# An Examination of Cointegration in Storable Commodities

by

T. Randall Fortenbery and Hector O. Zapata

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Understanding and identifying the components of market price risk is becoming an increasingly important part of managing an agricultural enterprise. The Food, Agriculture, Conservation, and Trade Act of 1990 (commonly called the 1990 Farm Bill) has reduced the number of farm acres eligible for deficiency payment benefits through the triple base provisions. With additional concern over government expenditures for farm programs and movements toward trade liberalization policies, it is conceivable that the government's contribution toward individual firms' management of commodity price risk will continue to diminish in future years.

An important component in understanding and managing market price risk for agricultural commodities is identifying the relationships between local cash markets and nationally traded commodity futures markets. It has long been argued that futures markets represent an assimilation of all relevant public information regarding the supply/demand relationship for a given commodity in some future time period (Telser; Cox; Garcia, Leuthold, Fortenbery, and Sarassoro). Understanding the extent to which local prices are cointegrated with national futures prices is critical in "localizing" futures price information. Without a thorough knowledge of the relationships between local and futures markets, it is difficult to decipher how changes in futures prices can be expected to impact local market agents.

Considerable effort has been devoted to measuring the dynamics of price discovery when both cash and futures markets exist. Recent studies in agricultural markets include Ollerman and Farris; Brorsen, Ollerman, and Farris; Koontz, Garcia, and Hudson; and Bessler and Covey. A common feature of these studies is that they focused on non-storable commodities. Research on storable commodities is necessary to further our understanding of the causal relationships between futures and cash markets, and lead to a more complete understanding of basis relationships and price forecasting opportunities in these markets. Such work can provide insight into the relative efficiency of markets for storable commodities, as well as provide important information for agents concerned with the process of price discovery and risk. One might expect, for instance, that because of the storage function, cash and futures markets for storables are more highly cointegrated than for non-storables (Bessler and Covey). A test of this hypothesis can provide insight into the relative functions and performance of futures and cash markets of storables versus non-storables.

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This paper proceeds with a short discussion of research in non-storable markets, an outline of this study's objectives, a discussion of the methodology and data used to accomplish the objectives, a discussion of the results, and concludes with a discussion of the study's implications.

## Previous Work

In their 1985 paper, Ollerman and Farris investigated the lead-lag relationship between cash and futures markets for live cattle. Their purpose was to identify the market in which the price discovery process originated. This was done using daily data on nearby live cattle contracts traded at the Chicago Mercantile Exchange and the average daily price for 1100 to 1300 pound choice steers in Omaha. The data ran from 1966 through 1982. Based on Granger causality tests for various sub-samples of their data, they concluded that live cattle futures prices tended to lead changes in live cattle cash prices. In addition, they found that the cash market generally responded to changes in futures prices within one trading day. They also found evidence of instantaneous feed back in some years. As a result, Ollerman and Farris concluded that futures markets were the center of price discovery for live cattle.

Brorsen, Ollerman, and Farris in 1989 went beyond studying the lead-lag relationships in cash and futures markets for live cattle, and investigated the direct impact of futures trading on the cash live cattle market. Specifically, they employed regression techniques to measure the impact of futures trading on the variability and volatility of cash prices. They found that the futures market did impact the behavior of cash prices. They concluded that the introduction of futures trading on live cattle has resulted in improving cash market efficiency, but at the same time increased short-run cash price risk.

The 1990 paper of Koontz, Garcia, and Hudson investigated the live cattle cash and futures markets for dominant-satellite relationships. Specifically, they were interested in measuring the extent to which the spatial nature of price discovery had changed over time. Koontz et al. used weekly data from 1973-1984. They considered several cash markets and the nearby Chicago Mercantile Exchange Live Cattle Contract. They looked at the dominant-satellite relationships between futures and cash, and between the various cash markets. They found that none of the markets were independent, meaning that information flowed between all markets within a one-week trading period. Interestingly, they found that cash markets had generally decreased their reliance on futures markets as the price discovery leader over time. They did find, however, that end of week futures markets had a strong influence on cash markets the following week.

