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Empirical Analysis on Price Discovery Efficiency of Cotton Futures in China

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Abstract: Futures markets are fundamentally driven by price discovery. China has the highest cotton output and consumption, so enhancing the cotton futures price discovery function promotes the sustainable and healthy growth of China's cotton sector. We used cotton futures and spot prices from 2018 to 2022 as research samples to examine the changes in cotton futures price discovery efficiency amid the Sino-US trade war and the appearance of Covid-19. Using the IS model, we observed that: (1) the cotton futures market always holds a dominating position in price discovery throughout 2018-2022, and (2) the impact of Covid-19 significantly lowered the price discovery function of the cotton futures market, which shows that: (1) the Chinese cotton futures market is not yet able to endure the impact of unexpected and large-scale health events such as Covid-19; and (2) when emergencies arise, we should respond expeditiously in order to reestablish market stability.

Keywords: Cotton futures, Futures price, Spot price, Price discovery.

1. Introduction

It is commonly considered that the objective of futures markets is to identify futures prices, which may be used to discover or anticipate the prices of commodities in the spot market using market information[1], so giving pricing references and transferring price risks to spot traders. Yet, the price discovery function of futures markets is bound by futures and spot market characteristics, and its efficiency varies over time, necessitating empirical assessment. China is the country with the highest cotton production, consumption, and import volume in the world, with a long industrial chain that has led to the establishment of numerous cotton production, processing, and sales firms. Cotton futures were introduced by the Zhengzhou Commodities Exchange in 2004, playing an increasingly vital role in reducing the danger of abnormal changes in spot prices for a significant number of cotton industry professionals.

According to a number of studies, the influence of unexpected events enhances futures' capacity for price discovery. Chatrath and Song (1998) [2] asserted that the Japanese foreign exchange futures market is more effective than the spot market at capturing information when the United States makes unexpected macroeconomic statements, hence playing a preeminent role in price discovery. In a similar vein, Yan et al. (2021) [3] discovered that the trade frictions between Canada and its major trading partners impacted the information structure of the Canadian foreign currency market, where the futures market integrated information more quickly and led the price discovery process.

Yet, others argue that the influence of unforeseen occurrences diminishes the efficacy of price discovery in futures markets. Foster (1996) [4] discovered that the 1990-1991 Gulf War accelerated the crude oil spot markets in the United States and the United Kingdom to assimilate new information, causing the spot price to lead the futures market in price discovery. Memon et al. (2022) [5] investigated the effect of the 2007-2009 global financial crisis and COVID-19 on the efficiency of the commodity futures market and discovered that the crisis event is accompanied by the herd effect, which will have a substantial impact on the commodities market's efficiency.

Some researchers discovered that during the global financial crisis, the European debt crisis, the oil price crash, and COVID-19, events had an unbalanced influence on the futures market's price discovery capability. Mensi et al. (2020) [6] discovered that COVID-19 caused the Brent crude oil (gold) futures market to become extremely efficient in an upward (downward) trend, as opposed to a downward (upward) trend prior to the outbreak of COVID-19. Several forms of futures markets are affected differently by the effects of emergencies. According to Hang and Qu (2015) [7], the impact of oil price shocks on the majority of agricultural products is asymmetric. The more the intensity of oil price increases, the better the efficiency of the natural rubber futures market, while the markets for grain, maize, soybeans, and cotton stay unchanged.

Emergencies such as the Sino-US trade war, the boycott of Xinjiang cotton, and the Covid-19 occurred frequently from 2018 to 2022, as the imposition of tariffs on agricultural products affected the import and export of cotton, clothing brands boycotted Xinjiang cotton, and the Chinese government doubled down on lockdowns and issued standstill orders in specific districts during the outbreak of the Covid-19 virus. How does the impact of the Sino-US trade war, the boycott of Xinjiang cotton, and the COVID-19 epidemic influence the price discovery efficiency of China's cotton futures market? Evaluating the price discovery efficiency of cotton futures during this period is useful for determining whether China's cotton futures market can withstand the impact of emergencies, as well as for analysing the impact mechanism of emergencies on the operation of the futures market, which provides recommendations for improving the price discovery efficiency of China's futures market.

2. Methodology

2.1. Basic content of the price discovery of futures market

Price discovery is the process of forming the transaction price, or the process by which buyers and sellers arrive at a transaction price for a particular quality and quantity of goods

at a certain time and location [8]. Owing to a lack of information and uncertainty, buyers and sellers discover prices based on uncertain assumptions, causing the transaction price to fluctuate around the market equilibrium price [9]. The essence of the price discovery function is that fresh information is initially reflected in the fluctuating futures or spot prices [10]. The process of price discovery mirrors the market's information generation and transmission [11]. This results in the dominant informational link between the futures market and the spot market. The futures market can capture and reflect new information more quickly than the spot market, creating a guiding relationship between the futures price and the spot price. Investors view commodity markets as an alternative means of diversification and risk management[5], and commodity futures markets demonstrate distinct volatility and returns compared to other financial markets, such as equities and bonds[12]. When unexpected occurrences occur, the commodity market suffers fundamental shifts that have a negative impact on the futures market's price discovery efficiency [13, 14].

