An Examination of Cointegration Relations between Futures and Local Grain Markets

T. Randall Fortenbery
Hector O. Zapata

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 (1958); Cox (1986); Garcia, Leuthold, Fortenbery, and Sarassoro (1988)]. 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 (1985); Brorsen, Ollerman, and Farris (1989); Koontz, Garcia, and Hudson (1990); and Bessler and Covey (1991). A common feature of these studies is that they focused on nonstorable commodities. Research on storable commodities is necessary to further understand 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 nonstorables [Bessler and Covey (1991)]. A test of this

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T. Randall Fortenbery is an Assistant Professor in the Department of Agricultural Economics, University of Wisconsin, Madison. Hector O. Zapata is an Associate Professor in the Department of Agricultural Economics and Agricultural Business, Louisiana State University, Baton Rouge.

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hypothesis can provide insight into the relative functions and performance of futures and cash markets of storables versus nonstorables.

The primary objective of this research is to build on previous literature by examining the relationships of cash and futures markets for storable commodities. This is done using the Chicago Board of Trade (CBOT) corn and soybean futures markets, and two cash markets for each commodity.

By utilizing daily data over an extended period, this study investigates the extent to which cointegration between markets is consistent over time. Following the most recent developments in cointegration, a full information maximum likelihood approach is adopted for estimation. In addition, when there is evidence of market cointegration, a test is performed to determine whether the flow of information between markets is unidirectional or bidirectional. The results measure the extent of cointegration in storables markets and are used to introduce some methodological issues related to cointegration analyses of commodity markets.

PREVIOUS WORK

In their 1985 article, Ollerman and Farris investigated the lead–lag relationship between live cattle cash and futures markets. 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 included 1966 through 1982. Based on Granger causality tests for various subsamples 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 (1989) went beyond studying the lead–lag relationships in live cattle cash and futures markets, and investigated the direct impact of futures trading on the live cattle cash 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 has increased short-run cash price risk.

Koontz, Garcia, and Hudson (1990) investigated the live cattle cash and futures markets for dominant-satellite relationships. Specifically, they measured 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 1-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 prices had a strong influence on cash prices early in 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.

METHODOLOGY AND DATA

The dynamics of price discovery are studied using the maximum likelihood approach of Johansen and Juselius (1990). Johansen and Juselius 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 nonstationary system takes the form:

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

where e_t is NID (O, Λ), $\Gamma_1, \ldots, \Gamma_{k-1}$, Π, ϕ, Λ are parameters to be estimated, $\Delta = 1 - L$, L is the lag operator, D is a matrix of dummy variables, and $t = 1, 2, \ldots, T$. 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 Π is zero, there is no cointegration and a VAR in differences is the appropriate model structure; but if the rank equals the number of variables in the system (p) then a VAR in levels should be estimated. If the variables are cointegrated, then the rank of Π is between zero and p, and, therefore, the hypothesis of interest is Ho: $\Pi = \alpha\beta'$, where α and β are $p \times r$ matrices, β is the cointegrating vector (the equivalent of the slope parameter in the first step of Engle–Granger), α is a weight vector which measures the speed of adjustment towards equilibrium, and r is the number of cointegrating relations.

To estimate β, Johansen eliminates all the parameters but β from the likelihood function:

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

This is accomplished by regressing ΔY_t and Y_{t-k} on their lagged differences. This eliminates the Γ parameters, and results in a system that has as a dependent variable R_{ot} (the residuals from a regression of ΔY_t on lagged ΔY_t's) and independent variable R_{kt} (the residuals from a regression of Y_{t-k} on lagged ΔY_t's). Letting $S_{ij} = T^{-1} \Sigma_t R_{it} R_{jt}$, $i, j = 0, 1$, assuming β known and using the estimate for α

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

the likelihood becomes

$$\ln L = (-T/2) \ln |\Omega(\beta)| \tag{4}$$

with

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

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

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

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

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

and is commonly known as the trace test. Johansen and Juselius 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 article. They also recommend the use of a λMAX test statistic which is similar to the trace test, except that it evaluates the maximum eigen values only.

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 are based on nearby futures contracts.[1] 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 multinational 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, the unit root test results are not reported here. The Phillips–Perron tests[2] indicate that all individual logarithmic series are integrated of order 1 at the 5% level. This result justifies the use of the ECM in eq. (1) to test cointegration. The 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 eq. (1) should be conducted to identify the adequate structure. A maximum of 10 lags are 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. Results by crop year are presented in Tables I and II. 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 eight and nine for Williamston.[3]

Table I suggests that soybean cash markets in both Greenville and Williamston are driven by the same set of supply demand fundamentals as the nearby futures market in four of the 11 years studied (namely in 1980–1981, 1983–1984, 1988–1989, and 1989–1990 crop years). During the other years, the cash markets do not show significant

[1]The nearby contract is defined as the one closest to maturity. In the first notice day of any given contract, the contrast is rolled to the next nearby contract. As such, the data do not overlap and avoids methodological problems associated with overlapping data.