In 1991, Bessler and Covey employed cointegration analysis to investigate the relationships between cash and futures markets for live cattle. Their data consisted of daily futures prices for the nearby live cattle contract from August 21, 1985 through August 20, 1986, and the corresponding cash price for 900 to 1300 pound slaughter steers in the Texas-Oklahoma market. The results of Bessler and Covey are mixed. They found slight evidence of cointegration between nearby futures prices and cash prices, but no evidence of cointegration when more distant futures contracts were considered. Like Ollerman and Farris, they found that the cash price generally responded to futures within one trading day. They also concluded that the cash market was inefficient, since cash prices could be forecast more accurately using futures prices in an error correction forecasting model than forecasting cash prices with a univariate autoregression model.

## Objectives

The primary objective of this research is to build on the literature discussed above by examining the long and short-term relationships of cash and futures markets for storable commodities. This is done using the Chicago Board of Trade (CBOT) soybean futures market, two cash markets for soybeans, the CBOT corn futures market, and two cash markets for corn.

Also, by utilizing daily data over an extended period, we propose to investigate the extent to which cointegration between markets is consistent over time. Following the most recent developments in the cointegration literature, we adopt a full information maximum likelihood approach to estimate and test for cointegration. In addition, when there is evidence of market cointegration, we test whether the flow of information between markets is symmetric or asymmetric. This allows inferences regarding market performance. The results are also used to discuss the relative efficiencies of the soybean and corn marketing systems, and compare the degree of integration in storables markets with previously generated results for non-storables.

## Methodology and Data

The dynamics of price discovery are studied using the maximum likelihood approach of Johansen et al. (1990). Johansen et al. proposed that estimation and inference should be based on a fully specified error-correction model (ECM). An important feature of this approach for studying market efficiency is that it jointly incorporates the long-run constraints between cash and futures markets resulting in median unbiased long-run coefficients. If all series are integrated of order one, then the ECM for a stochastic nonstationarity system takes the form:

(1)
$$\Delta Y_t = \Gamma_1 \Delta Y_{t-1} + \ldots + \Gamma_{k-1} \Delta Y_{t-k+1} + \Pi\, Y^*_{t-k} + \phi\, D + e_t$$

where $e_t$ is NID (O,$\Lambda$), ($\Gamma_1,\ldots,\Gamma_{k-1}$, $\Pi,\Phi$, $\Lambda$) are parameters to be estimated, $\Delta$ = 1-L, L is the lag operator, D is a matrix of dummy variables, and t = 1, 2,...,T. In this specification, the error correction term $Y^*_{t-k} = (Y'_{t-k}1)'$ includes a column of ones to account for stochastic trend behavior. If the rank of $\Pi$ is zero, there is no cointegration and a VAR in differences is the appropriate model structure, but if the rank equals to the number of variables in the system (p) then a VAR in levels should be estimated. If variables are cointegrated, then the rank of $\Pi$ is between zero and p, and therefore the hypothesis of interest is Ho: $\Pi = \alpha\beta'$, where $\alpha$ and $\beta$ are pxr matrices, $\beta$ is the cointegrating vector (the equivalent of the slope parameter in the first step of Engle-Granger), $\alpha$ is a weight vector which measures the speed of adjustment towards equilibrium and r is the number of cointegrating relations.

To estimate $\beta$, Johansen concentrates out all the parameters but $\beta$ from the likelihood function:

(2)
$$\ln L = -T/2 \ln |\Omega| - \Sigma_t e'_t \Omega^{-1} e_t,$$

where $e_t$ is defined in (1). First, the $\Gamma$ parameters are concentrated out; the resulting system has as dependent variable $R_{ot}$ (the residuals from a regression of $\Delta Y_t$ on lagged $\Delta Y_t$'s) and independent variable $R_{kt}$ (the residuals from a regression of $Y_{t-k}$ on lagged $\Delta Y_t$'s). Letting $S_{ij} = T^{-1} \Sigma_t R_{it} R_{jt}$, i,j = 0,1, assuming $\beta$ known and using the estimate for $\alpha$

