COTTON PRICE INTERDEPENDENCE IN THE DEVELOPED AND DEVELOPING COUNTRIES

Jian Yang and David J. Leatham
Department of Agricultural Economics
Texas A&M University
College Station, TX

Abstract

Using cointegration, we examined the cotton price relationship among six developing countries and the US. We found evidence for market linkage among some developing countries and the US. A higher degree of international market participation and participation in the same regional economic integration movement are factors that affect integration by developing countries in the international cotton market. Staple length of cotton is also confirmed to affect market integration.

Introduction

Most agricultural goods are traded in world markets, and international market-integration issues have been interesting to researchers. Measurement of market integration can be viewed as basic data for an understanding of how specific markets work. Particularly, the extent to which commodity markets are integrated has important implication for empirical international trade modeling and demand analysis (Monke and Petzel, 1984). The extent of market integration also has a direct influence on their regulation and on general economic policy. If the market is internationally integrated, the governmental intervention in one nation may be ineffective, or very costly.

This study statistically investigates the cotton market price relationship among the U.S. and six developing countries or regions, i.e., Franc-Zone Africa, Argentina, Paraguay, Sudan, Turkey, and Central Asia. All major cotton producers except the U.S. are developing countries (including transition economies). This provides us an opportunity to address the price relationship with the focus on developing countries, which may provide new insights. The work most relevant to this study is Monke and Petzel (1984). They examined international cotton market integration based on data in 1960s and 1970s, paying special attention to country of origin and staple length as the two most likely factors affecting international cotton market integration. They argued that a distinction should be made between extra long and other staple lengths, but not by country of origin after controlling for staple length. Our study extends their work in several ways. Particularly, we use more appropriate cointegration technique and the most recent 1990s data to revisit the issue. The cointegration analysis has been widely used to overcome the econometric shortcomings in earlier market integration studies, such as ignoring nonstationarity of the analyzed variables and inappropriate application of first difference (Ardeni, 1989). The last decade also provides evidence that the developing countries as a whole are also more internationally integrated than before. More importantly, allowing for difference in staple lengths, we explore more factors that may influence the international cotton market.

The empirical analysis in this study is structured around three questions. First, whether there exists a certain price linkage among the U.S. and some or all of the developing countries in international cotton markets? Second, whether some developing countries are excluded from the international market integration? If yes, what might be the plausible explanations? Third, do some of developing countries contribute to international price formation or are all of the developing countries simply following the U.S. price movement?

Methodology

This section provides an overview of the cointegration technique used to explore the issues posed in the Introduction. Johansen and Juselius (1990) have developed the maximum likelihood estimator and likelihood ratio tests for hypothesis testing in a cointegrated system. Let X_t denote a vector which includes k price series concerned (k=7 in this case). The k price series in X_t can be expressed as a reduced form error correction model:

$$(1) \qquad \Delta X_t = \Gamma_1 \Delta X_{t-1} + \ldots + \Gamma_{k-1} \Delta X_{t-k+1} + \Pi X_{t-1} + \mu + \varepsilon_t$$

where $\Pi = \alpha\beta'$ and the rank of Π determines the number of cointegrating vectors. To test the order of at most r cointegrating vectors for a kx1 vector, the trace test statistics is calculated as follows:

$$(2) \qquad Trace = -T \sum_{i=r+1}^{k} \ln(1-\lambda_i)$$

where T is the number of observations, λ_i's are the n-r smallest squared canonical correlations of X_{t-1} with respect to ΔX_t corrected for lagged differences (also called eigenvalue). The Johansen trace test statistic of the null hypothesis is that there are at most r ($0 \leq r \leq k$) cointegrating vectors and thus (n-r) common stochastic trends. The first question can be answered by testing $r \neq 0$. If $r \neq 0$, it implies there is some degree of market integration among some of or all of these seven markets.

Including a constant term μ in equation (1) is important. The role of transportation is found to be important in testing cointegration relationship between spatial prices. The μ here can properly account for the relatively constant transportation cost or the cost with a time trend. If transportation cost is relatively constant in the long run, we may restrict the constant to the cointegration space and μ =

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0 in the equation (2). If the transportation cost has a time trend, we should have a linear trend $\mu \neq 0$. Thus, we run trace test on two specifications, that is, restricted constant within the cointegrating space (no linear trend), and a linear trend in data.

