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INFLUENCE OF E-COMMERCE ON COTTON PRICE DISCOVERY

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Abstract

E-commerce trading in the cotton spot market has lowered trading costs, and may have increased the speed of incorporating new information into the spot price, making the cotton market more efficient. However, we did not find evidence of improved pricing efficiency using daily reported cotton spot prices and futures prices. Evidence of improved pricing efficiency may be uncovered using spot and futures transaction prices and the methods used in this paper.

This paper examines cotton prices for evidence of changes in price discovery from the use of e-commerce. Price discovery is the incorporation of new information into price. Its incorporation changes price levels. E-commerce is the use of the Internet and supporting computer languages and computer programs 1) to search for trading partners, for their price bids and offers and for other relevant transaction information, 2) to help in determining transaction prices, and 3) to exchange and process transaction documents. E-commerce reduces the cost of performing these functions. The reduced cost can influence price discovery by making more information available to market participants. Reducing transaction cost can change where price is discovered.

Cotton merchants and textile mills regardless of location can search all the cotton listed on an e-commerce market at low fixed cost and at close to zero marginal cost. As a result, e-commerce reduces transaction costs and increases the number of buyers and the competition for the available cotton which in turn increases the amount of information made available to farmers in arriving at transaction prices. In addition, e-commerce increases the amount of information available to cotton market participants by providing them with price and other completed transaction information in real time (instantaneous). E-commerce also reduces transaction cost by reducing the cost of and increasing the speed of processing and exchanging cotton transaction documents. The increased amount of information made possible by cotton e-commerce and the choice of sharing it with market participants is the way that cotton e-commerce influences price discovery.

Development of Cotton E-commerce

Farmers in Texas and Oklahoma from 1975 through most of 2000 had the choice of selling their cotton electronically using the TELCOT system. TELCOT was developed, owned and operated by the Plains Cotton Cooperative Association (PCCA). Access to the PCCA computers for buyers and sellers originally was by computer terminals connected by dedicated-leased phone lines to the cooperative’s computers. TELCOT was developed before the Internet was sufficiently enhanced for use in performing transactions. Farmers with the TELCOT usually had access to the cooperative’s computers via computer terminals at their local gins.

In 1998, PCCA computers and TELCOT were connected to gins and buyers using the Internet (Plains Cotton Cooperative Association). It was much less expensive for gins and buyers to connect to TELCOT using the Internet than using dedicated phone lines. Cost of leasing phone lines is avoided by using the Internet. In addition, programming expenses, to tie together incompatible computer systems are reduced considerably by using the Internet and its supporting computer languages and programs.

TELCOT was converted to a Windows based system and tested and used before transferring it to The Seam. The Seam is an e-commerce market supported and owned by cotton cooperatives, merchants, and textile manufacturers. Trading on The Seam began in December 2000. Producers in all seven marketing regions can list and sell their cotton on The Seam. Also, merchants can trade with one another on The Seam. The USDA began selling its Commodity Credit Corporation (CCC) stocks on The Seam in August 2003. Trading on The Seam is anonymous, that is, the identity of trading partners is not known.

Merchants gave up private trading information by participating in the founding of and in using The Seam. Information they could use to obtain more favorable trades. They came to the conclusion that Internet technology would quickly be used to develop a national e-commerce market and that their best choice is to be part of this new development rather than have it imposed on them, particularly, by firms outside the cotton industry (Robinson).

Buyers can search the cotton bales listed on The Seam by location, price, and quality. The information produced by the search and the resulting transactions should reduce price discrepancies among the seven marketing regions thus contributing to price discovery. Transaction prices are determined by buyers accepting posted selling prices, by sellers accepting counter offers by buyers and by sellers accepting the highest bids. Buyers and sellers choose the method of determining price. The Seam takes care of transferring funds and transferring electronic warehouse receipts. Funds can be transferred electronically using the Internet and inter bank electronic networks (Weiner). The direct link on The Seam with the New York Board of Trade should also contribute to price discovery by facilitating hedging.

An important feature of TELCOT and The Seam is the assumption of counterparty risk. This is an essential requirement for trading with strangers, particularly anonymous trading as was done on TELCOT and is done on The SEAM.