(3)
$$\hat{\alpha} = -S_{01} \beta (\beta' S_{11} \beta)^{-1},$$

the concentrated likelihood becomes up to a constant

(4)
$$\ln L = -(T/2) \ln |\Omega(\beta)|,$$

with

(5)
$$\hat{\Omega}(\beta) = S_{00} - S_{01} \beta (\beta' S_{11} \beta)^{-1} \beta' S_{10} .$$

The likelihood function is then maximized by choosing $\beta$ to be the first r eigenvectors of the determinantal equation in (4) corresponding to the r largest canonical correlations ($\lambda_i$). The value of the likelihood is given by

(6)
$$\ln \hat{L} = -(T/2) \{ \Sigma_i \ln (1-\lambda_i), + \ln |S_{00}| \}, \ i=1,2,\ldots,r.$$

A likelihood ratio test for the hypothesis that there are at most r cointegrating vectors is given by

(7)
$$-2 \ln Q = -T \ \Sigma_i \ln (1-\lambda_i), \ i = r+1,\ldots, p.$$

Johansen et al. show that the smallest p-r sample eigenvalues each multiplied by T converge weakly to a vector of random variables that are functions of Brownian motions. Tabulated critical values are provided in the appendices, at the end of their paper.

The analysis applied here evaluates two North Carolina corn and soybean markets relative to nearby Chicago futures for the period 1980-1991. Nearby futures are chosen because of an expectation that local cash bids will be based on nearby futures contracts. The North Carolina cash markets studied are the Williamston and Greenville markets. The markets are spatially separated by about 45 miles. Williamston is dominated by an elevator owned and operated by a large multinational firm. Greenville represents a larger metropolitan center, and includes an elevator owned and operated by a large multi-national firm, an elevator owned and operated by a large, privately held regional grain merchandiser, and a smaller local elevator. Both markets provide daily cash bids for corn and soybeans.

## Results

### Unit-Root Tests

In the interest of space, we do not report the unit root test results here. However, the Phillips-Perron tests[1] indicate that all individual logarithmic series are integrated of order 1 at the 5% level. Consequently, the ECM in equation (1) is estimated to test for cointegration. The specific unit root test results are available from the authors.

Johansen suggests that diagnostics on the residuals from the most parsimonious error-correction model corresponding to equation (1) should be conducted to identify the adequate structure. A maximum of five lags were tested and the results suggest that, based on the Box-Ljung Q statistic for serial correlation, parsimonious models can be specified with much lower lags. The results are presented in tables 1 and 2. The second column (LAG) identifies the lag at which the residuals are undifferentiated from white noise based on the Q-statistic. The trace and maximum eigenvalue tests for $r \leq 1$ (row 1) or $r = 0$ (row 2) cointegrating relations are presented in columns four and five for Greenville and columns nine and ten for Williamston.

A necessary condition for market efficiency requires that the futures and cash markets be cointegrated. Soybean cash markets in both Greenville and Williamston were apparently driven by the same set of supply demand fundamentals as the nearby futures market in four of the 11 years studied (namely in 1980-81, 1983-84, 1988-89, and 1989-90 crop years). During the other years, the cash markets did not show significant signs of co-movement with futures. During all years, dependence in the variance was present primarily in the cash price residuals. One result that emerges from table 1 is the tendency of the cash soybean markets to follow futures more closely in recent years (1988-89, 1989-90, and 1990-91). This applies to both Greenville and Williamston.

Another important result emerging from table 1 is the number of lags required for the cash soybean markets to completely adjust to futures market price changes. Note that the Greenville market adjusts more quickly than Williamston. The Greenville market most years adjusts within one trading day to futures market price changes. Further, the Greenville cash market appears to have become more responsive over time (i.e. the market in recent history has usually fully responded to Chicago prices within two days). These results are in contrast to those for Williamston soybeans.

