AN EMPIRICAL STUDY OF U.S. COTTON PRICE IN RESPONSE TO MARKET SHOCKS

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Abstract

The objective of this study was to investigate effects of macroeconomic and oil price shocks on the price of cotton using data from 1975 to 2009. Using a vector error correction model (VECM) and an empirical price model were used to analyze the effects of these factors. Results illustrate the response of cotton price to the stock-to-use ratio, production, and exports. This paper also explains the co-movement of cotton price with oil price, exchange rates, and other factors.

Introduction

Cotton is one of the most important field crops in the world, and cotton plays a major role in the U.S. agriculture. As sources of income to farmers, cotton and cottonseed still account for over 8% of total crop cash receipts. The U.S. ranks third in world cotton production, accounting for roughly 15% of world production. Domestic mill use of fiber in the U.S is only 3.2% of its total production, but the U.S accounted for more than 37.9% of cotton exports. Such major cotton producers as China, India, and Pakistan also import of cotton to meet the needs of their yarn, fabric, and textile manufacturing industries. As a major importer of cotton fiber, China became the largest producer of cotton, accounting for over 30% of world production. However, China still imports 10.9 million bales of cotton. Thus, the price of cotton in international trade would affect the incentive of cotton production in the U.S. On the supply side, beginning stocks and production are major determinants of cotton price. U.S. cotton imports have less impact on the domestic price. However, on the demand side, industrial use is a growing component of demand, strengthening farm-level prices. The production capability of major importers depends on government incentives and policies, agricultural technology including biotechnology, production by-product prices, and prices of artificial fiber substitutes.

Cotton has a long history as the main input for clothing. However, the emergence of “fossil” fibers has been widely applied since the World War II. A new category of synthetic fiber became a substitute for natural fiber (plant-origin and animal-origin). As a result, cotton’s share in total fiber consumption fell significantly. Furthermore, the world cotton price is affected by macroeconomic shocks and shifts in the oil market. The price of artificial fibers declined sharply, taking advantage of new developed technology in chemical fiber industry. Cotton and polyester together account for about two thirds of global fiber consumption.

Unlike other agricultural commodities, there has been limited progress in cotton price modeling in the past decades. The removal of the ban on cotton price forecasting by USDA in the 2008 Farm Bill has stimulated research to update existing cotton price forecasting approaches and to develop new empirical pricing models. The instruments of forecast for agricultural price are important to both private and public policymakers, as well as producers and consumers of cotton. In this paper, we analyze the effects of various factors underlying price determination in the cotton market.

Data and Methods

This study concentrates on the marketing-year average U.S. farm price of upland cotton, over 1975-2009. Historical data on fiber prices of commodities, such as cotton fiber, polyester, rayon, and synthetic fiber are collected from the USDA’s National Agricultural Statistics Service databases and maintained by the National Cotton Council of America. Data from the Commodity Credit Corporation is maintained by the USDA. The data on nominal effective exchange rate ($/¥) and the producer index are obtained from the database of Federal Bank of St. Louis, and the real effective exchange rate as REER=EX_t-PPI_t was converted by (Natural Log of) nominal effective exchange (EX_t) and (Log of) U.S. PPI (PPT_t). The oil price from the West Texas Intermediate is applied in this study. Data on production, stock-to use, mill use, export, and import are from USDA's FSA database. Table 1 shows descriptive statistics for the macroeconomic and commodity variables. In Table 1, oil price has the highest volatility among all variables as evident by the standard deviation. This result is consistent with earlier research on commodities (Hammoudeh *et al*. 2009; Kyongwook *et al*., 2010). The mean of log-differenced cotton price is 0.001263, the minimum was -0.273154, and the maximum was 0.232834.

