The Relationship Among Agricultural Futures, ETFs, and the US Stock Market

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Agriculture-related exchange-traded funds (ETFs) have become popular investments in recent years. I investigate the return dynamics among the agriculture ETFs, DBA and RJA (both traded on the New York Stock Exchange), their underlying futures, and the US stock market. ETF and futures returns are highly correlated and the results indicate a strong link between prices and public information. Using intraday data, I find that Granger-causality in returns primarily runs from individual futures to the agriculture ETFs. However, DBA and RJA returns are also significantly caused by S&P500 index returns, showing that stock market sentiment influences pricing behavior. The results are also consistent with the impact of financialization of commodities on agriculture prices.

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JEL Classification: G13, G14

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THE RELATIONSHIP AMONG AGRICULTURAL FUTURES, ETFS, AND THE US STOCK MARKET

With global agriculture prices hitting record levels in the first quarter of 2011, agriculture-related exchange-traded funds (ETFs) were in great demand. In January and February of 2011, buyers poured $1 billion into one of the largest agriculture ETFs (Pleven, 2011). Reasons for the surge of agriculture prices could be loose US monetary policy, a weak US dollar, increasing global demand from China and other developing countries, drought, and speculation.

Whether commodity index speculation drives prices up is strongly debated among academics, practitioners, and policy makers. Although Blanch et al. (2008) and Stoll and Whaley (2010) find no evidence to support this argument, some recent papers, (e.g., Inamura et al. 2011 and Tang and Xiong 2010), show that the financialization of commodities plays an important role in the volatility of commodity prices. Commodities have become increasingly financialized by the creation of futures and ETFs, and investors consider commodities an asset class similar to stocks. In particular, under a low-interest environment, enhanced market expectations will entail an increase in the risk appetite of investors who view commodities as an asset class.

Inamura et al. (2011) and Tang and Xiong (2010) report that global commodity markets have become more sensitive to portfolio investment by financial investors and, consequently, commodities prices have become more correlated with each other and with stock prices. Mayer (2009) and Wien (2011) further argue that financialization aggravates herding behavior and creates price bubbles.

The PowerShares DB Agriculture Fund (DBA) is the most active agriculture ETF, followed by the ELEMENTS Rogers International Commodity Agriculture Index (RJA). DBA
and RJA started trading in January and October, 2007, respectively. DBA invests in 11 agriculture futures contracts, including the top four components of corn, live cattle, sugar, and soybeans, and RJA invests in 21 of these contracts, such as wheat, corn, cotton, and soybeans. Retail investors are attracted by the easy trading of these broadly-based index agriculture ETFs.

In this study, I investigate the dynamics among DBA and RJA, each of the four futures contracts, and the US stock market for the period of January 2008 through December 2010. Both DBA and RJA are traded on the New York Stock Exchange Arca (NYSE Arca). Corn, live cattle, soybeans, and wheat futures are traded on the CME (Chicago Mercantile Exchange) Group, while sugar and cotton futures are traded on ICE Futures U.S. Investigating the relationship between the agriculture ETF and its underlying futures can strengthen our understanding of how investors exploit information from different markets. The results also test the hypothesis that financialized agriculture ETFs are influenced by the stock market.

Note that all the above-mentioned studies using daily or lower frequency futures data may not capture the fast dynamics between markets. I use daily and intraday data from the electronic trading exchange of NYSE Arca and the electronic platforms of the CME Group and ICE to investigate both the contemporaneous and lead-lag relationships. Moreover, no prior work has used ETFs to examine price formation in agriculture commodities.

Fleming, Kirby, and Ostdiek (2006) report that the variance ratios (daytime versus overnight volatilities) of weather-sensitive agricultural markets are significantly lower than the variance ratios in the stock market. They also argue that “under the extreme assumption that weather conditions are the only relevant information in these markets and that this information evolves randomly over the 24-hour day, the trading- and nontrading-period variances should be
equal per unit of time.” I find that the variance ratio of the stock index is greater than those of the two agriculture ETFs and the component futures, with the exception of live cattle futures. Corn, cotton, soybeans, sugar, and wheat prices are weather sensitive, while prices for live cattle futures are not. Cotton futures are much more actively traded on the Zhengzhou Commodity Exchange in China (open when the US market is closed) than the US market. The dominance of the Chinese cotton market leads to a variance ratio smaller than all the other futures. In contrast, Brazil (open with similar business hours as the US) is the largest producer and exporter of sugar, resulting in a larger variance ratio than for other futures. The overall results are consistent with the close relationship between public information flow and volatility for agriculture prices.