The Williamston soybean market in over half the crop years studied required a full three days to adjust to Chicago futures price changes. In addition, the long lags tend to be concentrated in the more recent data, suggesting that the Williamston cash market may have actually gotten less responsive over time.

Cointegration in corn markets was found in 1983-84, 1985-86, 1987-88, and 1988-89, coinciding with the results in soybean markets for 1983-84 and 1988-89 crop years. It is interesting to note that while North Carolina cash corn markets are cointegrated with futures as frequently as soybeans, the specific years of cointegration for the two commodities do not

Table 1. Cointegration and Diagnostic Tests, Soybean Nearby Futures and Cash Prices, Greenville and Williamston, North Carolina, 1980-1991

| | SOYBEAN | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Greenville | | | | Williamston | | | |
| YEAR | LAG | Q | TRACE | λMAX | LAG | Q | TRACE | λMAX |
| 80-81 | 1 | 13.45 | 4.55 | 4.55 | 1 | 12.89 | 5.24 | 5.24 |
| | | 22.53 | 28.24* | 23.69* | | 13.43 | 27.03* | 21.79* |
| 81-82 | 3 | 17.44 | 4.29 | 4.29 | 1 | 20.15 | 3.31 | 3.31 |
| | | 15.35 | 10.35 | 6.11 | | 22.57 | 9.76 | 6.45 |
| 82-83 | 3 | 30.18 | 2.66 | 2.66 | 3 | 25.24 | 2.51 | 2.51 |
| | | 26.12 | 11.29 | 8.63 | | 23.29 | 10.59 | 8.08 |
| 83-84 | 1 | 11.82 | 1.71 | 1.71 | 1 | 12.85 | 2.68 | 2.68 |
| | | 12.49 | 20.12* | 18.41* | | 14.70 | 23.11* | 20.43* |
| 84-85 | 1 | 13.72 | 3.93 | 3.93 | 3 | 11.34 | 2.57 | 2.57 |
| | | 11.87 | 12.20 | 8.27 | | 15.08 | 12.93 | 10.36 |
| 85-86 | 1 | 15.02 | 1.86 | 1.86 | 3 | 19.20 | 3.06 | 3.06 |
| | | 15.87 | 9.22 | 7.35 | | 11.45 | 9.34 | 6.29 |
| 86-87 | 1 | 17.96 | 3.67 | 3.67 | 1 | 19.67 | 3.01 | 3.01 |
| | | 24.11 | 15.87 | 12.20 | | 20.34 | 14.07 | 11.06 |
| 87-88 | 2 | 23.84 | 2.16 | 2.16 | 3 | 25.72 | 1.96 | 1.96 |
| | | 26.21 | 11.26 | 9.10 | | 34.45 | 8.99 | 7.04 |
| 88-89 | 1 | 24.81 | 1.99 | 1.99 | 1 | 24.44 | 1.87 | 1.87 |
| | | 23.20 | 19.41* | 17.42* | | 22.19 | 22.49* | 20.62* |
| 89-90 | 1 | 12.67 | 6.87 | 6.87 | 3 | 7.91 | 5.23 | 5.23 |
| | | 8.60 | 25.94* | 19.06* | | 10.15 | 31.03* | 25.80* |
| 90-91 | 2 | 24.78 | 5.21 | 5.21 | 3 | 22.66 | 5.94 | 5.94 |
| | | 23.33 | 13.93 | 8.72 | | 22.14 | 16.50 | 10.55 |

* Significant at the 5 percent level.