Results and Discussions

Domestic Use and Exports of U.S. Cotton

Figure 1 shows the market shift in deliveries from domestic to foreign market. The United States was itself a larger user of its own cotton, but the exports have risen rapidly since the expansion of textile manufactures in the overseas market in the last decade. Overseas manufacturing promotes the increase of export the raw cotton fiber, and import the intermediate or final by-product that have higher comparative advantage than goods produced in U.S. The tariff barrier in U.S. discourages domestic manufacturers from importing lower-priced world cotton. This is intended to protect U.S. cotton producer from foreign competition.

Table 1. Descriptive of nominal price variables

Variables	Mean	Minimum	Maximum	Standard Deviation	Skewness	Kurtosis
Oil	29.9580	11.1600	133.930	20.2197	2.28751	6.22656
Cotton	57.1336	26.7000	82.6000	10.7029	-0.32405	-0.03459
Polyester	68.2814	45.0000	92.0000	10.6811	0.08821	-0.64465
Synthetic fiber	99.9599	61.7000	122.100	14.1280	-1.35476	0.98227

Kurtosis and skewness give additional information on the "shape" of a probability distribution. Kurtosis with a value lower than 3, indicates distribution with fat or short tails. A value greater than 3 indicates distributions with slim or long tails. For a normal distribution, the kurtosis equals 3. For a normally distributed variable skewness equals 0. If it is less than 0, the distribution is left skewed. If it is more than 0, it is right skewed.

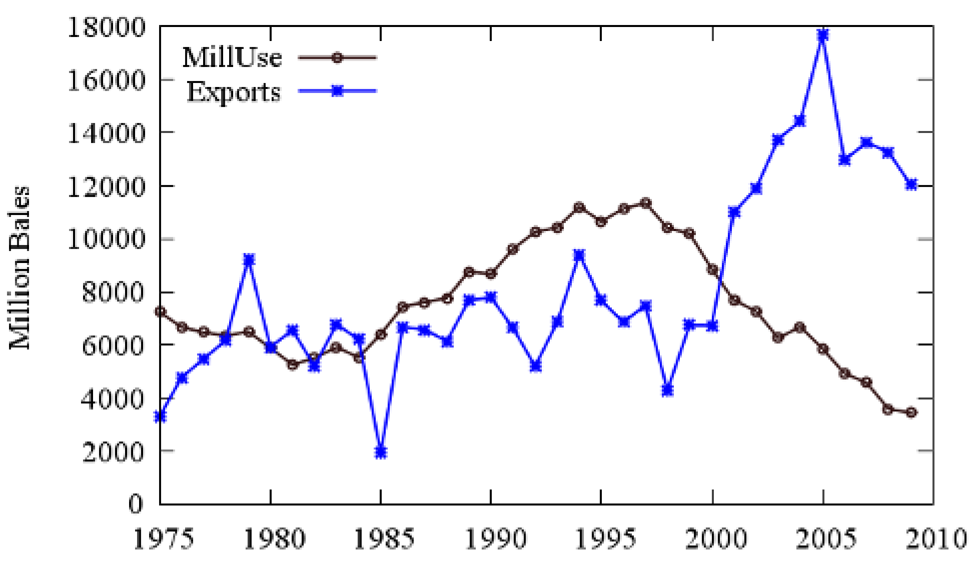

Figure 1. Domestic Mill Use and Export of U.S. cotton

Stock-to-Use ratio and U.S. Cotton Price

The basic model relates stock-to-use ratios to the price. The Stock-to-Use variable in the upland stock-to-use ratio for a given year, and is reported as a percentage. This variable indicates the tightness of U.S. supplies relative to demand. The Figure 2 shows a historical plot of U.S. farm price for upland cotton and the stock-to-use ratios for the 1975 through 2009 marketing years. As the stock-to-use ratio changes, the effect on price is expected to be in the opposite direction. As the production for export, the level of stock-to-use ratio in U.S. sustained at the relative lower level in the last decade (Figure 2).

