, 2012. (The data were acquired on November 7, with November 6 the last day available.) Only the December futures contract was used in the subsequent analysis in order to consistently examine intraday price volatility without having to account for contract switches. The December contract was used because it is the contract generally associated with the fall harvest and is heavily traded. In addition, only the days from June 1 to November 6 from each year were used in the analysis. In the springtime, although still fairly heavily traded, the December futures contract is less significant. Including springtime months in the analysis may have underemphasized the effects of WASDE releases on volatility during the key summer growing season and subsequent harvest by including less significant springtime WASDE releases.

In the second section, non-WASDE days were used as a baseline to measure the effect of a WASDE release on price volatility. Second-by-second price observations were obtained for each non-WASDE day. Then, a 60-second moving average of realized volatility was calculated as the squared returns from one price observation to the next. This series of realized volatility was regressed on time dummy variables. The dummy variables included a monthly dummy variable, a dummy variable for each hour of open trading 3 hours before and after a WASDE release, and a dummy variable for the first 3 minutes of open outcry trading to capture "market-opening" effects. The regression model is specified as follows.

The results of the regressions, using observations from non-WASDE days, to predict intraday volatility for a typical non-WASDE day, are provided in Tables 1a to 1e under the heading of Model 1. Although some variables were found to be insignificant in certain years, the time dummy variables used for each year were the same in order to consistently compare results across years. The coefficient estimate of the regression can be interpreted as the contribution to estimated volatility on an annualized percentage basis. For example, annualized volatility at 9:30 a.m. on a non-WASDE release day in July 2012 was estimated as 15.05 percent (-0.81 + 3.74 + 12.13). Assuming a normal distribution, standard errors were obtained from the coefficient estimates to generate a 95 percent confidence interval for expected price volatility.

Realized volatility on WASDE release days was calculated in a similar manner and then compared with the 95 percent confidence interval that might be expected in the absence of a WASDE release. Price volatility was considered excessive at each point in time when realized volatility on a WASDE-release day fell outside the 95 percent confidence interval.

As an alternative approach in the second section, previous-year WASDE days were used as a baseline to compare WASDE releases in 2012. In this approach, realized volatility was calculated for each WASDE-release day (one per month) for each year between 2008 and 2011. An average of realized volatility was then calculated for each month over these four years. Realized volatility on each WASDE-release day in 2012 (June through October) was then regressed on the corresponding-month average of realized volatility from 2008 to 2011 and dummy variables capturing each of the 10 minutes before and after a WASDE release (7:20 a.m. to 7:40 a.m.). As in the previous approach, a 95 percent confidence interval was calculated from the coefficient estimate standard errors. Volatility was considered excessive when the actual realized volatility for each WASDE day in 2012 fell outside this confidence interval. It should be mentioned that a shortcoming of this second approach is that there is no way to disentangle the "market-opening" effect from the "WASDE announcement effect" in the years 2008 to 2011. This is because the two events both coincided at 9:30 a.m.

In the third section, open interest for various trader groups were incorporated as additional explanatory variables. Weekly data on total open interest, managed money trader (MMT) open interest, and commodity index trader (CIT) open interest were obtained from the Commodity Futures Trading Commission (CFTC). Each measure of open interest was added separately as an explanatory variable for the entire corresponding week of realized volatility. Although total open interest is available daily, the weekly observation was used in order to compare marginal effects with those of the various trader groups consistently. Regression results are provided in Tables 1a to 1e under the headings of Model 2, Model 3, and Model 4 for the individual inclusion of total open interest, managed money open interest, and index trader open interest, respectively.