Table 2. Cointegration and Diagnostic Tests, Corn Nearby Futures and Cash Prices, Greenville and Williamston, North Carolina, 1980-1991

| | CORN | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Greenville | | | | Williamston | | | |
| YEAR | LAG | Q | TRACE | λMAX | LAG | Q | TRACE | λMAX |
| 80-81 | 1 | 16.04 | 0.69 | 0.69 | 1 | 16.65 | 1.30 | 1.30 |
| | | 17.16 | 7.38 | 6.69 | | 20.71 | 7.91 | 6.62 |
| 81-82 | 1 | 29.43 | 2.00 | 2.00 | 1 | 29.11 | 1.73 | 1.73 |
| | | 21.76 | 12.91 | 10.91 | | 20.99 | 13.22 | 11.49 |
| 82-83 | 1 | 19.67 | 2.84 | 2.84 | 1 | 19.23 | 2.32 | 2.32 |
| | | 19.79 | 10.36 | 7.52 | | 18.32 | 9.56 | 7.24 |
| 83-84 | 1 | 12.57 | 2.55 | 2.55 | 1 | 12.72 | 2.19 | 2.19 |
| | | 19.47 | 20.22* | 17.67* | | 15.97 | 21.43* | 19.24* |
| 84-85 | 1 | 10.48 | 1.86 | 1.86 | 3 | 9.72 | 1.65 | 1.65 |
| | | 26.57 | 14.74 | 12.88 | | 17.81 | 9.87 | 8.22 |
| 85-86 | 1 | 11.16 | 1.67 | 1.67 | 1 | 10.58 | 1.97 | 1.97 |
| | | 12.20 | 29.48* | 27.81* | | 14.40 | 29.45* | 27.47* |
| 86-87 | 1 | 9.31 | 2.29 | 2.29 | 1 | 9.57 | 2.24 | 2.24 |
| | | 12.16 | 6.34 | 4.05 | | 11.36 | 7.47 | 5.23 |
| 87-88 | 3 | 29.94 | 1.80 | 1.80 | 3 | 29.87 | 1.10 | 1.10 |
| | | 28.15 | 23.10* | 21.30* | | 28.12 | 27.71* | 26.61* |
| 88-89 | 1 | 16.10 | 5.88 | 5.88 | 1 | 17.44 | 2.95 | 2.95 |
| | | 15.14 | 27.24* | 21.37* | | 8.14 | 22.92* | 22.92* |
| 89-90 | 1 | 22.36 | 2.84 | 2.84 | 1 | 21.70 | 1.39 | 1.39 |
| | | 7.74 | 6.58 | 3.74 | | 10.07 | 4.53 | 3.13 |
| 90-91 | 2 | 23.89 | 1.54 | 1.54 | 2 | 22.99 | 1.69 | 1.69 |
| | | 19.39 | 5.40 | 3.86 | | 13.56 | 6.61 | 4.92 |

* Significant at the 5 percent level.

coincide. Another important result from table 2 is related to the lag structure for corn. Note that cash corn markets generally appear more responsive than soybeans (i.e. the lags are smaller). Also, note that the lag structures for both corn markets are identical (with the exception of 84-85). This is in contrast to the cash soybean markets, and suggests that the same basic fundamentals are driving both cash and futures markets for corn.

An initial hypothesis and motivation for this study was the expectation that markets for storable commodities would be more highly cointegrated than markets for non-storables. However, the results generated here do not support such a conclusion. While we do find individual years of significant cointegration, over half the years considered reveal no evidence of cointegration in either corn or soybean markets. One possible explanation could be the type of cash markets considered. Most, if not all, of the research in non-storables has focused on large cash markets where it is reasonable to expect the information flow between the futures and cash markets to be bi-directional. The cash markets considered were large enough that any change in local supply\demand could be expected to influence the future markets. In our analysis, we have considered small, local markets outside the primary grain producing states. As such, it is not reasonable to expect changes at the local level to feed back into the futures market. This uni-directional flow of information may have implications for the degree of cointegration found. To address this question, we are currently investigating the degree of cointegration between major cash markets and futures for storable commodities.[2]

