COTTON FUTURES PRICE VARIABILITY: THE ROLE OF CHINA'S COTTON INVENTORY POLICY

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Abstract

This article empirically examines the determinants of cotton futures prices variability, with a special focus on the cotton inventory policy of China. Maximum likelihood techniques are used to estimate the ARCH and GARCH models for price variability. Estimation results show that variability of cotton futures prices significantly increases with the ratio of world stocks to use. In recent years, the world stocks to use ratio of cotton has increased substantially mainly due to China's cotton stockpiling policy. Thus, China's cotton inventory policy adds to cotton futures price risks. The ratio of trading volume to open interests and speculative activity in the cotton futures market are not found to be significant in determining futures price variability.

Introduction

The variability of cotton futures prices has substantially increased since the 2008 global financial crisis. Understanding the role of China's cotton inventory policy in affecting cotton price variability has recently become an issue of considerable importance to policy makers, producers, commodity traders, and researchers. Price variability is explained in two dimensions, namely intra-season and inter-season variability. Different factors are likely to be associated with intra-season and inter-season variability. Inter-season variability is often influenced by long-run movements in supply and demand variables as well as policy changes. Intra-season variability pertains to price movements within the growing season as new information regarding expected production, inventory, and demand variables reaches the market. This article empirically examines the determinants of intra-season and inter-season variability in cotton futures prices, with a special focus on the cotton inventory policy of China.

China, the world's largest cotton growing country, currently holds more than half of the World's cotton stocks. As the 2008 global financial crisis substantially reduced China's export demand for cotton and yarn, the government of China designed and implemented a price support policy for subsidizing domestic cotton farmers. Under this policy, the government purchased domestically produced cotton at above world market prices. The policy continued even after the financial crisis ended. The government purchased 3.12, 5.83, and 5.50 million metric tons of cotton from its harvests of 2011, 2012, and 2013, respectively.

While some participants in the global cotton industry fear that China has certain deeper motives to manipulate the global market using the massive reserve, continued stockpiling of cotton by China suggests a continuation of market distortion. Even if the objective of China's cotton price support policy is only providing security of domestic farmers and fostering rural development as the government claims, the stockpiling has made domestic cotton prices in China higher than the world prices. Imports of raw cotton and yarn into China have been above average in recent years, while exports of cotton from China have been below average. It is reasonable to assume that the world prices of cotton would be much lower without the artificially tightened world supply. We address the question of whether and how China's stockpiling policy affected price variability in the U. S. futures markets for cotton.

Previous research has identified four types of shocks relevant to the determination of prices of storable commodities (Janzen, Smith, and Carter, 2012; Goodwin and Schnepf, 2000). These are shocks to real economic activity (flow demand), net current production (flow supply), external market price changes (co-movement), and rational speculation (inventory demand). We evaluate the relative contribution of such shocks to the variability of cotton futures prices. Previous research and anecdotal evidence have also demonstrated that price variability is time-varying. Therefore, we also evaluate autoregressive relationships in price variance terms.

The Empirical Model

Following Goodwin and Schnepf (2000) we adopt the basic model for cotton price variability of the following form:

$$\ln(p_t/p_{t-1}) = \alpha + X_t\beta + e_t, \tag{1}$$

where p_t is the price of cotton in time t, X_t is a vector of explanatory variables, and e_t is a random disturbance term. We assume that prices are log-normally distributed, and the disturbance term in equation (1) is normally distributed with a variance of σ_t^2. The variance of e_t may be influenced by exogenous factors, such as:

$$E(e_t^2) = Var(e_t) = \sigma_t^2 = f(Z_t\gamma), \tag{2}$$

where Z_t is a vector of determinants of conditional price variability.