Table 1a: Regression Results for 2008 Non-WASDE Days

2008												
	Model 1			Model 2 Total O.I.			Model 3 Managed Money O.I.			Model 4 Index Traders O.I.		
Variable	*p*-val.	Signific.	Est.	*p*-val.	Signific.	Est.	*p*-val.	Signific.	Est.	*p*-val.	Signific.	Est.
Intercept	0.14		-2.15	0.74		3.37	0.30		4.54	0.00	***	9.19
Jul.	0.72		-0.83	0.55		-1.37	0.24		-1.79	0.01	**	-2.33
Aug.	0.00	***	2.97	0.26		2.52	0.64		1.58	0.12		-2.36
Sep.	0.00	***	2.72	0.68		1.87	0.80		-1.38	0.01	**	-3.39
Oct.	0.00	***	5.83	0.00	***	5.43	0.00	***	4.89	0.71		1.61
Nov.	0.00	***	5.74	0.01	***	5.32	0.01	**	4.78	0.57		-2.29
5 a.m.	0.14		2.16	0.14		2.16	0.14		2.16	0.14		2.16
8 a.m.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9 a.m.	0.00	***	8.07	0.00	***	8.07	0.00	***	8.07	0.00	***	8.07
10 a.m.	0.00	***	6.09	0.00	***	6.09	0.00	***	6.09	0.00	***	6.09
11 a.m.	0.00	***	4.83	0.00	***	4.83	0.00	***	4.83	0.00	***	4.83
12 p.m.	0.00	***	5.14	0.00	***	5.14	0.00	***	5.14	0.00	***	5.14
1 p.m.	0.00	***	5.94	0.00	***	5.94	0.00	***	5.94	0.00	***	5.94
9:30 to 9:31	0.00	***	24.48	0.00	***	24.48	0.00	***	24.48	0.00	***	24.48
9:31 to 9:32	0.00	***	28.66	0.00	***	28.66	0.00	***	28.66	0.00	***	28.66
9:32 to 9:33	0.00	***	8.90	0.00	***	8.90	0.00	***	8.90	0.00	***	8.90
O.I.	N/A	N/A	N/A	0.64		-3.37	0.20		-7.19	0.00	***	-14.47
R-square		0.3074			0.3075			0.3075			0.3080	

Note: Significance levels of 1%, 5%, and 10% are denoted by *, **, and *** respectively.

Coefficient estimates are interpreted as the contribution to estimated volatility as an annualized percentage.

Table 1b: Regression Results for 2009 Non-WASDE Days

2009												
	Model 1			Model 2 Total O.I.			Model 3 Managed Money O.I.			Model 4 Index Traders O.I.		
Variable	*p*-val.	Signific.	Est.	*p*-val.	Signific.	Est.	*p*-val.	Signific.	Est.	*p*-val.	Signific.	Est.
Intercept	0.16		-2.59	0.07	*	11.81	0.92		-2.38	0.01	**	-16.24
Jul.	0.09	*	2.93	0.72		-1.66	0.09	*	2.93	0.31		-2.99
Aug.	0.00	***	3.84	0.89		-1.20	0.07	*	3.82	0.27		-3.82
Sep.	0.00	***	4.40	0.92		1.03	0.00	***	4.40	0.24		-4.56
Oct.	0.00	***	4.31	0.14		3.16	0.00	***	4.31	0.13		-5.85
Nov.	0.09	*	4.11	0.17		3.72	0.18		4.09	0.14		-5.98
5 a.m.	0.47		2.35	0.47		2.35	0.47		2.35	0.47		2.35
8 a.m.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9 a.m.	0.00	***	8.43	0.00	***	8.43	0.00	***	8.43	0.00	***	8.43
10 a.m.	0.00	***	6.44	0.00	***	6.44	0.00	***	6.44	0.00	***	6.44
11 a.m.	0.00	***	5.78	0.00	***	5.78	0.00	***	5.78	0.00	***	5.78
12 p.m.	0.00	***	5.77	0.00	***	5.77	0.00	***	5.77	0.00	***	5.77
1 p.m.	0.08	*	6.82	0.08	*	6.82	0.08	*	6.82	0.08	*	6.82
9:30 to 9:31	0.00	***	14.43	0.00	***	14.43	0.00	***	14.43	0.00	***	14.43
9:31 to 9:32	0.00	***	29.09	0.00	***	29.09	0.00	***	29.09	0.00	***	29.09
9:32 to 9:33	0.05	*	7.28	0.05	*	7.28	0.05	*	7.28	0.05	*	7.28
O.I.	N/A	N/A	N/A	0.06	*	-12.25	0.98		-1.70	0.02	**	29.60
R-square	0.0445			0.0446			0.0445			0.0447		

Note: Significance levels of 1%, 5%, and 10% are denoted by *, **, and *** respectively.