2.2. Empirical approaches to price discovery

(1) Vector error correction model

The vector error correction model (VECM) is utilised to investigate the relationship between futures and spot prices in price discovery. The VECM model expression is as follows:

$$\Delta p_{c,t}^{f} = \delta_0 + \delta_1 ecm_{t-1} + \sum_{i=t-l}^{t-1} \delta_i \Delta P_{c,i}^{s} + \sum_{j=t-k}^{t-1} \delta_j \Delta P_{c,i}^{f} + \varepsilon_t^{f} \quad (1)$$

$$\Delta p_{c,t}^{s} = \beta_0 + \beta_1 ecm_{t-1} + \sum_{i=t-l}^{t-1} \beta_i \Delta P_{c,i}^{s} + \sum_{j=t-k}^{t-1} \beta_j \Delta P_{c,i}^{f} + \varepsilon_t^{s} \quad (2)$$

Where $p_{c,t}^{s}$, $p_{c,t}^{f}$ represent the spot price and futures price of cotton; Δ represents a first order difference, and l and k represent the order of delay determined using the SC criterion. δ_1, β_1 are adjustment coefficients that reflect the adjustment speed and direction of agricultural product futures prices and spot prices when they deviate from long-term equilibrium relationships. ecm_{t-1} is the error correction term that lags one period in the cointegration relationship between futures and spot prices; $(\varepsilon_t^{f}, \varepsilon_t^{s})$ is the residual term of the estimation equation, which represents the information of agricultural futures and spot markets and follows an independent identical distribution, with an expected value of 0, and a variance covariance matrix of Ω:

$$\Omega = \begin{pmatrix} \sigma_1^2 & \rho\sigma_1\sigma_2 \\ \rho\sigma_2\sigma_1 & \sigma_2^2 \end{pmatrix} \quad (3)$$

σ_1^2, σ_2^2 are the variance of ε_t^{f} and ε_t^{s} accordingly, ρ is the correlation coefficient between them.

(2) Information share model

The information share model (IS) established by Hasbrouck (1995) [15] is based on the VECM model, which can objectively evaluate the contribution of futures and spot prices to price discovery and assess the effectiveness of price discovery in futures markets. It is commonly assumed that markets contributing more than 50 percent to price discovery play a pivotal role in price discovery.

The information share model represents price discovery with the variance of the influence of new information on the common trend term between futures and spot prices. Using a Cholesky decomposition of the variance, the relative contribution of information to the difference between futures and spot markets is examined in order to determine price discovery capabilities. Since Cholesky factorization is tied to the order of variables in the VECM model, the initial market price is assigned a relatively significant information share. By rearranging the variables, it is possible to determine the lower (or upper) limit of the information share in the first market and the upper (or lower) limit of the information share in the second market. Under the evaluation of the information share model, the top and lower limits of the contribution of price discovery on the agricultural futures market and the spot market are as follows:

$$IS_1^{U} = \frac{(\beta_1\sigma_1 - \delta_1\sigma_2\rho)^2}{\beta_1^2\sigma_1^2 - 2\rho\sigma_1\sigma_2\delta_1\beta_1 + \delta_1^2\sigma_2^2}, \; IS_1^{L} = \frac{\beta_1^2\sigma_1^2(1-\rho^2)}{\beta_1^2\sigma_1^2 - 2\rho\sigma_1\sigma_2\delta_1\beta_1 + \delta_1^2\sigma_2^2} \quad (4)$$

$$IS_2^{U} = \frac{(\delta_1\sigma_2 - \beta_1\sigma_1\rho)^2}{\beta_1^2\sigma_1^2 - 2\rho\sigma_1\sigma_2\delta_1\beta_1 + \delta_1^2\sigma_2^2}, \; IS_2^{L} = \frac{\delta_1^2\sigma_2^2(1-\rho^2)}{\beta_1^2\sigma_1^2 - 2\rho\sigma_1\sigma_2\delta_1\beta_1 + \delta_1^2\sigma_2^2} \quad (5)$$

The average of the upper and lower bounds might be considered the market's price discovery efficiency [16].

3. Results and Discussion

3.1. Sample Data Description

Annually from 2018 to 2022, we quantify the operational efficiency of the Chinese cotton futures market. The spot price data is collected from the Bric-Big-Data Database's Xinjiang quotation, and the futures price is selected from the Zhengzhou Commodities Exchange's data. We screened data from futures and spot markets trading on the same day for research purposes, considering the variations between spot trading days and futures trading days. To eliminate bogus regression issues induced by heteroscedasticity, the data are logarithmically processed.