Two developments further reduced the costs and improved the efficiency of TELCOT trading and now the efficiency of cotton e-commerce trading. One was the electronic warehouse receipt. The other was electronic cotton classing documents. Both electronic warehouse receipts and classing documents are records in electronic databases. USDA and the cotton industry cooperated in both developments. USDA continues to be involved in implementing electronic warehouse receipts through licensing and regulating Internet service providers. The service providers transfer electronic warehouse receipts from seller to buyer, store them, and provide an audit trail for resolving disputes. USDA provides electronic classing documents that describe the results of USDA's classing tests. Paper warehouse receipts and classing documents could not keep up with the increased speed from electronic cotton search and from the use of electronic trading. Electronic documents avoid the delays in completing transactions by avoiding the delays in processing and transporting paper documents.

An alternative trading model is used on eCotton, another e-commerce cotton market. Trading on eCotton is not anonymous –potential cotton buyers and sellers are identified. Price is determined by buyers accepting posted selling prices or by one-on-one bargaining, usually offline. Transfer of funds and transfer of electronic warehouse receipts are arranged by buyers and sellers. Counterparty risk can be reduced in this market by trading with known trading partners. It can also be reduced by using a bank as an escrow agent that releases funds to the seller upon receipt of the electronic warehouse receipt from the seller.

Anonymous cotton trading and cotton trading with identified partners can coexist indefinitely when some sellers and buyers can or think they can get better deals by trading anonymously and some can or think they can get better deals by trading with known trading partners.

Data

Daily closing cotton-futures prices on the New York Board of Trade and the base daily spot cotton quotations (DSCQ) for the seven market regions reported by the USDA's Agricultural Marketing Service were examined for evidence of changes in price discovery from e-commerce. Two of these market regions, East Texas-Oklahoma and West Texas, where served by TELCOT. Prices for crop marketing years 1998 and 1999 and for 2002 and 2003 were examined. The results for 1998 and 1999 were compared with the results for 2002 and 2003. The first pair of marketing years occur before trading started on The Seam. Crop marketing years 2000 and 2001 were transition or start up years.

Farmers in East Texas-Oklahoma and West Texas began selling their cotton on The Seam in December 2000. Farmers in the other five marketing regions began selling their cotton on the Seam in July 2001. Cotton trading among merchants and mills nationwide began on The Seam in February 2001.

The examination of each marketing year concentrated on daily price data from October 1 through March 31 when the spot markets are most active.

Figures 1 through 4 show the daily futures and average U.S. spot prices for the 1998, 1999, 2002, and 2003 marketing years. The horizontal axis measures the marketing years in trading days. Day 1 occurs on August 1 or on the first trading day after August 1. The price patterns vary significantly among the 4 years. Their jagged upward and downward movements suggest wandering behavior and are consistent with new information arriving randomly each day. For each marketing year, events can be identified that moved the cotton futures and spot prices. One feature of the prices that is used in the price discovery literature, as can be seen in the graphs, is that they move together.

Figures 5 through 8 show changes in the daily cotton futures and the daily average U.S. spot prices from one trading day to the next. Here the price patterns look much different. The price changes do not appear to wander but appear to be random variables about a mean. Both price levels and price changes are used to examine price discovery.

Procedures and Findings

Procedures from the active price discovery literature in economics and finance are used to examine the influence of e-commerce on cotton price discovery. These procedures build on and extend the graphical examination.

First, the cotton spot and futures prices are examined for unit roots. This part of the analysis involves choosing between new information having a permanent or temporary effect on price levels. It helps us to understand the earlier graphical examination. In addition, the graphical examination helps us to understand the examination of cotton price for unit roots. Procedures used in the active price discovery literature require prices to have unit roots in levels, but not in first differences.

Second, the prices are examined for unit root sharing. This involves choosing between the prices being independent or held together by arbitrage. Arbitrage takes advantage of price discrepancies among the markets and moves prices toward an equilibrium relationship. The equilibrium relationship is called a cointegrating relationship in the price discovery literature.

