Price Relationships in the U.S. Fiber Markets: Its Implications for Cotton Industry

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Abstract

The paper examined the price relationship between cotton and polyester. The results provide strong evidence of long term price transmissions and granger causality between cotton and polyester price as well as the asymmetry transmissions for cotton on cotton, cotton on polyester, and polyester on polyester price. However, we did not find any evidence that there exists asymmetry transmission for polyester price on cotton price. Our results also did not support the contemporaneous effects hypothesis between polyester price and cotton price.

Introduction

Cotton and manmade fibers are two most important textile fibers in the U.S. and collectively account for more than 95 percent of total U.S. fiber consumption (USDA, 2002). Although per capita fiber consumption in the U.S. has generally risen over times, changes in demand for specific fibers such as cotton and manmade fibers are normally dictated by changes in fashion trend, product acceptance and relative prices. For example, cotton accounted for 60 percent of total fiber demand in early 60s and over the next year, its share was cut in half due to popularity of manmade fibers. However, since early 80s, demand for cotton reversed its downward trend with per capita consumption rising from 20 pounds in 1982 to 35.8 pounds in 2000 (USDA, 2001). In an attempt to shed light on factors affecting cotton consumption, Meyer (1999) found significant negative relationship between cotton consumption and the price ratio (cotton over polyester price). The price ratio captures the competitiveness of cotton with respect to polyester, i.e., if polyester is relatively lower priced then fiber substitution may occur and less cotton is likely to be consumed. Similarly, Fang et al. (2001) also found negative relationship between cotton consumption and man-made fiber price in China while examining the factors responsible for the decline in cotton share in fiber consumption.

Since fiber demand is dictated to some extent by relative prices, it is extremely important to examine price dynamics in the fiber markets. Literature review reveals that empirical studies dealing with price dynamics in the US fiber markets are currently limited. However, in crops such as wheat, market structure, price leadership, and efficiency of government interventions among others have been addressed in the context of international market (Goodwin and Schroeder 1991). In the context of cotton, producer spot prices of cotton from the Southwest region were compared to futures prices for cotton to examine the cash/futures price relationship using a cointegration approach. The results showed that the cash producer price and the futures prices were not consistently related. The futures and cash prices were cointegrated in 2 of 4 years, while not cointegrated in the other two years (Hudson et al 1996).

The purpose of this study is to analyze fiber price relationships, i.e., whether the changes in one fiber price is reflected by the change in the other fiber price and if so, the length of time necessary for this to occur. In addition, it will also be useful to determine whether price responses are symmetric or not. Symmetric means a shock to one fiber price of a given magnitude would elicit the same response in the other fiber market, whether a shock reflected a price increase or a price decrease. However, asymmetric price response is said to occur, for example, when manmade fiber price changes differ for decreases or increases in the cotton price. Because of the structure of the fiber market, it is not unreasonable to suspect that the response to price changes might be different depending on the direction of the change.

The third question is to distinguish between short-run and long-run asymmetry of price transmission. This relates the amount of time required for a price change at one level to be reflected in a price change at another level. Researchers have recognized that there may be delays in the process of price transmission. Long-run asymmetry addresses the question whether manmade fiber prices respond similarly to cotton price increases and decreases after a certain period of time or vice-versa. It is possible for prices to be asymmetric in the short-run (e.g., the response to change differs for increases and decreases in a given month), but symmetric in the long run (e.g., after a certain amount of time, the response to increases and decreases overall is the same).

The remainder of the paper is organized as follows. First, a brief summary of the model is discussed. Next, collection of data and some important issues associated with the data are discussed. Following this, the asymmetry model is estimated. Finally the results are discussed and implications of the results for cotton industry are discussed

Model Specification

Past studies addressing price asymmetric question have focused on industries such as meat (Bailey and Brorsen, 1989; Boyd and Brorsen, 1988; Hahn, Schroeder, 1990; Schroeter and Hayenga, 1987; Miller and Hayenga, 2001), fresh vegetables (Ward, 1982), dairy (Kinnucan and Forker, 1987), broiler (Bernard and Willett, 1996), butter (Chavas and Mehta, 2002) petroleum (Balke, Brown, and Yucel, 1998). Most of these studies have focused on examining asymmetry in prices at different levels such as retail, wholesale and producer markets rather than between two related markets. In this study, we examine relationships between U.S. cotton and man-made fiber prices using the methodology built on the efforts noted above.