3.2. Trend Analysis of Historical Cotton Futures and Spot Prices

Figure 1 depicts the historical price patterns of cotton futures and spot prices based on sample data. From 2011 to 2015, cotton prices continued to drop, especially in 2011 and 2014, when cotton futures and spot prices declined dramatically. During the early period of 2016–2018, cotton prices returned marginally, and subsequent price levels remained generally stable; after a minor decrease in 2019, prices rebounded to a higher level in 2020 and 2021, and a substantial decline happened in 2022.

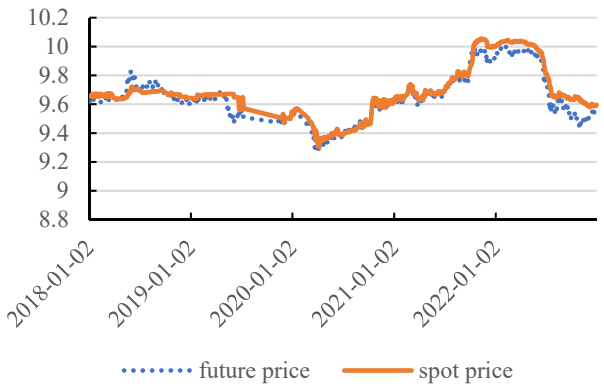

Figure 1. Historical price trends of cotton futures and spot prices

3.3. Empirical Findings of Cotton Futures Price Discovery Efficiency

According to Table 1's results of price discovery efficiency for the years 2018 to 2022, the cotton futures market played a prominent role in price discovery, influencing the spot price of cotton, and its price discovery efficiency was exceptionally high.

Compared to 2018, the price discovery efficiency of cotton futures in 2019 has improved marginally, probably as a result of the optimistic negotiations between China and the United States on the problem of economic and trade frictions in 2019, which are anticipated to yield favourable results. Thus, traders on the cotton futures market and the spot market are excited about trading, enhancing the cotton futures market's price discovery efficiency.

As a result of COVID-19's impact on traffic control and transaction control, the efficiency of cotton futures price discovery in 2020 will be severely diminished. The Chinese government intensified lockdowns and issued stop-work orders in specific locations, impeding cotton harvesting and shipping. Concurrently, consumer demand was primarily focused on food, resulting in a decline in cotton consumption, and the cotton spot market faced a scenario of weak sales; There have been numerous irregular shifts in the financial market, such as the US stock market's four circuit breakers in March, which were caused by investors' gloomy outlook on the market and withdrawal of funds. This ultimately resulted in the flight of foreign money, aggravating global financial volatility and diminishing the efficacy of price discovery on the cotton futures market.

Although many Western clothing firms called for a boycott of Xinjiang cotton in China in 2021, the efficiency of China's cotton futures market increased dramatically. Due to the fact that China has taken the lead in emerging from the epidemic, Chinese cotton prices have become the global benchmark for quality and affordability. China has assumed the lead in cotton pricing, enhancing the cotton futures market's ability to detect spot prices and enhancing the efficiency of futures price discovery.

In 2022, China's epidemic prevention and control efforts stopped the domestic epidemic from spreading on a large scale, allowing for the orderly restoration of labour and production. Growing optimism in the domestic cotton futures and spot markets has led to a rise in trading volume and market liquidity, consequently enhancing the cotton futures market's price discovery efficiency.

Table 1. Price Discovery Effectiveness on the Cotton Futures and Spot Markets

year	futures	spot
2018	95.05%	4.95%
2019	97.06%	2.94%
2020	88.09%	11.91%
2021	94.64%	5.36%
2022	98.17%	1.83%

4. Conclusion

We conducted a quantitative evaluation of the price discovery efficiency of the cotton futures market from 2018 to 2022, and found that despite the influence of unforeseen events, the cotton futures market maintained a dominant position in price discovery, influencing the spot price of cotton to a significant degree. The COVID-19 outbreak has the greatest impact on the efficiency of price discovery on the futures market, compared to the Sino-American trade war, the cotton boycott in Xinjiang. This was due to the fact that the COVID-19 pandemic reduced the liquidity of the cotton futures and spot markets, and market pessimism reduced the trade volume on both markets. Based on the evaluation results of futures price discovery efficiency over the past five years, it is evident that the improvement of international relations, the high quality of domestic spot goods, and the control of the spread of COVID-19 will increase the efficiency of futures price discovery by reducing market uncertainty and instilling confidence in traders. Hence, it is essential that, in the event of an emergency, prompt action be taken to prevent the incident from spreading and causing traders to become pessimistic. Similarly, emphasis should be made to the quality of product supply, which will contribute in enhancing the price discovery efficiency of China's futures market.

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