Third, the prices are examined to determine where the arbitrage price adjustments occur and if e-commerce has changed where they occur. Prices tend to adjust in the lowest trading cost markets. Reducing trading cost encourages more trading if transaction information is shared.

Figure 1. Cotton Futures and U.S. Average Spot Prices for the 1998 Marketing Year.

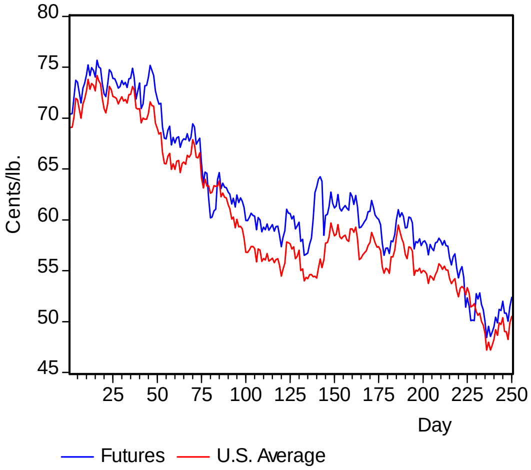


Figure 2. Cotton Futures and U.S. Average Spot Prices for the 1999 Marketing Year.

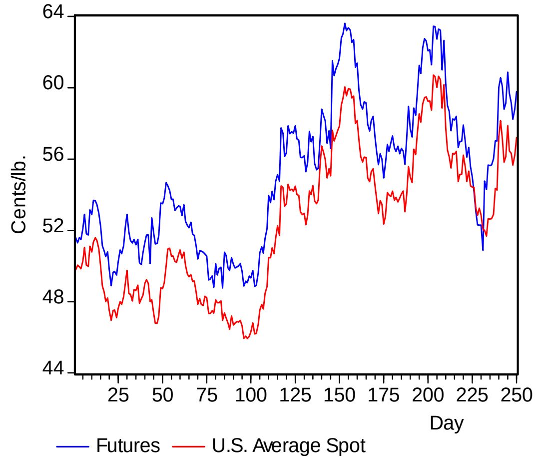


Figure 3. Cotton Futures and U.S. Average Spot Prices for the 2002 Marketing Year.

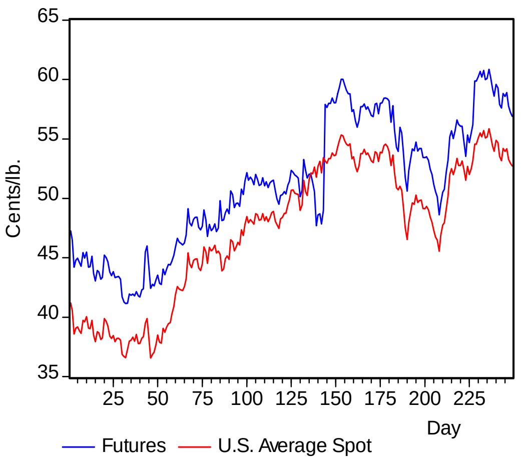
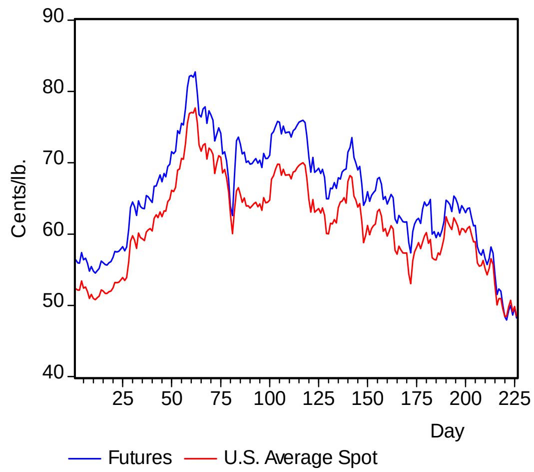


Figure 4. Cotton Futures and U.S. Average Spot Prices for the 2003 Marketing year.



Unit Roots

Equation 1 is used to explain the examination of cotton prices for unit roots.