Following Chavas-Mehta (2002), let $y_t=(y_{1t},y_{2t})$ be a vector of cotton and polyester price at time t, the error correction model of vector autoregression (VAR) can be represented as

$$\Delta y_t = \alpha + B_0 y_{t-1} + \alpha_1 T + \sum_{s=1}^{S-1} \alpha_s D_{ts} + \sum_{k=1}^{K-1} B_k \Delta y_{t-k} + e_t \qquad (1)$$

where $y_t=(y_{1t},y_{2t})$ be a vector of cotton and polyester price at time t. A time trend T and seasonal dummies D_{ts} are included in the model so that the long term price trends and season effects are captured.

To analyze the asymmetric response in the model, the equation (1) is modified and the positive and negative changes of cotton and polyester prices are included. At time *t,* let $\Delta y^{+}_{t-j} = \max(\Delta y_{j,t-j},0)$ and $\Delta y^{-}_{t-j} = \min(\Delta y_{j,t-j},0)$

$$\Delta y_{it} = \alpha_{i0} + \alpha_{i1} t + \sum_{j=1}^{m} B_0 y_{j,t-1} + \sum_{l=1}^{L-1} \alpha_{il} D_{tl} + \sum_{k=1}^{K} \sum_{j=1}^{m} [B^{+}_{kij} \Delta y^{+}_{j,t-k} + B^{-}_{kij} \Delta y^{-}_{j,t-k}] + e_t \text{ , (2)}$$

where i=cotton and man-made fibers

Next consider the Cholesky decomposition of the variance of e_t: $\Omega = SS'$, where

$\mathbf{S} = \begin{bmatrix} s_{11} & 0 \\ s_{21} & s_{22} \end{bmatrix}$ is a lower triangular matrix satisfying $S_{ii} > 0$.

The equation (2) can be alternatively written as:

$$\mathbf{S^{-1}} \begin{bmatrix} \Delta y_{t1} \\ \Delta y_{t2} \end{bmatrix} = \mathbf{S^{-1}} \alpha + \mathbf{S^{-1}} \alpha_1 t + \mathbf{S^{-1}} \mathbf{B_0} y_{t-1} + \sum_{\mathbf{l=1}}^{L\mathbf{-1}} \mathbf{S^{-1}} \alpha_l D_{tl} + \sum_{\mathbf{k=1}}^{\mathbf{K-1}} \mathbf{S^{-1}} [B^{+}_{k} \Delta y^{+}_{t-k} + B^{-}_{k} \Delta y^{-}_{t-k}] + \varepsilon_t$$

(3)

where $\varepsilon_t = S^{-1} e_t$ is normally distributed with mean zero and variance I_2. The covariance between cotton price and polyester price is $\text{cov}(y_{1t}, y_{2t}) = s_{11} s_{21}$ and the contemporaneous impact of a shock in y_{2t} on y_{1t} is $\frac{\partial y_{1t}}{\partial y_{2t}} = \frac{s_{21}}{s_{11}}$. The null hypothesis of $s_{12}=0$ is used to test whether there are contemporaneous cross-price effects between cotton and polyester.

To test whether price respond asymmetrically to price increases versus price decreases, we only need to test whether $\mathbf{B}^{+} = \mathbf{B}^{-}$. The lags in the equation can be used to capture the shocks after k lag, which allows for dynamic asymmetry to vary between the short run and the intermediate run. A likelihood ratio test is used.

Under cointegration, the model captures deviations from long-term relationships among prices. If $\mathbf{B_0}=0$, the model is the same as the Miller-Hayenga (2001) specification of time domain model. A Johnson cointegration test for the null hypothesis H_0: rank($\mathbf{B_0}$)=0 versus H_1: rank($\mathbf{B_0}$)=1 is calculated by a likelihood ratio test.