An extensive literature has recognized that conditional terms often exhibit autocorrelation. A large class of autoregressive conditional heteroscedasticity (ARCH) and generalized autoregressive conditional heteroscedasticity (GARCH) models have been developed. The ARCH model introduced by Engle (1982) is given by:

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{k} \alpha_i e_{t-i}^2 + Z_t\gamma. \tag{3}$$

Bollerslev (1986) generalized and extended the ARCH process including the lags of the variance terms:

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{k} \alpha_i e_{t-i}^2 + \sum_{i=1}^{k} \delta_i \sigma_{t-i}^2 + Z_t\gamma. \tag{4}$$

Estimation of the ARCH and GARCH models is usually accomplished by assuming a parametric distribution for the dependent variable and maximizing the appropriate likelihood function using the sample of data.

Data

We investigate the variability of Intercontinental Exchange cotton futures Wednesday settlement prices observed between August 1999 and July 2010. Nearby cotton futures prices, volume, and open interest data for cotton are obtained from the Commodity Research Bureau (CRB) database. Monthly data on cotton use and stocks in the United States and the world (including China) are obtained from the United States Department of Agriculture (USDA). Weekly cotton stocks and uses are interpolated using the monthly data. Weekly averages of the ratio of volume to open interest are used to represent scalping and day trading. Following Streeter and Tomek (1992), we construct a speculation index. The speculation index is given by the ratio of speculative short positions to total hedges when the short hedge volume exceeded the long hedge volume and the ratio of speculative long positions to total hedges when the long hedge position exceeded the short hedge position. Table 1 provides the summary statistics of the variables used in the ARCH and GARCH models.

Table 1. Summary statistics of the variables

Variables	Observations	Mean	Standard Deviation
Cotton Futures Price, $\ln(p_t)$	569	4.624	0.279
Return, $\ln(p_t/p_{t-1})$	569	−0.001	0.021
US Stocks/Use	569	33.937	9.443
Foreign Stocks/Use	569	40.402	4.885
World Stocks/Use	569	42.230	5.502
Speculation Index	569	0.506	2.287
Volume/Open Interest	495	0.273	0.333

Source: Commodity Research Bureau (CRB) database of futures prices, and USDA.