(1) $x_t = \psi x_{t-1} + \varepsilon_t$

x_t and x_{t-1} are cotton spot prices from one of the seven AMS marketing regions or futures prices on day t and the previous day t-1. ε_t is the effect of day's t information on price that day.

A value of ψ equal to one implies that the cotton price has a unit root and implies that the effect of new information represented by ε_t does not die out, but remains permanent with the passage of time. A value between 1 and –1 implies that the cotton price does not have a unit root and implies that the effect of new information dies out with the passage of time. The difference between remaining permanent and dying out is shown using equation 2.

(2) $x_t = \varepsilon_t + \psi\varepsilon_{t-1} + \psi^2\varepsilon_{t-2} + \ldots$

Equation 2, which can be derived from equation 1, shows that the effect of ε_{t-k} on x_t represented

Figure 5. Cotton Futures and U.S. Average Spot Price Changes for the 1998 Marketing Year.

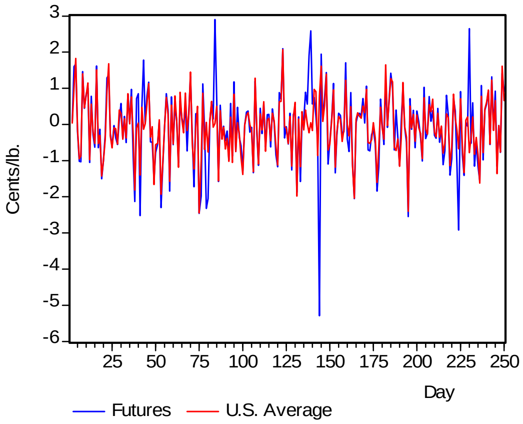


Figure 6. Cotton Futures and U.S. Average Spot Price Changes for the 1999 Marketing Year

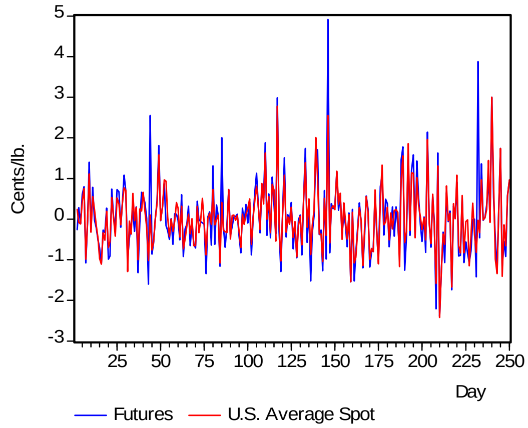


Figure 7. Cotton Futures and U.S. Average Spot Price Changes for the 2002 Marketing year.

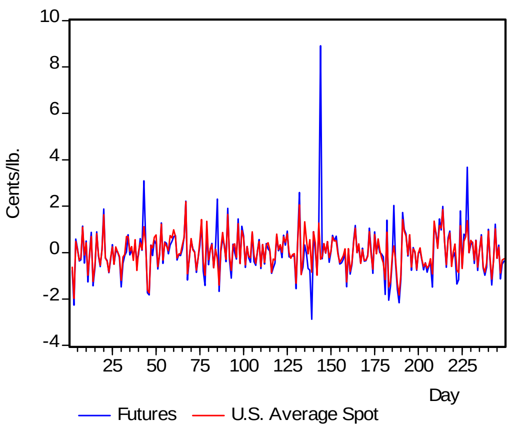
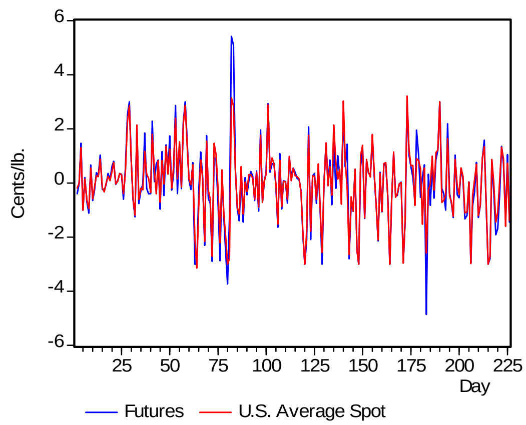


Figure 8. Cotton Futures and U.S. Spot Price Changes for the 2003 Marketing Year.



examination helps us to understand the examination of cotton price for unit roots. Procedures used in the active price discovery literature require prices to have unit roots in levels, but not in first differences.