The Granger causality between cotton price and polyester price is easy to test based on the model. The null hypothesis of no causality between y_c and y_p is the same as B_{0ij}=0, $B^+_{kij} = B^-_{kij} = 0$ for all k=1,2,…,K-1. The associated likelihood-ratio test also can be used to do the test.

The S_{21} allows for situation-specific contemporaneous cross-price effects. If S_{21}=0, the result implies zero contemporaneous effects between cotton price and polyester price.

Data and Estimation Procedure

The data used in this analysis are monthly prices for the period from January 1975 to December 2002. The specific price series for cotton is national mill-delivered price and polyester price is used as a representative for man-made fibers. These prices are collected from National Cotton Council. The standard error of monthly changes in average cotton price and polyester price are 10.29 and 11.36, respectively.

First, some diagnostic tests were conducted on both cotton and polyester prices. The augmented Dickey-Fuller (ADF) test for a unit root was implemented for each price separately with a drift component and time trend. This was done based on a model with 6 lags in prices themselves and 5 lags in price differences. The lag structure was determined using the Aikaike information criterion (AIC). Based on ADF test statistics, unit roots cannot be rejected for both the price series in level at the 5 percent significance level. However, the unit root hypothesis is rejected for both the series when they are expressed as first differences at the same significance level. Because determination of the lag order using statistical tests alone has been criticized, the ADF test is conducted using different lag orders. These alternative representations did not alter the results discussed above. Overall, it is reasonable to conclude that price series are integrated of order one or I (1). The results also can be verified in figure 2.

Having confirmed that the price series are first differenced stationary, we proceed with the cointegration tests using Johansen's maximum likelihood procedure based on the error correction representation.

In the next step, seasonality of price series is checked by regressing the prices on both monthly and quarterly dummy variables. Quarterly dummies are found to be statistically significant in both cotton prices and polyester prices. This provides evidence seasonality in price series.

Empirical Results

The error correction specification (equation 3) was estimated using the maximum likelihood estimation and the results are given in Table 1. Based on the AIC criterion, the number of lags was chosen to be 5. The coefficients (α_{is}) of the quarterly seasonally dummies D_{st} show there exist seasonality in both cotton price and polyester prices. The negative and significant of time trend in the cotton price equation and insignificant with the same sign of polyester price reflected that the spread between these two prices has decreased over time. The negative of lagged own (both cotton and polyester) price and positive of substituted lagged price on cotton price indicated the presence of significant dynamic adjustments in the fiber market.

The significant Johansen cointergration test (with statistic 11740.69) combined with the earlier Augmented Dickey Fuller test show that cotton and polyester prices are strongly cointegrated, which implies that they exhibit strong long-term relationships.

The likelihood ratio test for Granger causality is -101.03 for the effects of lagged cotton on polyester prices, and -326.03 for the effects of polyester price on cotton prices. The associated test is –93.30 for lagged own cotton price effects, and is –326.03 for lagged own polyester price. At the 10 percent significance level and with 5 degree of freedom, the critical value is 9.24. We therefore strongly reject the null hypothesis of no causality and no own lagged effects.

Table 2 is the likelihood ratio test statistics for symmetry of lagged cotton and polyester prices. Based on a chi square distribution with 4 degree of freedom, at the 10 percent significant level, the critical value is 7.78. The results provide evidence that a positive cotton price shock and a negative cotton price shock generate the different effects on both cotton and polyester price; however, a positive polyester price shock and a negative polyester price shock generate strong different effects on polyester price itself but the asymmetry in cotton price response on polyester price tends to be weak.

The insignificant correlation coefficient between the disturbances in the equations indicates that random error in the cotton price equation is uncorrelated with polyester price. The results implied that there is no contemporaneous cross price effects between cotton and polyester prices.

Concluding Remarks

The paper applied Chavas-Mehta model to polyester and cotton price dynamics in the US fiber market, the results provide strong evidence of long term price transmissions and granger causality between cotton and polyester price as well as the asymmetry transmissions for cotton on cotton, cotton on polyester, and polyester on polyester price. However, we did not find any evidence that there exists asymmetry transmission for polyester price on cotton price. Our results also did not support the contemporaneous effects hypothesis between polyester price and cotton price.