The second question concerns testing linear restriction on cointegration vectors β, i.e.,

$$(3) \qquad H_2: R'\beta = 0$$

Of particular interest, we test two subhypotheses here. The first subhypothesis is zero long-run price effect, i.e., whether for a given i (i=1,...,7), $\beta_{ij} = 0$ for all j (j = 1,...,r). If the null hypothesis is not rejected, it means that ith market is not subject to the equilibrium price relationships and thus is not integrated into the international market. We are interested to see whether at least some developing country markets are excluded from the international market. The second subhypothesis is long run price equality among the integrated country markets, i.e., $\beta_{ij} - \beta_{kj} = 0$ for all j (j=1,...,r). The appropriate likelihood ratio test statistics is:

$$(4) \qquad LR = T\sum_{i=1}^{r} \ln\left[(1-\lambda_{H0,i}) / (1-\lambda_i)\right]$$

The third question involves α matrix that reflects the dynamic structure among integrated markets. Specifically, we are interested in examining weak exogeneity of the ith market price. If a market is weakly exogenous to the deviation from long-run relations, it implies that the market unidirectionally provides the information to the international price formation. The hypothesis testing is framed as the following:

$$(5) \qquad H_3: \quad B'\alpha = 0$$

The similar likelihood ratio test statistics as indicated in equation (6) can be employed.

Results and Discussion

Seven cotton price series are obtained through Datastream International. The daily data covers three years from January 1, 1992, to December 31, 1994, with a total of 781 observations. They represent U.S. (Texas, 1-1/16), Franc-Zone Africa (1-3/32), Argentina (Grade C), Paraguay (1-3/32), Sudan (Barakat), Turkey (1-1/16), and Central Asia (1-3/32). Except the cotton price series from Sudan, which reflects the price for extra long staple length, all price series are for short to medium staple lengths.

The cointegration analysis was originally designed to explore the relationship of nonstationary time series. Hence, before testing whether the price series are cointegrated, we needed to establish that each univariate series is nonstationary, i.e., I(1). Two standard unit root test procedures were applied. One was the augmented Dickey-Fuller (ADF) test and the other was the Phillips-Person (PP) test. Both tests were further considered with the cases of with or without trend. Table 1 reports test results for I(1) versus I(0) (level prices), and I(2) versus I(1) (first price differences). The null hypothesis in each test was that each of the price series contains a unit root, and it should be rejected if the test statistics is less than the critical value. The results showed that there is one unit root in each of cotton prices, but no unit root in their first differences, at 5% significant level.

The first question addresses whether there was to some extent market integration among these markets in developing countries. The majority of world cotton production is produced in developing countries (including transition economies). The cotton price signal may be distorted because production is usually encouraged with substantial subsidies. However, there have been several policy changes that encourage international price interdependence in cotton markets. First, the developed country US has lessened its protection on its farm commodity production. As noted by Anderson and Cleveland (1995), the 1990 legislation imposed less restriction on acreage planted, and was directed toward more market dependence for the cotton prices during the sample period. Second, developing countries also changed their agricultural policy and encouraged more market-oriented production. For example, since the 1980s Sudan government abolished the export tax on cotton, and lowered the exchange rate applicable to cotton exports, set the domestic price near the export price, announced the price before harvest, and paid it as soon as tenants delivered their cotton (World Bank,1986, p108). Overall, though many trade barriers to international cotton markets still exist, we expect some degree of price linkage among these markets.

Table 2 reports the trace test results on the first question. The results suggest that there was one cointegration vector, which implies some degree of international cotton price interdependence. However, it is not yet clear whether all seven prices are subject to the equilibrium price constraint as revealed by the one identified cointegration vector.

The second question addresses the more specific pattern of international market integration. There are several factors possibly affecting the pattern of international market integration. First, the product differentiation may fundamentally affect the market integration. The distinctive product varieties may be better regarded as separate products and do not follow the same price movement. As mentioned above, Monke and Petzel (1984) suggest a certain market segmentation pattern based on consideration of the staple lengths. Second, the degree of international market participation may be important. A developing market with higher degree of international market participation may be expected to be more likely to be integrated with other major market participants. In terms of average export share during 1989/90-1992/93 in world cotton market, U.S.

(23.9%) and Franc-zone Africa (7.4%) are No.1 and No.3 exporters, while other five countries have insignificant share. Third, geographical location may have important implications for determining international market integration. It is very common for developing countries in geographical neighborhood to participate in the regional market integration. Also, geographical location may imply the difference in distance or perceived distance between market location. The distance is positively correlated with transportation cost. If the transportation cost is too high to carry out sufficient arbitrage, the market may fail to be integrated with another market. According to World Bank's (1997, p264-5) classification of economy by regions, among the selected seven countries and regions, Franc-Zone Africa and Sudan are located in Africa, Argentina and Paraguay and USA in America, Turkey in Europe, central Asian countries in Asia. Thus, it is more likely for countries in same region, for example, Argentina, Paraguay, and USA to be integrated.

The results on the second question are summarized in Table 3. We found that cotton prices in three countries (Turkey, Central Asia, and Sudan) do not enter the long run relationship. Exclusion of the Sudan cotton price from the long-run relationship may be most obviously attributed to its product variety since the Sudan cotton price refers to the price for extra staple length. According to Monke and Petzel (1984), the extra long staple cotton should be regarded as a differentiated product from the cotton of other staple lengths in the international market. Based on four price series that are included in the long-run relationship, we further conducted the price quality tests. We report the results in Table 4. We failed to reject that US and Franc-Zone African cotton prices tend to be equal in the long run. We also found that the Argentina and Paraguay cotton prices tend to be equal in the long run. The plausible explanation is that regional economic integration has caused Argentina and Paraguay commodity prices to move very closely.