Second, the prices are examined for unit root sharing. This involves choosing between the prices being independent or held together by arbitrage. Arbitrage takes advantage of price discrepancies among the markets and moves prices toward an equilibrium relationship. The equilibrium relationship is called a cointegrating relationship in the price discovery literature.

Third, the prices are examined to determine where the arbitrage price adjustments occur and if e-commerce has changed where they occur. Prices tend to adjust in the lowest trading cost markets. Reducing trading cost encourages more trading if transaction information is shared.

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A value of ψ equal to one implies that the cotton price has a unit root and implies that the effect of new information represented by ε_t does not die out, but remains permanent with the passage of time. A value between 1 and –1 implies that the cotton price does not have a unit root and implies that the effect of new information dies out with the passage of time. The difference between remaining permanent and dying out is shown using equation 2.

(2) $x_t = \varepsilon_t + \psi\varepsilon_{t-1} + \psi^2\varepsilon_{t-2} + \ldots$

Equation 2, which can be derived from equation 1, shows that the effect of ε_{t-k} on x_t represented by $\psi^k\varepsilon_{t-k}$ does not decrease when ψ equals 1 but does decrease and approaches zero when ψ is between 1 and –1.

The spot prices for the seven AMS marketing regions, the U.S. average spot price, and the futures price in each of the four marketing years were examined for unit roots using the augmented Dicky-Fuller test. The test is used to choose between a price being nonstationary (having one or more unit roots) and being stationary (having no unit roots).

Equation 3 is used to perform the augmented Dicky-Fuller test.

(3) $\Delta x_t = \mu + \gamma t + \delta x_{t-1} + \sum_{j=2}^{q} \delta_j \Delta x_{t-j+1} + \varepsilon_t$

The derivation of equation 3 from equation 1 is shown in many econometric and time series books (for example, Franses and Seddighi et al). Time lags of Δx (the fourth term in equation 3) are used, if necessary, to make ε_t a serially uncorrelated variable. The number of time lags chosen is based on the Schwarz information criterion. We used μ but not γ t in testing for unit roots. μ is storage cost. γ t is a linear deterministic trend in cotton prices.

The test helps us choose between the coefficient, δ, in the third term being equal to zero or being less than zero. A value of zero implies that the variable has a unit root and is nonstationary. A value less than zero implies that the variable does not have a unit root and is stationary.

The augmented Dicky-Fuller test results for price levels are shown in part A of Table 1. The unit root hypothesis (nonstationary) can not be rejected for any price levels at even the 10 percent level of significance. The results suggest that prices contain one or more unit roots.

The test was repeated for price changes to determine if price contains an additional unit root. The test results for price changes are shown in part B of Table 1. The unit root hypothesis for price change is rejected for all the prices at the one percent level. The results suggest that the change in price level does not contain a unit root and is a stationary random variable.

The test results for price level and price change suggest that each price contains only one unit root. They suggest that the prices follow a random walk and that new information each day is a random variable. The Schwarz information criterion for choosing the lag in the fourth term in equation 3 almost always suggested that no price lags should be used in equation 1. These results imply that all the new information each day is incorporated into the price before the day's end.

Cointegration and Price Discovery

Finding one unit root in each price raises the question, Do the prices share unit roots implying that they move together due to arbitrage? If unit roots are shared, Has e-commerce influenced arbitrage? Sharing unit roots is called cointegration. Finding cointegration raises the questions, Which prices adjust to arbitrage? Has e-commerce changed which prices adjust to arbitrage?