## Implications

The results in table 1 above suggest that the two North Carolina cash soybean markets respond asymmetrically to futures price changes, with the Williamston market generally requiring a longer trading period to fully incorporate Chicago futures price changes into cash bids. Previous studies have tended to conclude that lag structures such as those found in the Williamston cash markets imply cash market inefficiency. However, while a delayed response is a necessary condition, it may not be sufficient. As noted by Garcia et al., and Rausser and Carter, the sufficiency condition for market inefficiency rests on an evaluation of the benefits and costs of acquiring and using information. One measure of benefit from the potential inefficiencies in this study is to determine whether arbitrage opportunities exist between Greenville and Williamston. In other words, if soybean futures prices decrease, resulting in a price decrease in Greenville within one trading day, could an economic agent buy Greenville soybeans, transport them to Williamston, and then sell in the Williamston market for a profit? For this to occur, the price differential between Greenville and Williamston would have to, on average, exceed the transport costs between the two cities. As expected, the data do not support the existence of an arbitrage opportunity between the two markets. The cost of transporting between the two markets is about 13 cents per bushel for soybeans.[3] A study of average price differentials by month (that is, taking the monthly averages of the absolute value of the Greenville minus the Williamston price) reveals no month between 1980 and 1991 in which the average price differential even approached 5 cents, much less the necessary 13 cents. A search for individual trading days in which the price differential was 14 cents or greater reveals 21 such occurrences. The dates along with prices are listed in table 3. Note that there does not appear to be any systematic pattern relative to when in the year these events occur. Also note that only twice, in August 1980 and October 1986, are there two consecutive days of price differentials of 14 cents or

Table 3. Dates and prices When the Greenville/Williamston

Price Spread Exceeds Transport

| Date | Nearby Futures | Greenville Soybeans | Williamston Soybeans | Greenville/ Williamston Spread |
|---|---|---|---|---|
| 2/26/80 | 6.37 | 6.41 | 6.27 | .14 |
| 7/2/80 | 7.11 | 6.84 | 6.64 | .20 |
| 8/4/80 | 7.75 | 7.15 | 7.43 | -.28 |
| 8/14/80 | 7.52 | 7.39 | 7.21 | .18 |
| 8/15/80 | 7.33 | 7.19 | 7.02 | .17 |
| 8/18/80 | 7.44 | 7.30 | 7.13 | .17 |
| 4/21/81 | 7.87 | 7.60 | 7.76 | -.16 |
| 5/22/84 | 8.89 | 8.88 | 8.68 | .20 |
| 5/31/84 | 8.47 | 8.47 | 8.97 | -.50 |
| 3/14/85 | 5.90 | 5.95 | 5.45 | .50 |
| 10/1/85 | 5.14 | 4.99 | 4.49 | .50 |
| 10/1/86 | 4.88 | 4.88 | 4.68 | .20 |
| 10/2/86 | 4.87 | 4.87 | 4.67 | .20 |
| 9/17/87 | 5.33 | 5.38 | 5.18 | .20 |
| 9/24/87 | 5.25 | 5.30 | 5.10 | .20 |
| 1/16/89 | 7.85 | 7.76 | 7.55 | .21 |
| 5/30/89 | 7.17 | 7.03 | 6.83 | .20 |
| 7/20/89 | 6.81 | 6.69 | 6.94 | -.25 |
| 8/18/89 | 5.84 | 6.23 | 6.08 | .15 |
| 9/1/89 | 5.79 | 5.99 | 6.14 | -.15 |
| 9/14/89 | 5.76 | 6.11 | 5.66 | .45 |

greater. We can thus conclude that when the price spread between Greenville and Williamston exceeds transportation costs, it is immediately arbitraged away (i.e. within the next trading day). This is, of course, as we would expect.

The total number of trading days included in the overall sample is 2723. The 21 days in which the Greenville/Williamston price spread exceeds the transportation costs by 14 cents or more accounts for only .7 of 1 percent of total trading days considered. Further, there are only two occurrences in which such a spread existed for more than one day. Based on the criteria suggested by Garcia et al., and Rausser and Carter, we conclude the Williamston market is not inefficient relative to Greenville, despite the fact that it can take a full 2 days additional time to respond to a change in the Chicago market. The Williamston market does respond sufficiently in the immediate run to maintain a Greenville/Williamston price spread which is on average (based on monthly averages) less than 40 percent the spread necessary to induce transportation, and thus provide a profit potential.[4]