Not surprisingly, DBA, RJA, and futures returns are highly correlated. DBA and RJA are also substantially correlated with an ETF that tracks the S&P500 Index. Using intraday five-minute returns, I find, on average, that Granger-causality runs from the component futures to the agriculture ETFs, showing that futures markets disseminate information more efficiently than the ETFs. Moreover, DBA and RJA returns are significantly caused by the stock index, indicative of the effects of stock market sentiment and location of trade. These results do not reject the hypothesis that the agriculture ETFs are influenced by the stock market.

The remainder of the paper is organized as follows. Section I describes the agriculture ETFs and data. Section II reports the results and the empirical analysis of variance ratio and intraday Granger-causality. Concluding remarks and suggestions for future research are offered in Section III.
I. AGRICULTURE ETFS AND DATA

Earlier studies, e.g., Gorton and Rouwenhorst (2006) and Erb and Harvey (2006), show that commodities have returns comparable to stocks while having a low correlation with the stock market, therefore providing diversification benefits for stock portfolios. More recent papers, including Inamura et al. (2011) and Tang and Xiong (2010), report that prior to the mid-2000s, energy and agriculture commodities (e.g., crude oil and soybeans) had almost zero correlation. However, after 2004 commodities (particularly those that are included in an agriculture index) are becoming highly correlated to each other and to other asset classes.\(^1\)

In recent years, commodity exchange-traded funds (ETFs), exchange-traded notes (ETNs), and index futures spanning agriculture, energy, and metals have offered an easy way to invest in these commodities. Sizemore (2011) finds that the financialization process has caused the commodities market to largely replicate the stock market, noting that whereas the equity and commodities markets used to be populated by different types of investors, there is now almost total overlap. Mayer (2009) shows that index-trader positions have a causal price impact on agricultural commodities.

With rising global agriculture prices, the demand for agriculture-related ETFs has been increasing. The PowerShares DB Agriculture Fund (DBA) was introduced by Deutsche Bank (DB) on January 5, 2007 and is now the most active ETF on agricultural commodities. The second-most active agriculture ETF is the ELEMENTS Rogers International Commodity Agriculture Index (RJA) issued by Swedish Export Credit Corporation (SEK) on October 17, 2010.

\(^1\)Tang and Xiong (2010) also report that the Chinese commodities markets, which are off-limits to foreigners and index funds, have been much less correlated than the US markets, indicating that the emergence of China and other developing countries is the not reason for the surge in commodity prices.
2007. As of March 2011, assets under management of DBA and RJA are $2.8 billion and $0.4 billion, respectively. DBA is a much larger agriculture ETF than RJA in terms of assets under management and trading volume. All of the other agricultural ETFs or ETNs that track futures prices started trading in later periods, with assets under management lower than $0.2 billion. If investors simply want to bet on rising food prices, a broadly based agricultural ETF such as DBA or RJA, would be a better choice. See, e.g., Waggoner (2011).

The DBA fund is based on the DBIQ diversified Agriculture Index Excess Return and managed by DB Commodity Services LLC. The DBA fund offers exposure to 11 agricultural commodities by investing in futures contracts. The RJA fund is indexed to the ELEMENTS Rogers International Commodity Index Agriculture Total Return. The index represents the value of a basket of 21 agriculture commodities futures contracts. See the FactSheet of PowerShares DB Agricultural Fund (March 2011) and Prospectus Supplement of ELEMENTS Rogers International Commodity Index (November 2011) for detailed descriptions of DBA and RJA, respectively.  

Table 1 lists the base weights of the DBA and RJA indexes as of December 2010. The top four components of DBA are corn (12.50%), soybeans (12.50%), sugar #11 (12.50%), and live cattle (12.50%), comprising 50% of the index. The index is rebalanced to the base weights annually in November. The top four holdings of RJA are wheat (12.50%), corn (13.61%), cotton (12.50%), and cotton (12.50%).

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2 Other smaller agriculture ETFs are the three iPath DJ-UBS indexes, JJG, JJA, and COW in the order of assets under management. More recent agriculture ETFs tracking individual futures include Teucrium corn fund (CORN), iPath cocoa fund (CHOC), coffee (CAFE), sugar (SGAR), and cotton (BAL).