This section uses the Johansen method to test for cointegration and to examine price discovery. The Johansen method estimates and examines the vector error correction model shown in equation 4.

$$(4)\quad \Delta X_t = \Pi X_{t-k} + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + \varepsilon_t$$

Both price levels and price changes are included in the error correction model. In this study X_t is an 8 by 1 vector containing the futures and seven spot prices for day t and ΔX_t is an 8 by 1 vector containing the changes in these prices from day t –1 to day t. ε_t here is an 8 by 1 vector showing the influence of new information on each price for day t.[1] The Johansen method considers all the cotton prices jointly rather than individually as was done in the previous part of this section.

Table 1. Unit Root tests for Cotton Futures and Spots Prices in the 1998, 1999, 2002, and 2003 Marketing Years. 1/

Part A. Unit Root Tests on Price Levels.

	1998	1999	2002	2003
Futures	-1.90 (.33)	-1.25 (.65)	-1.65 (.45)	-1.90 (.33)
U.S. average	-1.73 (.41)	-0.85 (.80)	-1.42 (.57)	-1.73 (.41)
Southeast	-1.98 (.30)	-1.01 (0.75)	-1.59 (.48)	-1.47 (.55)
North Delta	-1.88 (.34)	-1.05 (.73)	-1.79 (.39)	-1.89 (.34)
South Delta	-1.88 (.34)	-1.05 (.73)	-1.77 (.39)	-1.88 (.34)
East TX-OK	-1.59 (.49)	-0.84 (.80)	-0.40 (.90)	-1.59 (.48)
West Texas	-1.48 (.54)	-0.72 (.83)	-1.13 (.70)	-1.48 (.54)
Desert SW	-1.72 (.42)	-0.83 (.80)	-1.42 (.57)	-1.72 (.42)
SJ Valley	-1.54) (.51)	-1.73 (,41)	-1.44 (.56)	-1.54 (.51)

Part B. Unit Root Tests on Price Changes

	1998	1999	2002	2003
Futures	-11.02 (.00)	-13.78 (.00)	-10.94 (.00)	-11.02 (.00)
U.S. average	-11.83 (.00)	-11.23 (.00)	-10.05 (.00)	-1.02 (.00)
Southeast	-12.65 (.00)	-12.44 (.00)	-10.27 (.00)	-12.65 (.00)
North Delta	-12.07 (.00)	-12.27 (.00)	-12.02 (.00)	-12.08 (.00)

South Delta	-12.07 (.00)	-12.27 (.00)	-11.75 (.00)	-12.08 (.00)
East TX-OK	-11.99 (.00)	-13.07 (.00)	-9.77 (.00)	-11.99 (.00)
West Texas	-12.40 (.00)	-11.82 (.00)	-8.41 (.00)	-12.40 (.00)
Desert SW	-11.70 (.00)	-11.28 (.00)	-10.75 (.00)	-11.70 (.00)
SJ Valley	-11.60 (.00)	-11.20 (.00)	-10.90 (.00)	-11.60 (.00)

1/ Each number in parenthesis is the probability that the corresponding estimating δ from equation 3, shown above, occurred by chance.

The Johansen method factors the Π matrix (an 8 by 8 coefficient matrix in this analysis) into $\alpha\beta^{'}$. If the prices are cointegrated, then β is a 8 by r matrix where r is the number of cointegrating relationships that describes the longrun relationships among the prices. Each of the r columns in β describes a cointegrating relationship. α is a 8 by r matrix that describes which prices adjust to deviation from longrun relationships by arbitrage. Baillie et al. explain that in the price discovery literature deviations from longrun relationships in β occur because markets process news at different rates, p, 310.

We use the Johansen method to test for the number of cointegrating relationships among the cotton prices, to examine if each price is included in a cointegrating relationship, and to examine which prices adjust to arbitrage.

Using the Johansen trace test we found two cointegating vectors for the 1998 and 2002 marketing years and one for the 1999 and 2003 marketing years at the 5 percent significance level. We are interested in whether or not each cotton price is in a cointegrating vector rather than in estimating the magnitude of the cointegrating coefficients. Estimating their magnitudes requires identifying unique cointegrating vectors or relationships (Harris and Sollis). Bessler et al. comment that p markets (prices) connected by arbitrage and perfect competition, implies or identifies p – 1 cointegrating vectors all sharing the same root. They say this may not happen in agriculture markets because of imperfect competition and because transportation costs may be nonstationary. Studies of financial instruments with essentially zero transportation costs often assume that there are p –1 cointegrating vectors all sharing the same root and specify the cointegrating vectors and their coefficients rather than estimating them using the Johansen method. (Baillie et al., p. 310).