Coefficient estimates are interpreted as the contribution to estimated volatility as an annualized percentage.

Table 1c: Regression Results for 2010 Non-WASDE Days

2010												
	Model 1			Model 2 Total O.I.			Model 3 Managed Money O.I.			Model 4 Index Traders O.I.		
Variable	*p*-val.	Signific.	Est.	*p*-val.	Signific.	Est.	*p*-val.	Signific.	Est.	*p*-val.	Signific.	Est.
Intercept	0.18		2.67	0.00	***	13.57	0.00	***	16.04	0.92		3.77
Jul.	0.71		-1.45	0.09	*	-3.20	0.00	***	-4.81	0.75		-1.41
Aug.	0.98		0.36	0.04	**	3.81	0.85		-1.03	0.95		0.81
Sep.	0.92		0.73	0.00	***	5.35	0.00	***	5.16	0.92		0.96
Oct.	0.21		-2.67	0.01	***	5.98	0.00	***	7.00	0.27		-2.64
Nov.	0.19		-3.61	0.02	**	6.76	0.00	***	7.89	0.19		-3.63
5 a.m.	0.47		2.49	0.47		2.49	0.47		2.49	0.47		2.49
8 a.m.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9 a.m.	0.00	***	6.81	0.00	***	6.81	0.00	***	6.81	0.00	***	6.81
10 a.m.	0.00	***	5.37	0.00	***	5.37	0.00	***	5.37	0.00	***	5.37
11 a.m.	0.00	***	4.43	0.00	***	4.43	0.00	***	4.43	0.00	***	4.43
12 p.m.	0.00	***	4.62	0.00	***	4.62	0.00	***	4.62	0.00	***	4.62
1 p.m.	0.33		5.43	0.33		5.43	0.33		5.43	0.33		5.43
9:30 to 9:31	0.00	***	23.39	0.00	***	23.39	0.00	***	23.39	0.00	***	23.39
9:31 to 9:32	0.00	***	26.25	0.00	***	26.25	0.00	***	26.25	0.00	***	26.25
9:32 to 9:33	0.40		5.03	0.40		5.03	0.40		5.03	0.40		5.03
O.I.	N/A	N/A	N/A	0.00	***	-12.11	0.00	***	-22.10	0.96		-3.89
R-square	0.0326			0.0330			0.0336			0.0326		

Note: Significance levels of 1%, 5%, and 10% are denoted by *, **, and *** respectively.

Coefficient estimates are interpreted as the contribution to estimated volatility as an annualized percentage.