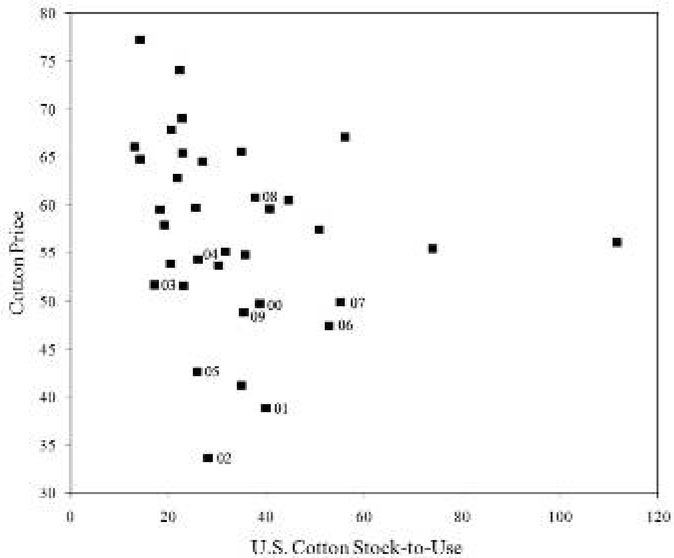

Figure 2. Price and Stock-to-Use of U.S. cotton

<u>Analysis of Impulse Response</u>

Figure 3 reports the accumulated response of cotton price with production, export, and indicator of exchange volatility. The figures also include one standard error for each response, generated by a VECM impulse model. Domestic mill use of cotton has less impact on cotton production and price. Cotton production responds positively to the expectation of future of exportation. On the other hand, increased cotton cotton would promote international cotton trade. A higher stock-to-use rate slows the the expansion of production. The nominal U.S. dollar depreciates in response to the real exchange rate shock, which shows negative preferential shocks to U.S. production. The depreciation of the U.S. dollar reflects an upward shift of foreign aggregate demand and domestic production. The price response to the currency shock is significant in the short run, but this response fades in the long run.

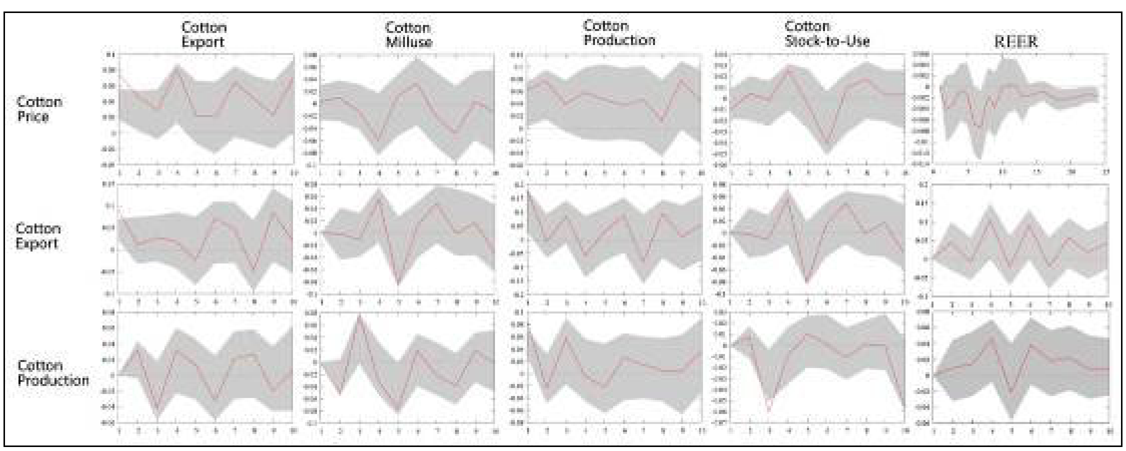

Figure 3. Impulse response of aggregate variables to the aggregate shocks (1975-2009).Implication of VECM with Bootstrap confidence (α=95%).Red solid curve show actual response, shade curve show one standard error for each shock (Lags=4).

Figure 4 reports the accumulated responses which are price responses of cotton fiber to own and fuel commodities shocks. The cotton price is not significantly affected by its own shock in the long run, but the response to an oil price rise are significatnt in the short and long run. All analyzed fuel-fiber commodities show positive responses to oil shocks, implying oil shocks can move the fuel fiber product price up.