The test for a price being included in a cointegrating relationship or relationships is done by setting its cointegrating coefficient(s) to zero, estimating the error correction model with the restriction(s), and then checking to see if the zero restriction can be rejected. If the zero null hypothesis can be rejected then the price should be included in the cointegrating relationship.

Table 2 part A shows the results for inclusion in and exclusion of the prices from the cointegrating vectors. The results show that many of the prices, at the 10% significance level, are included in the cointegrating vectors and imply that the included prices are held together by arbitrage.

The results for the San Joaquin Valley suggest that its price may often be in a separate market. The San Joaquin Valley price was excluded from cointegrating relationships for three out of the four marketing years. Interestingly, East Texas-Oklahoma and West Texas were included in cointegrating relationships at the 10 percent significance in all four marketing years, the only prices that were included in all four marketing years. These are the two areas in which farmers could sell their cotton electronically prior to The Seam. Surprisingly, the futures price was excluded from the cointegrating vector in the 1999 marketing year. The Southeast and Desert Southwest were each included in a cointegrating vector for three out of the four marketing years.

The South Delta price was excluded from the analysis in 1998 and 1999 because it was perfectly correlated with the North Delta price for these years. The North Delta price was included in the

Table 2. Tests for Including Cotton Futures and Spots Prices in Arbitrage and in Adjusting to Arbitrage in the 1998, 1999, 2002, and 2003 Marketing Years.1/

Part A. Chi Square tests for Inclusion in Cointegrating Vectors

	1998	1999	2002	2003
Futures	β(1,1)= β(2,1)=0 (.00)	β(1,1)=0 (.41)	β(1,1)= β(2,1)=0 (.03)	β(1,1)=0 (.09)
Southeast	β(1,2)= β(2,2)=0 (.07)	β(1,2)=0 (.06)	β(1,2)= β(2,2)=0 (.02)	β(1,2)=0 (.16)
North Delta	β(1,3)= β(2,3)=0 (.07)	β(1,3)=0 (.05)	β(1,3)= β(2,3)=0 (.54)	β(1,3)=0 (.78)
South Delta	β(1,4)= β(2,4)=0 (NA)	β(1,4)=0 (NA)	β(1,4)= β(2,4)=0 (.12)	β(1,4)=0 (.30)
East TX-OK	β(1,5)= β(2,5)=0 (.00)	β(1,5)=0 (.01)	β(1,5)= β(2,5)=0 (.01)	β(1,5)=0 (.06)
West Texas	β(1,6)= β(2,6)=0 (.00)	β(1,6)=0 (.01)	β(1,6)= β(2,6)=0 (.01)	β(1,6)=0 (.09)
Desert SW	β(1,7)= β(2,7)=0 (.03)	β(1,7)=0 (.33)	β(1,7)= β(2,7)=0 (.06)	β(1,7)=0 (.10)
SJ Valley	β(1,8)= β(2,8)=0 (.98)	β(1,8)=0 (.01)	β(1,8)= β(2,8)=0 (.14)	β(1,8)=0 (.73)