A more likely explanation for the differences in response time for Greenville and Williamston soybean markets lies in the institutional structure of the two markets. As mentioned earlier, Greenville is a larger market with a competitive market structure, i.e. more than one major buyer. Williamston only has one major buyer. The Williamston market can afford to lag Chicago to a larger degree than Greenville because the buyer does not have to aggressively bid against another buyer to maintain market share. His market power, however, is limited in that if he allows the spread to widen to the cost of transportation, he will lose market share to the Greenville buyers. As noted above, the Williamston market seldom even comes close to allowing the price spread to widen equal to transport costs. While some may want to argue that the existence and exercise of market power in adjusting prices implies inefficiency, it does not meet the conditions outlined by Garcia et al., and Rausser and Carter. Further, if the Williamston price lags were resulting in abnormal profits for the Williamston buyer, even though the price differentials do not justify shipment to Greenville buyers, we would expect buyer competition in Williamston. To our knowledge, there are no abnormal barriers to entry in the Williamston market.

One interesting point emerging from the results is the near perfect symmetry in Williamston and Greenville corn markets. It is not clear why the Williamston buyer would be unable to exercise the same market power for corn as for soybeans. One possible explanation is that corn can be sold as grain from a crop farm directly to a livestock farm. Since there is no processing necessary, farmers could bypass the grain merchandiser. Thus, while the Williamston elevator may be the only local soybean merchandiser, he may not be the only local corn buyer, and thus his market power in corn is diminished because of the demand generated by local livestock farms.

## Conclusions

This study has investigated the relationship between two Southeastern cash grain markets and Chicago futures markets. Several interesting results have emerged.

First, utilizing small markets outside the major grain producing states we do not find a higher degree of cointegration for storable cash and futures markets than was previously found for non-storables. This is contrary to our initial hypothesis. However, this result may be driven by the fact that changes in the local markets considered cannot be expected to affect national prices. We are investigating this possibility by conducting cointegration tests involving major cash and futures markets for the same storable commodities considered here.

The second interesting result involves the asymmetry with which the Williamston and Greenville soybean markets react to Chicago futures. Contrary to previous research, we argue that this is not prima facia evidence of inefficiency in the Williamston market. We suggest this only constitutes a necessary, not a sufficient condition of market inefficiency. Further, by investigating the price spreads between Williamston and Greenville relative to the cost to transport between the two markets, we fail to find market inefficiency. We suggest that the asymmetric market impacts are due to relative buyer concentration in the two markets, but the magnitude of the price differentials do not warrant a conclusion of market inefficiency.

A result of note is that the Williamston corn market does not behave differently than the Greenville corn market relative to Chicago price changes. While a complete investigation of this result is beyond the scope of this study, a potential reason for this result is the existence of livestock farms in the Williamston area. Since livestock producers can buy directly from corn producers and consume the grain without processing, their existence erodes the market power the Williamston elevator enjoys in the soybean market. As a result, the elevator must be a more aggressive bidder in the corn market to maintain market share.

The discussion above suggests that an important area for further research involves measuring the effect of buyer concentration on local basis levels. This is especially true for Southeast markets which are often dominated by single buyers. While one potential result of buyer concentration has been alluded to here (i.e. a tendency to lag national markets), it needs to be rigorously investigated so as to provide accurate estimates of the welfare implications of monopsony power in local grain markets.

## Endnotes

1. Baillie and Bollerslev suggest these tests for identifying the type of non-stationarity.

2. Preliminary results comparing Chicago cash soybean markets with Chicago futures have revealed much stronger cointegration relations than those discussed above. For the crop years 1981/82 through 1988/89, we find strong cointegration between Chicago cash and futures for soybeans. In addition, for all but the 1988/89 crop year, information flows between the markets is completed within one trading day. Results for other crop years are not yet complete.

3. This rate was provided by J. B. Coltrain, a Williamston farmer and area Farm Management Agent, North Carolina Cooperative Extension Service.

4. The monthly average numbers are available from the authors.

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