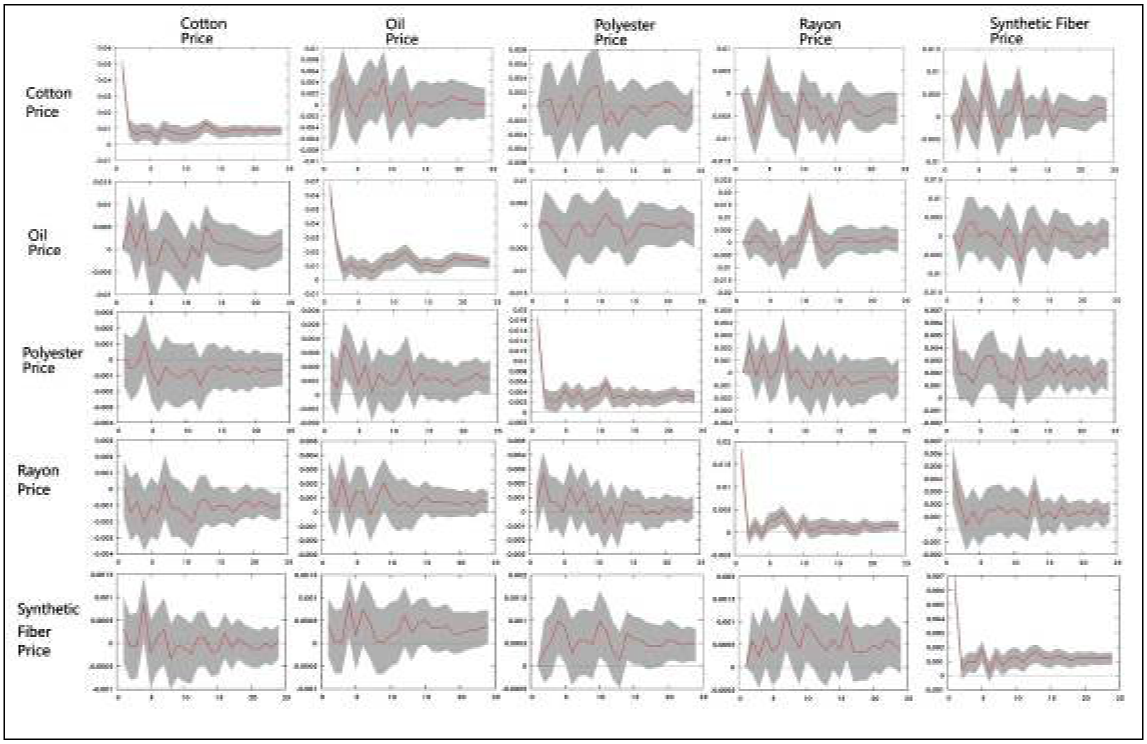

Figure 4. Impulse responses of variables to the price shock (1975 -2009). Implication of VECM with Bootstrap confidence (α=95%).Red solid curve show actual response, shade curve show one standard error for each shock (Lags=12).

Empirical Analysis of Cotton Price Model

The model presented follows a general equilibrium model (Leslie *et al*., 1998; Westcott *et al*., 1999). In this simple form, the government subsidy programs and policy effects are excluded from the model. Factors are a function of cotton price. These variables shift the cotton price determination function up or down to reflect the relationships and effects of these factors. The volalitity of the cotton price was treated as the implicit function:

$$P^{cot} = f\,(S/U,\ CCC,\ Index,\ REER^{CN},\ Export,\ P^{com},\ \varepsilon) \qquad (1)$$