[2]Baillie and Bollerslev suggest these tests for identifying the type of nonstationarity.

[3]Note that each cash market is being tested relative to the futures market individually. While it would be appropriate to look at the relationship between the two cash markets, that is not the focus of this article. Two separate cash markets are considered because they differ in several respects. These differences, such as elevator concentration, may have an impact on market performance.

Table I
COINTEGRATION AND DIAGNOSTIC TESTS, SOYBEAN NEARBY FUTURES AND CASH PRICES, GREENVILLE AND WILLIAMSTON, NORTH CAROLINA, 1980–1991 BY YEAR

	Soybean							
	Greenville, NC				Williamston, NC			
Year	LAG	Q	Trace	λMAX	LAG	Q	Trace	λMAX
80–81	1	13.45	4.55	4.55[a]	1	12.89	5.24	5.24[a]
		22.53	28.24[b]	23.69[b]		13.43	27.03[b]	21.79[b]
81–82	3	17.44	4.29	4.29	1	20.15	3.31	3.32
		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[b]	18.41[b]		14.70	23.11[b]	20.43[b]
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[b]	17.42[b]		22.19	22.49[b]	20.62[b]
89–90	1	12.67	6.87	6.87	3	7.91	5.23	5.23
		8.60	25.94[b]	19.06[b]		10.15	31.03[b]	25.80[b]
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

[a]The value of the Q-statistic in the first and second rows of each year corresponds to the cash and futures equation residuals, respectively. For the trace and λ max statistics the first row corresponds to the test for $r \leq 1$, and row two for $r = 0$.

[b]Significant at the 5% level. Insignificance of row 1 tests combined with significance of row 2 tests indicates the existence of 1 cointegrating vector.

signs of comovement with futures. During all years, dependence in the variance is present primarily in the cash price residuals.

An important result emerging from Table I is the number of lags required for the cash soybean markets to completely adjust to futures market price changes.[4] Note that

[4]Care must be taken in interpreting lags in years of no cointegration. Recall from above that when cointegration is not detected, the appropriate model structure is a VAR in differences. The specific VAR structure is the identified lag from the cointegration regression minus 1. The soybean market lag in the 1982–1983 crop year, for example, is of order 2 for a VAR in first differences.

Table II
COINTEGRATION AND DIAGNOSTIC TESTS, CORN NEARBY FUTURES AND CASH PRICES, GREENVILLE AND WILLIAMSTON, NORTH CAROLINA, 1980–1991 BY YEAR

	Corn							
	Greenville, NC				Williamston, NC			
Year	LAG	*Q*	Trace	λMAX	LAG	*Q*	Trace	λMAX
80–81	1	16.04	0.69	0.69[a]	1	16.65	1.30	1.30[a]
		17.16	7.38	6.99		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[b]	17.67[b]		15.97	21.43[b]	19.24[b]
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[b]	27.81[b]		14.40	29.45[b]	27.47[b]
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[b]	21.30[b]		28.12	27.71[b]	26.61[b]
88–89	1	16.10	5.88	5.88	1	17.44	2.95	2.95
		15.14	27.24[b]	21.37[b]		8.14	22.92[b]	22.92[b]
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

[a]See note on Table I.
[b]Significant at the 5% level. Insignificance of row 1 tests combined with significance of row 2 tests indicates the existence of 1 cointegrating vector.

the Greenville market adjusts more quickly than Williamston. The Greenville market in 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 usually responds to Chicago prices within one day). These results are in contrast to those for Williamston soybeans.

The Williamston soybean market in some crop years studied require 3 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 become less responsive over time.

Cointegration in corn markets is found in 1983–1984, 1985–1986, 1987–1988, and 1988–1989, coinciding with the results in soybean markets for 1983–1984 and 1988–1989 crop years. Interestingly, North Carolina cash corn markets are cointegrated with futures as frequently as soybeans; however, the specific years of cointegration for the two commodities do not coincide. Another important result from Table II is related to the lag structure for corn. 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 corn cash and futures markets.