Figure 1 depicts foreign and world stocks to use ratios for cotton during 1999-2010. A strong correlation is evident from these time series plots. Note that both the foreign and world stocks to use ratios for cotton substantially increased and reached the highest levels during 2008-10. This is mainly because of stockpiling of cotton by China. Figure 2 shows the time series plot of the first differences of natural logarithm of Wednesday closing prices. It is evident from figure 1 that cotton futures price variability substantially increased during 2008-10.
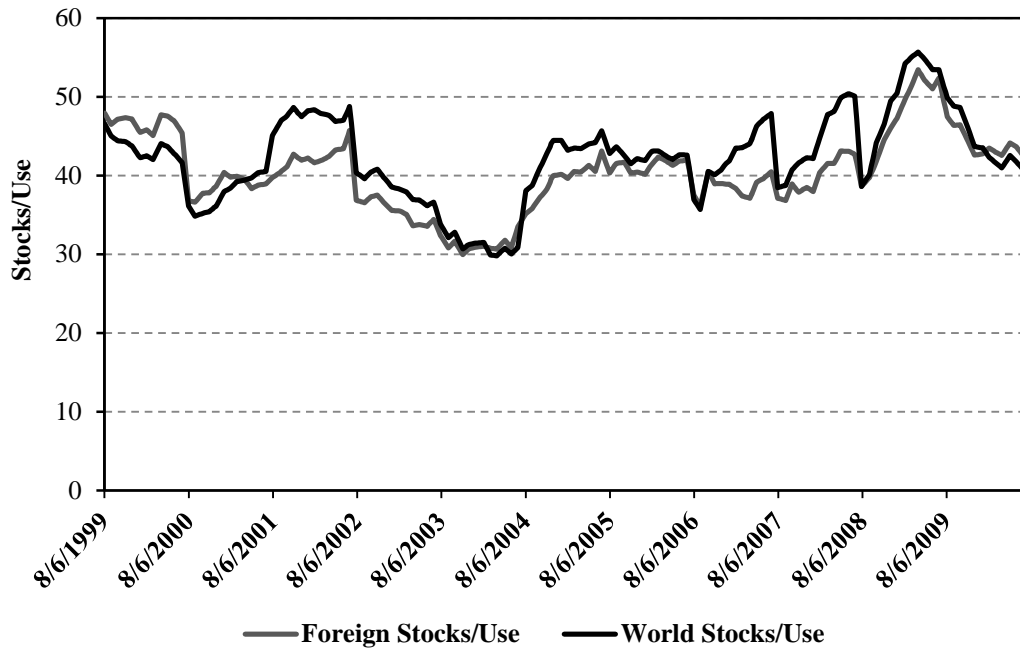
Figure 1. World and foreign (excluding the US) stocks to use ratios of cotton.
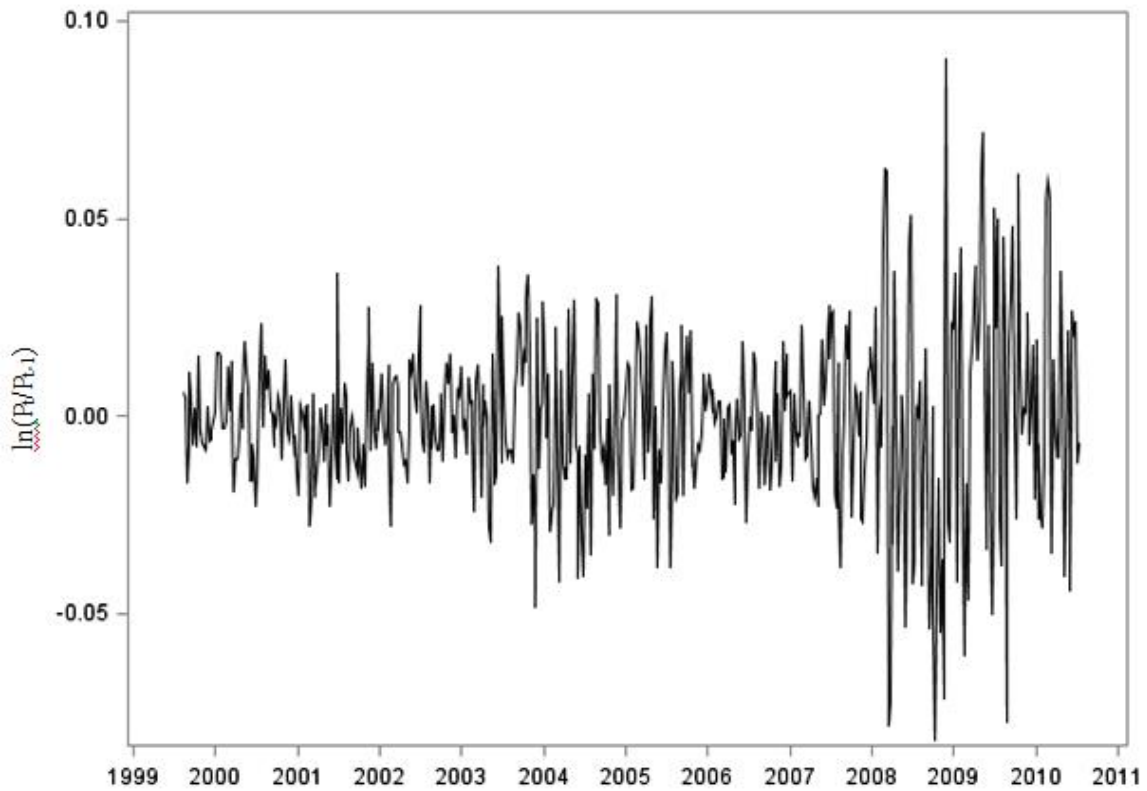

Figure 2. Time series plot of the first differences of the natural logarithms of cotton futures prices
(Wednesday closing prices of nearby contracts in Intercontinental exchange)