3 The DBA and RJA funds do not incur either the cost of storing a physical commodity or the cost of entering into a commodity-linked note with a dealer, which is usually much higher than entering into an exchange-traded futures contract. Moreover, investors cannot invest directly in the index.
#2 (12.03%), and soybeans (9.6%), contributing 52.4% of the index. The weights are adjusted at the beginning of each year. All of the components of DBA (except feeder cattle) are included in RJA with a total weight of 78%, resulting in a close relationship between these two ETFs.

In this study, I investigate the dynamics among the agriculture ETFs, the top four component futures, and the US stock market for the period of January 2008 through December 2010. I do not include data from 2007 to avoid potential liquidity problems at the beginning of the trading period (see, e.g., Tang and Xiong 2010, p.8). This may also mitigate the impact of the migration from open outcry to electronic trading starting in October 2006 (for corn, live cattle, soybeans, wheat) and March 2007 (for cotton and sugar).

DBA and RJA are traded on the New York Stock Exchange Arca (NYSE Arca), a fully electronic exchange. Corn (ticker: C), live cattle (LC), soybeans (S), and wheat (W) futures are traded on the CME Group composed of CME, Chicago Board of Trade (CBOT), and New York Mercantile Exchange (NYMEX), whereas cotton (CT) and sugar (SB) futures are traded on ICE Futures U.S. While the CME/CBOT contracts are traded on both the floor and the electronic Globex trading platform, most of the contracts trade on Globex: 88% of corn, 66% of live cattle, 87% of soybeans, and 95% of wheat in 2010. Moreover, although Globex is open almost 24 hours, trading happens mostly during the regular floor trading hours.

The ICE cotton and sugar futures contracts trade on the electronic platform of ICE, but they are only active during the floor trading hours of their options contracts. The DBA fund tracks the ICE sugar futures instead of the less-active CME sugar futures, although both

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4 This 3-year period has 751 trading days after excluding the flash crash of May 6, 2010 and six other days with shorter trading hours.

5 The average daily trading volume of DBA in 2007 is 0.32 million contracts, much smaller than the 2008 volume of 2.1 million shares.
contracts have the same underlying commodity, raw cane sugar. Among the six futures contracts, corn is the most active, followed by soybeans, sugar, wheat, live cattle, and cotton.\(^6\)

As reported in Table 2, the floor trading hours of the futures contracts are 9:30 am to 1:15 pm (Central time) for corn, cotton, soybeans, and wheat; 9:05 am to 1:00 pm for live cattle; and 7:10 am to 12:30 pm for sugar. All of the empirical results are based on the Globex and ICE electronic data during these floor trading hours. While examining the relationship between the agricultural ETFs and their underlying futures, I incorporate US stock index returns into the analysis to test the hypothesis that the agriculture ETFs are influenced by the stock market.

Prior studies, e.g., Bodurtha, Kim, and Lee (1995), Froot and Dabora (1999), and Chan, Hamed, and Lau (2003), have shown that international securities traded on the NYSE are more influenced by the US stock market than their home countries. This phenomenon is commonly known as the location of trade or market sentiment effect. Financialization of commodities further increases the impact of the stock market on commodity prices. I use the SPDR S&P 500 ETF (SPY) to represent the US stock market. I also use iShares S&P 500 Index (IVV) which has a more comparable trading volume to the agriculture ETFs than the remarkably active SPY. During the period examined, the average daily volumes (million shares) of DBA, RJA, IVV, and SPY are 2.0, 0.36, 4.6, and 218.7, respectively. However, the results using SPY and IVV are almost the same; therefore, all results reported are based on SPY.

I collect transaction data of the nearby futures and ETFs from the TickData and NYSE Trade and Quote (TAQ) datasets, respectively, and daily futures data from Commodity Systems, Inc.

\(^6\) In 2010, the average daily volume for corn is 277 thousand contracts, soybeans 147, sugar 116, wheat 91, live cattle 45, and cotton 23.
II. METHODOLOGY AND EMPIRICAL RESULTS

I present the summary statistics of daily returns for the three-year period of 2008 to 2010 in Panel A of Table 3. Daily returns are the log difference of closing prices of regular floor trading hours. Corn (with a standard deviation of 2.22), cotton (2.28), sugar (2.45), soybeans (2.01), and wheat (2.70) are more volatile than DBA (1.79) and RJA (1.63), while live cattle (0.90) is less volatile than the agriculture ETF funds. That is, on average, the two baskets of futures are less volatile than individual futures. The S&P index fund (1.90) and the agriculture ETFs have similar volatility. It is worth noting that during the period examined individual commodities are generally more volatile than the stock index.