The results from Tables I and II indicate that cointegration relations are not consistent across crop years in the markets studied. Since cointegration measures the long-run relations between two series it might be argued that Tables I and II present results over too short a time frame to arrive at stable long-run results.[5] To address this issue, the cointegration relationships over the aggregate data are estimated also. The results are presented in Table III. Note that all four markets show significant cointegration, and lag structures are identical across markets with the exception of Williamston corn. In general, cash markets over the aggregate period reflect new information within 5 days of futures markets. The Williamston corn market took up to 7 days to completely react to futures price changes.[6]

In dealing with crop commodities which experience a one-time supply shock each year and exhibit futures price structures which essentially allocate the crop through the current crop year, the long run would be that crop year. This is the horizon over which most marketing and storage decisions are made and the period over which futures markets allocate supply. The experience of the 1980s clearly illustrates that market dynamics can vary greatly by year and, as a result, market relationships can be quite different across years. As such, the year-by-year analyses are more representative of the market relations than the aggregate results.[7]

One expectation of this study is that markets for storable commodities are more highly cointegrated than markets for nonstorables, as suggested by Bessler and Covey. However, the results generated here do not support such a conclusion. While some individual years exhibit 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 nonstorables has focused on terminal cash markets where it is reasonable to expect the information flow between the futures and cash markets to be bidirectional. The cash markets considered

[5]An anonymous reviewer correctly pointed this out in an earlier version of the article. However, results by crop year actually are long-run relations given the decision processes of market agents, and the dynamics of crop production.

[6]While the analyses with aggregate data provide the strongest cointegration results, they also represent the least appropriate specification. As noted by Hakkio and Rush (1991), the definition of *long run* varies depending on the economic problem being addressed and the specific data used. They suggest that for some problems the long run may be decades, while for others the long run may be measured in months.

[7]An important implication of accepting the results over the aggregate sample is the inference of market inefficiency. Hakkio and Rush (1989) have noted that efficient markets for dissimilar commodities cannot be cointegrated since cointegration would imply that one market could be forecast from the other. In general, one would expect the local North Carolina markets and the nearby futures markets to be markets for different commodities since they reflect both spatial and temporal differences. Indeed, one of the most interesting results, which is discussed more fully below, is that cointegration is detected more when market differences are minimized (i.e., in drought years when carrying changes are minimal or nonexistent) and cointegration is not found in years of full carry.

Table III
COINTEGRATION AND DIAGNOSTIC TESTS, SOYBEAN AND CORN NEARBY FUTURES AND CASH PRICES, GREENVILLE AND WILLIAMSTON, NORTH CAROLINA, 1980–1991

	Greenville, NC				Williamston, NC			
Commodity	LAG	Q	Trace	λMAX	LAG	Q	Trace	λMAX
Soybeans	5	20.96	8.86	8.86[a]	5	23.46	8.46	8.46[a]
		26.58	43.73[b]	34.87[b]		25.05	44.46[b]	36.00[b]
Corn	5	25.15	6.23	6.23	7	15.58	6.86	6.86
		28.82	31.96[b]	25.73[b]		25.53	32.11[b]	25.24[b]

[a]See note on Table I.
[b]Significant at the 5% level. Insignificance of row 1 tests combined with significance of row 2 tests indicates the existence of 1 cointegrating vector.

are large enough that any change in local supply/demand could be expected to influence the futures markets. This analysis considers 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 markets. This unidirectional flow of information may have implications for the degree of cointegration found. A more likely explanation for the weak cointegration results, however, is that bivariate cointegration analysis does not explicitly account for the fact that futures and cash markets for crop commodities are not markets for identical commodities. If returns to storage or transport are nonstationary in a given crop year, then, under an assumption of efficient markets, one would expect no cointegration to exist. As noted by Hakkio and Rush (1989), efficient markets for different commodities should not be cointegrated. The year-by-year results reinforce this concept. Cointegration is consistently found across both corn and soybeans in the drought years 1983–1984 and 1988–1989. These are years in which one would expect carrying charges to be minimal, and thus temporal differences between markets diminished. In other words, these are years in which the futures and local cash markets most closely resemble markets for identical commodities.[8] In more normal crop years, little cointegration is found. This further suggests that aggregating across dissimilar crop years in an attempt to find the "long run" is inappropriate. For seasonally produced commodities, the long run appears most appropriately defined across the period in which the initial supply is being allocated.[9]

IMPLICATIONS FOR CASH MARKET EFFICIENCY

The results in Table I above suggest that the two North Carolina cash soybean markets respond differently to futures price changes, with the Williamston market generally requiring a longer trading period to fully incorporate Chicago futures price changes

[8]This, of course, does not account for the fact that the markets differ spatially. There may be several explanations for the seeming lack of spatial differences to impact cointegrating relationships in drought years, such as stationary transport rates. While the implications of spatial differences across markets is an important area for further study, it is beyond the scope of this article.