Table 1d: Regression Results for 2011 Non-WASDE Days

2011												
	Model 1			Model 2			Model 3			Model 4		
				Total O.I.			Managed Money O.I.			Index Traders O.I.		
Variable	*p* -val.	Signific.	Est.	*p* -val.	Signific.	Est.	*p* -val.	Signific.	Est.	*p* -val.	Signific.	Est.
Intercept	0.04	**	3.33	0.00	***	20.07	0.00	***	11.37	0.15		11.71
Jul.	0.17		-2.81	0.00	***	-8.26	0.00	***	-5.69	0.25		-2.59
Aug.	0.04	**	-3.42	0.00	***	-7.79	0.00	***	-5.04	0.01	**	-4.01
Sep.	0.95		-0.63	0.00	***	-7.49	0.00	***	-4.60	0.48		-2.18
Oct.	0.17		-2.79	0.00	***	-8.02	0.00	***	-5.25	0.06	*	-4.38
Nov.	0.36		-3.04	0.00	***	-7.79	0.07	*	-4.25	0.12		-4.52
5 a.m.	0.60		2.12	0.60		2.12	0.60		2.12	0.60		2.12
8 a.m.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9 a.m.	0.00	***	5.44	0.00	***	5.44	0.00	***	5.44	0.00	***	5.44
10 a.m.	0.00	***	4.07	0.00	***	4.07	0.00	***	4.07	0.00	***	4.07
11 a.m.	0.04	**	3.40	0.04	**	3.40	0.04	**	3.40	0.04	**	3.40
12 p.m.	0.03	**	3.50	0.03	**	3.50	0.03	**	3.50	0.03	**	3.50
1 p.m.	0.57		4.12	0.57		4.12	0.57		4.12	0.57		4.12
9:30 to 9:31	0.00	***	25.54	0.00	***	25.54	0.00	***	25.54	0.00	***	25.54
9:31 to 9:32	0.00	***	27.11	0.00	***	27.11	0.00	***	27.11	0.00	***	27.11
9:32 to 9:33	0.39		5.12	0.39		5.12	0.39		5.12	0.39		5.12
O.I.	N/A	N/A	N/A	0.00	***	-16.62	0.00	***	-14.82	0.19		-18.47
R-square	0.0376			0.0386			0.0384			0.0377		

Note: Significance levels of 1%, 5%, and 10% are denoted by *, **, and *** respectively.

Coefficient estimates are interpreted as the contribution to estimated volatility as an annualized percentage.

Table 1e: Regression Results for 2012 Non-WASDE Days

2012												
	Model 1			Model 2 Total O.I.			Model 3 Managed Money O.I.			Model 4 Index Traders O.I.		
Variable	*p*-val.	Signific.	Est.	*p*-val.	Signific.	Est.	*p*-val.	Signific.	Est.	*p*-val.	Signific.	Est.
Intercept	0.00	***	3.31	0.00	***	10.35	0.00	***	7.56	0.74		-3.87
Jul.	0.68		-0.81	0.39		-1.15	0.00	***	-2.46	0.78		0.89
Aug.	0.00	***	-3.29	0.03	**	-2.02	0.00	***	-3.12	0.06	*	-2.90
Sep.	0.00	***	-3.16	0.00	***	-2.59	0.00	***	-2.79	0.05	*	-2.79
Oct.	0.00	***	-3.50	0.08	*	-1.89	0.00	***	-2.41	0.01	***	-3.20
Nov.	0.00	***	-3.57	0.90		-0.63	0.14		-2.24	0.03	**	-3.25
5 a.m.	0.00	***	2.46	0.00	***	2.46	0.00	***	2.46	0.00	***	2.46
8 a.m.	0.00	***	2.69	0.00	***	2.69	0.00	***	2.69	0.00	***	2.69
9 a.m.	0.00	***	3.74	0.00	***	3.74	0.00	***	3.74	0.00	***	3.74
10 a.m.	0.00	***	3.52	0.00	***	3.52	0.00	***	3.52	0.00	***	3.52
11 a.m.	0.00	***	3.18	0.00	***	3.18	0.00	***	3.18	0.00	***	3.18
12 p.m.	0.00	***	3.06	0.00	***	3.06	0.00	***	3.06	0.00	***	3.06
1 p.m.	0.22		3.54	0.22		3.54	0.22		3.54	0.22		3.54
9:30 to 9:31	0.00	***	12.13	0.00	***	12.13	0.00	***	12.13	0.00	***	12.13
9:31 to 9:32	0.00	***	13.51	0.00	***	13.51	0.00	***	13.51	0.00	***	13.51
9:32 to 9:33	0.03	**	4.65	0.03	**	4.65	0.03	**	4.65	0.03	**	4.65
O.I.	N/A	N/A	N/A	0.00	***	-9.21	0.00	***	-9.72	0.56		8.10
R-square	0.0174			0.0184			0.0183			0.0174		

Note: Significance levels of 1%, 5%, and 10% are denoted by *, **, and *** respectively.

Coefficient estimates are interpreted as the contribution to estimated volatility as an annualized percentage.