As expected, Panel B indicates that DBA and RJA returns are highly correlated (with a coefficient of 0.88). DBA is significantly correlated with all the four futures components: corn (0.74), live cattle (0.45), sugar (0.60), and soybeans (0.78); RJA with its futures components: corn (0.78), cotton (0.59), soybeans (0.76), and wheat (0.78). The six futures are also significantly correlated among themselves. I use Johansen statistics to test cointegration between DBA and RJA and each of their four underlying futures. The results (available upon request) show that DBA and RJA prices are not cointegrated with the underlying individual futures prices.7

Several studies (e.g., Greer 2000) have shown that commodity index returns are negatively correlated with US stocks. However, Table 2 indicates that S&P 500 returns are positively related to DBA (correlation = 0.38) and RJA (0.39) and with all of the six futures

7 As discussed in Baillie, Booth, Tse, and Zabotina (2002), cointegration and correlation are different statistical concepts. The high correlation suggests that the two markets are contemporaneously related because of correlated information, while noncointegration indicates that the error correction process does not exist between the two prices.
markets (corn 0.23; cotton 0.27; live cattle 0.28; sugar 0.19; soybeans 0.24; and wheat 0.23). As discussed in Basu and Gavin (2011) and others, when institutional investors began to use commodity futures index funds as an asset class in recent years, the negative correlation between commodity futures and stock returns has disappeared, and investors have unintentionally increased the correlation. The effect of trading location (NYSE) and US stock market sentiment can further increase correlation between the agriculture ETFs and S&P 500 returns. The positive correlations reported here are consistent with the results of Mayer (2009), Tang and Xiong (2010), Inamura et al. (2011), and Wien (2011). The results suggest that hedging opportunities using commodities, as examined in Gorton and Geert (2006) and Erb and Harvey (2006), may no longer exist.

A. Trading and Non-trading Volatilities

Many papers show that the return variance for stocks is higher during trading hours than during non-trading hours. See, e.g., Oldfield and Rogalski (1980) and French and Roll (1986). These results can be explained by the presence of more information (both public and private) and noise trading revealed during the trading period. While private information and noise trading are more likely to occur during the trading period, public information is evenly distributed throughout the day. Examining trading- versus nontrading-period variance ratios (i.e., variance ratios of daily open-close to close-open returns) may determine whether private or public information is related to the agriculture ETFs and the underlying futures prices.

Fleming et al. (2006) point out that most of the public information flow in weather-sensitive markets occurs around the clock, independent of trading hours. Because information
flow generates volatility, weather-sensitive markets should have lower variance ratios than other markets. They find that the variance ratios of weather-sensitive agricultural markets are significantly lower than the variance ratio in the stock market. Using futures data for corn, soybeans, and wheat, they conclude that volatility in these futures markets is mainly driven by public information flow regarding weather conditions.

I extend the results of Fleming et al. (2006) using a greater number of agriculture futures contracts studied over more recent years. This will shed more light on the link between agriculture prices and public information flow. Fleming et al. consider only three agriculture futures, corn, soybeans, and wheat, without discussing the markets outside the US. As noted by the authors, the US is the largest world market in these three crops during the period examined, 1982 through 2004. Weather information outside the US trading hours is the major public information for these crops. However, if a foreign market exists, information will also be released during the business hours of the foreign market. In particular, in recent years China is the largest cotton market (26% of world production in 2010 according to the US Department of Agriculture, USDA). Moreover, cotton, corn, and soybeans futures markets in China are more active than the respective US markets. As public information regarding cotton, corn, and soybeans from China is released when the US futures markets are closed, the non-trading volatility of the US markets will be higher, further decreasing the variance ratios. In contrast, Brazil, which has similar business hours as the US, is the world’s largest producer of cane sugar

\[\text{8 Tse (1999) uses similar arguments for the Japanese government bonds futures markets in Tokyo and London. The London market (the less active market) is more volatile when it is closed with a variance ratio smaller than one, but the Tokyo market is more volatile when it is open with a ratio greater than one.}\]
(29% of world production). Public information revealed from Brazil will increase the trading volatility and, accordingly, the variance ratio of the US market.

Consistent with the results of Fleming et al. (2006), I report in Panel C of Table 3 that the variance ratio of S&P 500 (2.08) is higher than the ratios of the agriculture ETFs, DBA (1.73), RJA (1.53), and their component futures, corn (1.36), cotton (0.87), sugar (1.78), soybeans (1.21), and wheat (2.02), except live cattle (2.54). Unlike the other five futures, live cattle is not weather sensitive (as discussed in Fleming et al.) and the US is still the major live cattle futures market worldwide.