[9]The authors are currently investigating the degree of cointegration between terminal cash markets and futures for storable commodities explicitly taking into account their temporal relationships. Preliminary results comparing Chicago cash soybean markets with Chicago futures reveal much stronger cointegration relations than those discussed above. For the crop years 1981–1982 through 1988–1989, strong cointegration is found between Chicago cash and futures for soybeans. For all but the 1988–1989 crop year, information flows between the markets is completed within one trading day. Results for other crop years are not yet complete.

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. This study considers next 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¢ per bushel for soybeans.[10] 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 approaches 5¢. A search for individual trading days in which the price differential is 14¢ or greater reveals 21 such occurrences. The dates along with prices are listed in Table IV. There does not appear to be any systematic pattern relative to when in the year these events occur. Also, only twice, in August, 1990, and October, 1986, are there any two consecutive days of price differentials of 14¢ or greater. One can, therefore, 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 as expected.

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¢ or more accounts for only 0.7 of 1% of total trading days considered. Further, there are only two occurrences in which such a spread exists for more than one day. Based on the criteria suggested by Garcia et al. and Rausser and Carter, this study concludes that the Williamston market is not inefficient relative to Greenville, despite the fact that it can take 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% of the spread necessary to induce product movement and provide a profit potential.[11]

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 has only 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. Some may argue that the existence and exercise of market power in adjusting prices implies inefficiency; however, it does not meet the conditions outlined by Garcia et al. and Rausser and Carter. Further, if the Williamston price lags

[10]This rate was provided by a Williamston area Farm Management Agent, North Carolina Cooperative Extension Service.

[11]The monthly average numbers are available from the authors.

Table IV
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	0.14
7/2/80	7.11	6.84	6.64	0.20
8/4/80	7.75	7.15	7.43	−0.28
8/14/80	7.52	7.39	7.21	0.18
8/15/80	7.33	7.19	7.02	0.17
8/18/80	7.44	7.30	7.13	0.17
4/21/81	7.87	7.60	7.76	−0.16
5/22/84	8.89	8.88	8.68	0.20
5/31/84	8.47	8.47	8.97	−0.50
3/14/85	5.90	5.95	5.45	0.50
10/1/85	5.14	4.99	4.49	0.50
10/1/86	4.88	4.88	4.68	0.20
10/2/86	4.87	4.87	4.67	0.20
9/17/87	5.33	5.38	5.18	0.20
9/24/87	5.25	5.30	5.10	0.20
1/16/89	7.85	7.76	7.55	0.21
5/30/89	7.17	7.03	6.83	0.20
7/20/89	6.81	6.69	6.94	−0.25
8/18/89	5.84	6.23	6.08	0.15
9/1/89	5.79	5.99	6.14	−0.15
9/14/89	5.76	6.11	5.66	0.45

result in abnormal profits for the Williamston buyer, even though the price differentials do not justify shipment to Greenville buyers, one would expect buyer competition in Williamston. The authors know of 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 investigates the relationship between two Southeastern cash grain markets and Chicago futures markets. Using cointegration analysis, results are calculated by crop year, and across all crop years. Using aggregate data, cointegration is found between all futures and cash market pairs considered. To accept these results, one must either conclude that the markets are inefficient, or that carrying charges and transport rates are stationary. Both assumptions are suspect. Results reported by crop years reveal a more likely pattern; cointegration is found when local and futures market differences are minimized (i.e., drought years) and not when markets exhibit full carry. These results suggest that it is inappropriate to aggregate across crop years which exhibit unique relationships between cash and futures prices. Further, they suggest that bivariate cointegration models are not as powerful in identifying various market relationships in commodity markets as they are in exchange rate markets. To aid agricultural market agents in localizing futures price information, it is necessary to augment cointegration models to explicitly address spatial and temporal differences between the markets.

Based on crop year analyses, several interesting results emerge. First, utilizing small markets outside the major grain producing states, this study does not find stronger evidence of cointegration for storable cash and futures markets than was previously found for nonstorables. However, this result may be influenced by the fact that changes in the local markets considered cannot be expected to affect national prices, and by the fact that in most crop years, the local and nearby futures markets are, in fact, markets for separate products. The authors are investigating these possibilities by conducting cointegration tests involving terminal cash and futures markets for the same storable commodities considered here, and explicitly accounting for temporal market differences within the cointegration framework.

The second interesting result involves the asymmetry with which the Williamston and Greenville soybean markets react to Chicago futures. Contrary to previous research, this study argues that this is not prima facia evidence of inefficiency in the Williamston market. 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 of transport between the two markets, this study does not find market inefficiency. The asymmetric market impacts may be due to relative buyer concentration in the two markets, but the magnitude of the price differentials do not warrant a conclusion of market inefficiency.

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 of the Williamston elevator in the corn 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.

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