Finally, we addressed the third question by conducting the weak exogeneity test. The results are reported in Table 4. We failed to reject that the US Texas cotton price and the Paraguay price are exogenous. The above findings imply that both the US and Paraguay markets unidirectionally contribute to the formation of international cotton price in the long run. Thus, the developing countries do not simply follow the price movement in the developed country, US.

Conclusions

In this study, we examined the cotton price relationship among six developing countries and the US. We found evidence for market linkage among some developing countries and US. We further suggest that except staple length, other factors may affect the international cotton market integration. Developing counties with a higher degree of international market participation may be more likely to be integrated with other countries, and easier to follow the price leader. There is also some evidence that two developing countries, Paraguay and Argentina, share more aligned cotton price movement, most obviously due to their participation in the same regional economic integration movement.

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Table 1. Results Of Unit Root Tests.

	Without Trend		With Trend	
Market	ADF	PP	ADF	PP
Level Prices				
AFR	-1.07	-2.01	-2.19	-7.76
ARG	-1.11	-1.83	-1.28	-5.50
PGY	-1.42	-1.91	-1.33	-6.22
TKY	-0.57	-1.46	-2.25	-9.43
ASIA	-1.16	-1.27	-2.30	-6.05
SUD	-1.25	-3.62	-1.57	-4.78
US	-1.20	-2.85	-2.14	-8.53
First Differences of Prices				
AFR	-10.96	-1065.07	-10.96	-1064.53
ARG	-8.40	-1060.08	-8.44	-1057.81
PGY	-7.79	-1071.04	-7.85	-1068.36
TKY	-18.60	-1041.07	-18.61	-1041.25
ASIA	-6.00	-1447.56	-6.00	-1446.76
SUD	-7.54	-1132.25	-7.55	-1130.71
US	-18.24	-1012.50	-18.23	-1012.01

Note: The critical values of the ADF unit root tests with and without trend are –2.86 and –3.41 at 5 per cent level, respectively. The critical values of the PP unit root tests with and without trend are –14.1 and –21.7 at 5 per cent level, respectively.

Table 2. Johansen Trace Test Results For Seven Markets.

	Without		With Linear Trend	
$H_{0=}^{b}$	T^c	$C^d(5\%)$	T^c	$C^d(5\%)$
r = 0	132.34	131.70	128.14	124.24
r = 1	74.04	102.14	71.43	94.15
r = 2	47.71	76.07	45.12	68.52
r = 3	32.10	53.12	30.25	47.21
r = 4	18.79	34.91	17.32	29.68
r = 5	8.09	19.96	7.87	15.41
r = 6	2.48	9.24	2.26	3.76

a. r is the number of cointegrating vectors

b. T is the trace test statistics

c. C is the trace test critical value

Table 3. Test of hypothesis $H_2 = R'\beta = 0$ in seven markets

Hypothesis	χ^2 test statistics	Degrees of Freedom	Result[a]
Exclusion of a market in the long-run relations			
H_2: $\beta_{11} = 0$	26.09	1	R
H_2: $\beta_{12} = 0$	9.85	1	R
H_2: $\beta_{13} = 0$	23.14	1	R
H_2: $\beta_{14} = 0$	21.13	1	R
H_2: $\beta_{15} = 0$	0.65	1	F
H_2: $\beta_{16} = 0$	0.27	1	F
H_2: $\beta_{17} = 0$	1.47	1	F
H_2: $\beta_{15} = \beta_{16} = \beta_{17} = 0$	2.21	3	F

a. "R" denotes rejection of the null hypothesis an "F" failure to reject the null hypothesis at 0.05 level of significance.

Table 4. Test of hypothesis $H_2 = R'\beta = 0$ and $H_3 = \beta'\alpha = 0$ in four markets

Hypothesis	χ^2 test statistics	Degrees of Freedom	Result[a]
Price Homogeneity			
$H_2 : \beta_{11} = -\beta_{12}$	1.96	1	F
$H_2 : \beta_{13} = -\beta_{14}$	0.20	1	F
Weak exogeneity of adjustment coefficients (with unrestricted β)			
$H_3 : {}_{11} = 0$	0.37	1	F
$H_3 : {}_{12} = 0$	19.29	1	R
$H_3 : {}_{13} = 0$	13.94	1	R
$H_3 : {}_{14} = 0$	1.88	1	F
$H_3 : {}_{11} = {}_{14} = 0$	1.99	2	F

[a] "R" denotes rejection of the null hypothesis an "F" failure to reject the null hypothesis at 0.05 level of significance.