Cotton futures are much more actively traded on the Zhengzhou Commodity Exchange in China (the world’s largest cotton producer) than on the US market. The dominance of the Chinese cotton market leads to a variance ratio smaller than one. Corn and soybeans contracts are also actively traded on the Dalian Commodity Exchange in China, resulting in higher volatility during non-US trading hours and, consequently, lower variance ratios. The underlying sugar of the futures contract traded on the Zhengzhou Commodity Exchange is white sugar, instead of raw cane sugar. In addition, Brazil, which has similar business hours as the US, is the world’s largest producer and exporter of cane sugar. This explains why ICE sugar futures have a higher variance ratio than corn, soybeans, and cotton. The overall results are consistent with a strong link between agricultural prices and public information flow.

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B. Intraday Return Causality

I examine the information transmission between the agriculture ETFs and the four underlying futures by using five-minute returns. To include the effect of US stock market sentiment, I include S&P 500 ETF returns into the following three-variable autoregressive (VAR) model.

\[
\Delta DBA_t = a_1 + \sum_{i=1}^{6} b_{1i} \Delta DBA_{t-i} + \sum_{i=1}^{6} c_{1i} \Delta SP_{t-i} + \sum_{i=1}^{6} d_{1i} \Delta X_{t-i} + e_{1t} \quad (1a)
\]

\[
\Delta SP_t = a_2 + \sum_{i=1}^{6} b_{2i} \Delta DBA_{t-i} + \sum_{i=1}^{6} c_{2i} \Delta SP_{t-i} + \sum_{i=1}^{6} d_{2i} \Delta X_{t-i} + e_{2t} \quad (1b)
\]

\[
\Delta X_t = a_3 + \sum_{i=1}^{6} b_{3i} \Delta DBA_{t-i} + \sum_{i=1}^{6} c_{3i} \Delta SP_{t-i} + \sum_{i=1}^{6} d_{3i} \Delta X_{t-i} + e_{3t} \quad (1c)
\]

where \(\Delta DBA_t\), \(\Delta SP_t\), and \(\Delta X_t\) are the log five-minute returns of DBA (or RJA), S&P 500, and one of the four agricultural futures. I use 6 lags to allow for a 30-minute information flow. The results are similar if 12 lags are used. Because DBA and RJA (with regular trading hours from 8:30 am to 3:00 pm Central time) have different regular trading hours from the futures contracts as shown in Table 2, the overlapping trading hours examined in each futures market are different: 9:30 am - 1:15 pm for corn, cotton, soybeans, and wheat, 9:05 am - 1:00 pm for live cattle, and 8:30 am - 12:30 pm for sugar.

The VAR model in eq. (1) is estimated using OLS with the Newey-West heteroskedasticity and autocorrelation consistent covariance matrix. I use two restriction tests for coefficient testing, e.g., from \(\Delta X_t\) to \(\Delta DBA_t\) in eq. (1a), as follows:

\[H_{0,1} : d_{11} = d_{12} = d_{13} = d_{14} = d_{15} = d_{16} = 0\]

\[H_{0,2} : d_{11} + d_{12} + d_{13} + d_{14} + d_{15} + d_{16} = 0\]
The first Granger-causality test assumes that all coefficients are jointly equal to zero. The second test assumes that the sum of all coefficients is zero. The magnitude (sign) of summed coefficients indicates the economic significance (directionality) of the causal relationship. In particular, the second test provides information about the long-run multiplier effect of one market on the other. For simplicity, I use “sum” to represent the “sum of coefficients” when describing the causality results. Because of a large sample size (about 35 thousand), I use the 0.1% significance level and consider the results statistically significant only when both $H_{o,1}$ and $H_{o,2}$ are rejected. Significant results are bolded in Tables 4 and 5.

Panels A, B, C, and D of Table 4 report the results of DBA with corn, live cattle, sugar, and soybeans, respectively. I present the sum of coefficients and two p-values. The first p-value is associated with $H_{o,2}$ (the sum test) and the second one with $H_{o,1}$ (the joint test). In Panel A, DBA returns are significantly Granger-caused by lagged corn returns, with summed coefficient = 0.108 and both p-values = 0 (or less than 0.0001), and lagged S&P returns, with summed coefficient = 0.115 and both p-values = 0. These results indicate that DBA returns are significantly caused by both S&P 500 index and corn returns. The larger impact of the stock index on DBA shows that DBA returns are influenced by trading location (NYSE) and stock market sentiment. However, Panel A also shows that corn returns are caused by S&P returns (sum = 0.134), but not by DBA returns (sum = 0.041). Not surprisingly, S&P returns are not affected by the lagged returns of DBA and corn. The results of soybeans represented in Panel D are similar.