The cotton farm price model was estimated using ordinary least squares regression, using annual data for marketing years 1975 through 2009. All tested variables are log-differenced. The estimated regression equation is:

$$P_t^{cot} - P_{t-1}^{cot} = \beta_0 + \beta_1(S/U_t^{cot} - S/U_{t-1}^{cot}) + \beta_2(P_t^{oil} - P_{t-1}^{oil}) + \beta_3(P_t^{pol} - P_{t-1}^{pol}) + \beta_4(Index_t - Index_{t-1}) + \beta_5(EX_t^{US} - EX_{t-1}^{US}) + \beta_6(CCC_t - CCC_{t-1}) + \beta_7(REER_t^{CN} - REER_{t-1}^{CN}) + \epsilon \qquad (2)$$

Table 2 presents ordinary least squares estimation of cotton price model (Equation 2) over 1975-2009. The estimated model explains over 79.4% of the variation in the U.S. cotton price. The impact of the oil price is statistically significant. The stock-to-use variable has a negative, significant effect on the cotton price. The index changes have approximately a one-to-one promotion effect on price. Figure 5 illustrates the model's goodness of fit.

Table 2. OLS Estimation of Cotton Price Model

Variable	Coefficient	*Std. Error*	t-Statistic	Probability
Intercept	0.0817	0.1334	0.6126	0.5459
Stock-to-Use	-0.1002	0.0480	-2.0880	0.0476
Oil Price	0.2022	0.0884	2.2877	0.0312
Polyester Price	0.2776	0.2219	1.2504	0.2232
Index	0.7289	0.1338	5.4477	0.0000
$Export^{US}$	0.0397	0.0683	-0.5812	0.5665
CCC	-0.0415	0.0443	-0.9353	0.3589
$REER^{CN}$	0.0674	0.0944	0.7147	0.4817
R-squared	0.7940			
Adjusted R-squared	0.7339			
S.E. of Regression		0.0994		
Sum squared residual	0.2372			
Log-likelihood	33.0672			
F-Value	13.2146			
Durbin-Watson	25.6262			
Chow Test	2.5518			

Conclusion

This paper analyzed the effects of various shocks including production, export, exchange rate, and fuel commodity shocks on the price of cotton. Results illustrate the importance of the stock-to-use ratio on cotton price determination, consistent with the earlier research. The decrease in domestic mill use and barriers to cotton imports creates incentives for production for export. This paper explored the role of oil shocks and fuel commodity shocks as important determinants of cotton price. Oil price shocks could raise cotton prices in both the short and long run. Exchange rate shocks appear important in the short run, but are not significant in the long run.

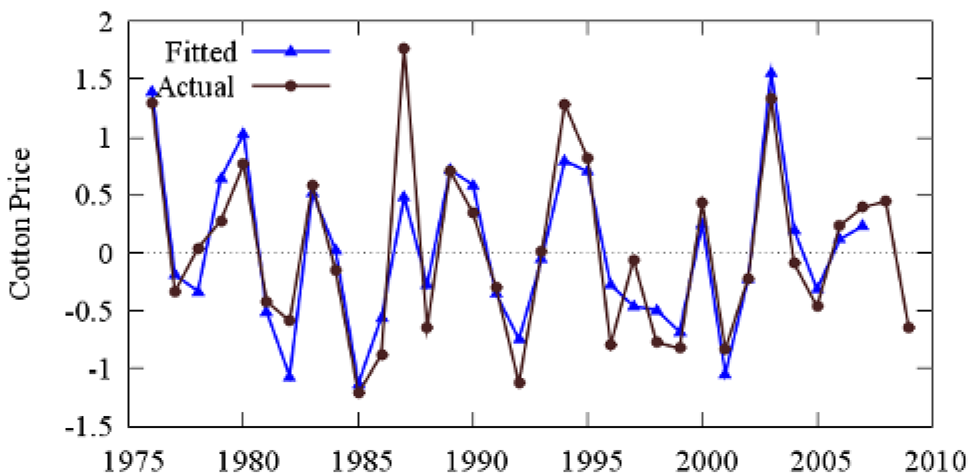

Figure 5. Actual and Fitted estimation of U.S. cotton price 1975-2009

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