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Table 1 Maximum Likelihood Estimation

	Cotton Price		Polyester Price	
Parameters	Estimate	Std. Error	Estimate	Std. Error
Constant	3.9594**	1.7468	1.0834*	0.5508
Trend	-0.0054*	0.0028	-0.0007	0.0009
Dummy for First Quarter	0.3234	0.7547	0.5210**	0.2372
Dummy for Second Quarter	0.5009	0.7481	0.3184	0.2393
Dummy for Third Quarter	-1.5110*	0.7563	0.1766	0.2392
lag of cotton price	-0.1327**	0.0274	0.0053	0.0088
lag of polyester price	0.0856**	0.0307	-0.0220**	0.0098
Positive Cotton Price shock after lag 1	0.2442**	0.1176	0.0439	0.0374
Positive Cotton Price shock after lag 2	0.1570	0.1233	-0.0081	0.0444
Positive Cotton Price shock after lag 3	0.2041*	0.1217	0.0063	0.0387
Positive Cotton Price shock after lag 4	-0.0497	0.1246	0.0128	0.0430
Negative Cotton Price shock after lag 1	0.0430	0.0778	-0.0232	0.0245
Negative Cotton Price shock after lag 2	-0.0600	0.0785	0.0395*	0.0246
Negative Cotton Price shock after lag 3	0.0386	0.0764	0.0006	0.0244
Negative Cotton Price shock after lag 4	0.0423	0.0755	0.0026	0.0256
Positive Polyester Price shock after lag 1	0.0863	0.2331	0.0347	0.0728
Positive Polyester Price shock after lag 2	-0.1564	0.2220	0.0088	0.0639
Positive Polyester Price shock after lag 3	-0.1100	0.2188	0.0159	0.0741
Positive Polyester Price shock after lag 4	0.1365	0.2248	0.2227**	0.0703
Negative Polyester Price shock after lag 1	0.3129	0.3021	0.2950**	0.0948
Negative Polyester Price shock after lag 2	0.0536	0.2710	0.0805	0.0785
Negative Polyester Price shock after lag 3	0.0841	0.2472	0.0671	0.0772
Negative Polyester Price shock after lag 4	0.032	0.2093	0.1390*	0.0764
Variance of Cotton Equation	4.5966**	0.1781		
Variance of polyester Equation	1.4474**	0.0561		
Covariance	0.0305	0.0539		

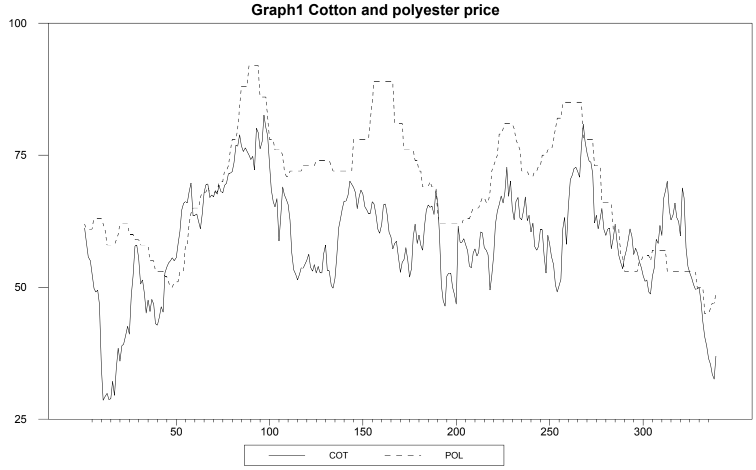
Log-likehood=-963.91; Number of Observations = 334.

** means |t|-value greater than 2; * ** means |t|-value greater than 1.6.

Table 2 Likelihood Ratio Test for the Asymmetry Transmission

Effect	Cause	Statistics
Cotton	Cotton	8.62
Cotton	Polyester	-1.20
Polyester	Cotton	-104.67
Polyester	Polyester	-104.67

Graph1 Cotton and polyester price



Graph2 Frist Difference of Cotton and polyester price