In contrast, Panel B shows that DBA returns cause live cattle returns (sum = 0.060), but not the reverse (0.036). Panel C shows that the causal relationship between DBA and sugar is
bidirectional, with more significant causality running from sugar to DBA. That is, sugar returns cause DBA returns (sum = 0.098), and vice versa (0.058). Moreover, the impact of S&P returns on live cattle and sugar is significant but smaller than the impact on DBA and corn. Overall, the DBA returns are influenced by corn, sugar, soybeans, and S&P 500, but not by live cattle. Live cattle and sugar returns are also moderately influenced by lagged DBA returns.  

I report the causality results of RJA in Table 5. Panel A shows that lagged RJA returns are caused by both corn returns (sum=0.502) and stock returns (0.291). Panel B, C, and D indicate similar results with the causal relationship running from futures (cotton, soybeans, and wheat, respectively) and stock markets to the agriculture ETF. Corn and cotton futures are also caused by the stock market.

The results show that the agricultural ETFs are informationally linked with their underlying futures. Futures returns lead the ETF returns, suggesting that the futures markets disseminate information more rapidly than the ETF markets. These results, however, do not imply arbitrage opportunities between the futures and ETF markets. S&P 500 returns also influence the ETF and most futures returns.

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10 In the previous version of the paper, I incorporate DBA, S&P 500, and all the four agricultural futures into a six-variable VAR model to examine the dynamics among these six markets simultaneously. However, the common overlapping hours are shorter, 9:30 am – 12:30 pm. More important, including more independent variables that are highly correlated will induce the problem of multicollinearity, lowering the power of the individual causality tests. Nevertheless, the results (available upon request) are similar to the individual results in Table 4.

11 Consider the relationship between the US stock index cash market and stock index futures market. Although many studies show that the index futures market leads the cash market (e.g., Kawaller et al., 1987, Stoll and Whaley, 1990, and Chan, 1992), results of index arbitrage are still inconclusive (e.g., Harris, 1989, Kleidon, 1992, Miller et al., 1994, Tse, 2001).
III. CONCLUSIONS

In recent years, the broad-based agriculture ETFs, DBA (PowerShares DB Agriculture Index) and RJA (ELEMENTS Rogers International Commodity Agriculture Index), have been popular investments based on agricultural and food prices. I investigate the dynamics among the two agriculture ETFs, their four major underlying futures components (corn, live cattle, sugar, and soybeans for DBA; wheat, corn, cotton, and soybeans for RJA), and the US stock index. The ETFs of the agriculture indexes and the S&P 500 index are all traded on the NYSE.

DBA and RJA daily returns are highly correlated with agricultural futures returns and S&P 500 returns. The positive correlation between the agriculture ETFs and S&P 500 suggests that the diversification benefits of using an agricultural index have decreased.

While DBA, RJA, and the five weather-sensitive futures (corn, cotton, sugar, soybeans, and wheat) have lower trading-versus nontrading-variance ratios than that of the S&P 500, the variance ratio of the non-weather-sensitive live cattle is larger. The dominance of the Chinese cotton market (open when the US market is closed) leads to a variance ratio smaller than all the other futures. These results are generally consistent with the notion that agricultural futures prices are strongly associated with public information.

Using five-minute intraday returns, I find that DBA and RJA returns are Granger-caused by corn, sugar, soybeans, and stock returns. Live cattle and sugar returns are moderately caused by the ETF returns. RJA returns are caused by all of the four individual futures and stock returns. On average, futures returns lead DBA and RJA returns. Stock returns also have significant influence on the agriculture ETFs.
The overall results suggest that futures markets disseminate information more rapidly than the ETFs. The results also support the hypothesis that financialized agriculture ETFs are affected by the stock market and show that trading location and stock market sentiment influence pricing behavior.

Since January 2011, under the Dodd-Frank Act, all the underlying agricultural futures of the ETFs are subject to the position limit required by the CFTC. Limiting the size of an ETF fund (by creating additional units) may affect the relationship between the ETF price and its net asset value and, accordingly, result in shares trading at a premium or discount to the net asset value. This warrants future research when more data are available.
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