Part B. Chi Square tests for Adjusting During Arbitrage

	1998	1999	2002	2003
Futures	α (1,1)=a(1,2)=0 (.00)	α (1,1)=0 (.92)	α (1,1)=a(1,2)=0 (.14)	α (1,1)=0 (.27)
Southeast	α (2,1)=a(2,2)=0 (.96)	α (2,1)=0 (.41)	α (2,1)=a(2,2)=0 (.44)	α (2,1)=0 (.28)
North Delta	α (3,1)=a(3,2)=0 (.34)	α (3,1)=0 (.80)	α (3,1)=a(3,2)=0 (.36)	α (3,1)=0 (.12)
South Delta	A (4,1)=a(4,2)=0 (NA)	α (4,1)=0 (NA)	α (4,1)=a(4,2)=0 (.36)	α (4,1)=0 (.12)
East TX-OK	α (5,1)=a(5,2)=0 (.03)	α (5,1)=0 (.03)	α (5,1)=a(5,2)=0 (.35)	α (5,1)=0 (.36)
West Texas	α (6,1)=a(6,2)=0 (.10)	α (6,1)=0 (.97)	α (6,1)=a(6,2)=0 (.70)	α (6,1)=0 (.35)
Desert SW	α (7,1)=a(7,2)=0 (.84)	α (7,1)=0 (.17)	α (7,1)=a(7,2)=0 (.77)	α (7,1)=0 (.17)
SJ Valley	α (8,1)=a(8,2)=0 (.53)	α (8,1)=0 (.97)	α (8,1)=a(8,2)=0 (.68)	α (8,1)=0 (.41)

1/ Each number in parenthesis is the probability that the corresponding zero cointegrating or adjustment coefficient(s) occurred by chance.

cointegerating vectors for these years but was not included in 2002 and 2003 when the South Delta price was included in the analysis. The South Delta price was not included in the cointegrating vectors at the 10 percent significance level in 2002 and 2003.

There is no general pattern of inclusion in or exclusion from cointegrating relationships that describes the differences between 1998 and 1999 from 2002 and 2003. The results suggest that nationwide electronic cotton trading did not influence prices being included in or excluded from a cointegrating relationship.

Our attention next turns to examining the influence of e-commerce on arbitrage price adjustment. Significance test for the price adjustment coefficients are shown in part B of table 2. In 1998 the price adjustment coefficients for futures, East-Texas Oklahoma, and West Texas were significant at the 10 percent level. In 1999 only the price adjustment coefficient for East-Texas Oklahoma was significant. There were no significant price adjustment coefficients for 2002 and 2003 at the 10 percent or higher levels.

The results are surprising except for 1998. Arbitrage price adjustments in 1998 occurred in the futures market and in the two spot markets with electronic trading. These are the markets in which trades can be made most quickly to take advantage of information. One might expect that more significant price adjustment coefficients would be found in 2002 and 2003 as the result of electronic cotton trading available regardless of location.

Finding cointegration implies that at least one price adjusts to arbitrage for each cointegrating relationship. Yet we did not find evidence of arbitrage price adjustment at the 10 percent significance level in either 2002 or 2003.

We found no significant coefficients for lagged price changes (the second term in equation 4). These results suggest that there are no current price adjustments (changes) to past price changes except for possible arbitrage price adjustments.

Summary

We found that many of the prices are held together by cointegrating relationships. However, we did not find that e-commerce influenced the inclusion or exclusion of prices from the cointegrating relationships. We expected to find an influence because the use of e-commerce provides more information about price discrepancies nationwide and because it reduced transactions cost nationwide.

Nonstationary transportation cost could have kept some of the prices out of the cointegrating relationships. Unfortunately, we do not have information on transportation costs. Another possible problem is that the futures price is at the end of the trading day and the spot prices are the average for the day. The error correction model assumes that all variables are measured at the same time or for the same time period.

We expected to find more prices adjusting to arbitrage from nationwide e-commerce trading. Instead we did not detect any arbitrage price adjustments in 2002 and 2003 at the 10 percent significance level. However, the Johansen method tells us that detection of cointegration implies arbitrage price adjustment. Although some of our results are unexpected, the procedures we used provide us with a rigorous way to think about and examine cotton price discovery.

We plan to further examine the closing futures data and the base daily spot price data using the directed acyclic graphic approach (Bessler et al.). This approach is used to estimate the instantaneous effect of information entering a market on its own price and on the prices in the other markets based on the errors (new information) from equation 4.

Examination of cotton spot and futures transaction price data using the Johansen method would likely improve our understanding of cotton price discovery and the influence of e-commerce on cotton price discovery. An interesting question that could be examined using spot and futures transaction price data is, Are there seven regional markets or one national spot market? The Grammig et al. study of the identical equities (stocks), trading in three different markets provides a good example of using transaction data and the Johansen method to examine price discovery.

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