Estimation Results

We start our empirical analysis with an ordinary least squares (OLS) estimate of the model; $\ln(p_t/p_{t-1})$ is regressed on the world stocks to use ratio, the ratio of volume of trade to open interest, and the speculation index. The OLS results show significant ARCH effect (results are not shown to conserve space). Therefore, we estimate the ARCH and GARCH models of cotton price variability using the same specification. Maximum likelihood techniques (under the assumption of normally distributed residuals) are used to estimate the ARCH and GARCH models. The estimation results are presented in Table 2. Results from both models show strong autoregressive effects in heteroscedasticity terms. Note that estimation with the foreign (excluding the US) stocks to use ratio, instead of world stocks to use ratio of cotton, provides similar results.

Table 2. Maximum likelihood estimates of the ARCH and GARCH models

Variable/Parameter	ARCH Model	GARCH Model
Intercept	−0.012**	−0.016**
	(0.006)	(0.008)
World Stocks/Use	0.0002*	0.0004**
	(0.006)	(0.0002)
Volume/Open Interest	0.001	−0.00002
	(0.002)	(0.003)
Speculation Index	−0.0003	−0.0004
	(0.0004)	(0.0003)
Variance		
Intercept	0.0002***	0.00001
ARCH(1)	0.296***	0.137***
ARCH(2)	0.270***	0.142**
ARCH(3)	0.103	0.054
GARCH(2)		0.648***

Note: The dependent variable for the ARCH and GARCH models is $\ln(p_t/p_{t-1})$. Asterisks, ***, **, and * indicate significance at 1%, 5%, and 10% levels, respectively.

As shown in Table 2, the ratio of world stocks to use has a strong positive influence on the variability of cotton futures prices, implying that increases in the cotton stocks to use ratio add to cotton futures price risks. Streeter and Tomek (1992) found similar relationship while examining soybeans futures price variability. Goodwin and Schnepf (2000) also found similar relationship while examining variability of corn and wheat prices. This result is of particular importance given the substantial increase in the world stocks of cotton, mainly because of the stockpiling policy of China that accounts for more than half of the world stocks of cotton. However, this calls for further investigation with time series data on cotton stocks of China.

In contrast to the results of Goodwin and Schnepf (2000) and Streeter and Tomek (1992), we do not find that the ratio of volume to open interest has a significant influence on cotton futures price variability. We also do not find that speculative activity in the cotton futures market has a significant effect on price variability. This result is in accordance with the finding of Goodwin and Schnepf (2000) for corn and wheat futures prices.

Conclusions

This article empirically examines the determinants of cotton futures price variability. Estimation results for autoregressive conditional heteroscedasticity model and generalized conditional heteroscedasticity models show that

variability of cotton futures prices significantly increases with the ratio of world stocks to use. The foreign (excluding the US) stocks to use ratio of cotton is highly correlated with the world stocks to use ratio of cotton while China accounts for a major share of the foreign stocks. In recent years, the world stocks to use ratio of cotton has increased substantially mainly due to China's cotton stockpiling policy. Thus, cotton futures price risks increased due to China's cotton inventory policy.

However, further investigation is required to analyze the effects of China's stockpiling policy on cotton futures price variability. First, estimations including and excluding China's inventory of cotton would provide a clear insight. Second, weather and other crop growing conditions are likely to influence agricultural prices. We are in the process of obtaining time series data on China's stocks of cotton and constructing a growing condition index based on the National Agricultural Statistics Service's (NASS) weekly report that describes the progress of crops in each state and on an (acreage-weighted) national basis. Third, we recognize that the model should also incorporate external market price change for examining the effects of co-movement. We would like to use cash prices for West Texas Intermediate Crude oil to capture such effects. Finally, from a technical point of view, the empirical analysis should have a second component that involves the application of nonstructural vector-autoregressive (VAR) models to market-based measures of price volatility. We intend to extend this research using a four-equation VAR system.

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