Determinants of Agricultural Futures Price Volatility: Literature Review

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Abstract: In recent years, China's agricultural futures prices have experienced significant fluctuations, which have a profound impact on the agricultural and financial markets. While, the volatility of futures price, which becomes a key indicator for measuring market risk, has gradually caught scholars' and stakeholders' eyes. Differing from the rationality of investors and the sufficiency of arbitrage, the traditional and the behavioral finance have made fruitful and complementary works on this topic. By reviewing the relevant literature, this article aims to clarify the traditional and behavioral factors that affect the volatility of agricultural futures prices. In addition, this article find that with the development of financialization in commodity futures markets, the influence of irrational factors in the market has become increasingly important. Specifically, behavioral financial factors such as investor sentiments and irrational investor behaviors have become increasingly important in influencing agricultural futures prices. This may provide references and materials for relevant studies and help participants control risks accurately. In summary, under the background of commodity financialization, it is important to study the price fluctuations of agricultural product futures from the perspectives of traditional finance and behavioral finance.

Keywords: Agricultural Futures; Futures Price Volatility; Traditional Finance; Behavioral Finance

1. Introduction

As an important supplementary derivatives, agricultural futures play an important role in serving the real economy, ensuring food security and supporting rural revitalization. In recent years, under the background of financialization of commodity futures agricultural futures prices have experienced significant fluctuations, which have a profound impact on the real economy. While its related studies have gradually attracted academic attention. By reviewing the relevant literature, this article aims to clarify the factors that affect the volatility of agricultural futures prices. This may provide references and materials for relevant studies and help participants control risks. In addition, it may also help stabilize agricultural products' prices, safeguard farmers' income, promote agricultural development and provide strong support for the agricultural economy.

Clearly, the related studies on this topic can be traced back to the commodity futures pricing theories. Based on different assumptions of the sufficient degree of arbitrage and the rational degree of traders, the traditional and the behavioral finance have made fruitful and complementary works.

2. Theoretical Studies

2.1 Theoretical Studies from the Perspective of Traditional Finance

From the perspective of traditional finance, the relevant studies can be traced back to the commodity futures pricing theories. These theories are based on the assumption of rational expectation and sufficient arbitrage, and attempt to explain the formation and fluctuation of futures prices through risk premium, inventory, cost, convenient yields and other factors. Generally speaking, relevant theories include The Normal Backwardation, Hedging Pressure Hypothesis, the Theory of Storage and so on.

Keynes [1] and Hicks [2] put forward the Normal Backwardation by introducing 'Risk Premium' to explain the situation that the futures price is lower than the spot price.

According to this theory, the hedging demand of futures is net short position, and the hedgers set the futures price as a discount relative to the expected future spot price to attract the participation of speculators. The spot premium is the hedger's compensation for the speculators' exposure to price fluctuations. Houthakker [3] expands this theory by studying the long and short returns of large speculators and finds support for the spot premium in the monthly data of cottons, wheat and corns.

In order to make up for the deficiency that the Normal Backwardation theory cannot explain the futures premium, Cootner [4] proposes the Hedging Pressure Hypothesis. According to this theory, the hedgers of futures can be either net short positions or net long positions. The hedgers may hold long positions in the futures market, which will lead to a decrease in future equilibrium futures prices. Therefore, the sign of the futures risk premium depends on the net position change of the hedgers. Then, Hirshleifer [5] have developed the Hedging Pressure Hypothesis under the framework of general equilibrium analysis. He believes that under the condition of sufficient arbitrage, the hedging pressure will have an impact on commodity futures prices. His model shows that in equilibrium, the futures risk premium depends on the systematic risk and the residual risk, and the sign of the residual risk premium depends on the sign of the net hedging pressure.

Subsequently, Kaldor [6] proposes the concept of 'Convenient Yield' and the Theory of Storage [6,7]. According to this theory, spot holders can obtain 'convenient yields' to deal with the uncertainty of future shortage of inventories and reduce the volatility of futures prices. Convenient yields are approximately equal to spot futures premium, so spot premium can be seemed as convenience yields, which are positively correlated with the expected future gains. Geman and Smith [8] extend the Theory of Storage from the perspective of commodity scarcity, and find that when the inventory is low (i.e. scarce), the spot price volatility will exceed the futures price volatility. On the contrary, spot prices and their volatility will remain relatively low during periods when there is no scarcity.

To sum up, based on the assumption of rational expectation and full arbitrage, the traditional commodity futures pricing theories have been gradually developed. These theories have made necessary explanations for the formation and fluctuation of futures prices through factors such as inventory, cost, risk premium and convenience gains. However, traditional economic models lack certain applicability and explanatory power to the actual prices and fluctuations due to its perfect assumptions.

2.2 Theoretical Studies from the Perspective of Behavioral Finance

In 1958, Working put forward a Theory of Anticipatory Prices based on the bounded rationality of futures traders. Working [9] relaxes the completely rational assumption in the unbiased estimation hypothesis. He believes that the futures price depends on the investors' future expectations, which will be affected by short-term behavior and emotions, leading to the deviation of the futures price from its basic value. With the development of behavioral finance, a large number of studies begin to explain asset prices and their fluctuations from the perspectives of market noises, cognitive biases, investor sentiments, etc.

Fraditional futures pricing theories hold that the behavior of noisy traders will be gradually digested by the participation of other rational traders, while behavioral finance acknowledges the role of noisy traders in the market. Shiller believes that irrational noise trading and unbalanced arbitrage are widespread in the market. Since 1990, papers published by DeLong, Shleifer, Summers and Waldmann (DSSW) [10] have formed the basic framework of noise theory. The DSSW model divides investors into rational investors and noise traders. It is believed that the behavior of noise traders may be affected by factors such as emotions, cognitive biases and information asymmetry. Consequently, that might lead to price fluctuations and the spread of irrational market behavior. China's scholars have carried out studies and expansion on this basis. For example, Xiao and Wu [11] distinguish informed traders from noisy traders, and Ji [12] uses the EGARCH model to explore the impact of noise on market efficiency.

Influenced by personal information, emotions and cognition, investors inevitably have cognitive biases in the decision-making

process. Behavioral biases driven by cognitive biases, such as over-trading, herding, disposition effect, etc., will lead to increased investment risk and uncertainty. In China's agricultural futures markets, Lv [13,14]introduces the behavioral finance theory into the commodity futures price formation mechanism. Lv examines the cognitive biases of soybean futures investors in China's agricultural futures markets. Based on the DHS model, Wang et al [15] prove that the overconfidence degree of speculators and arbitrageurs will affect the stabilization of price fluctuations caused by noise trading. Lv tests the investors' cognitive biases in Chinese soybean futures markets and affirms its importance.

Because of the difficulty in measuring noise and cognitive biases, scholars begin to study their impact on asset prices from the perspective of investor sentiments. Baker and Wurgler[16] believe that there are two conditions for sentiments to play a role in asset prices: speculative demands and arbitrage constraints. In commodity futures markets, with the development of commodity financialization and the entry of financial investors, especially index investors, and the market with short selling restrictions have created the necessary conditions for emotions to play an important role. Chen et al. [17] believe that the futures price is not only driven by the supply and demand of the underlying commodities, but also driven by investor sentiments. Subsequently, Gao and Süss find the important role of investor sentiments in commodity futures returns after controlling the stock market returns, macroeconomic variables and commodity-related factors.

To sum up, with the development of commodity financialization, the influence of irrational factors in the market has become increasingly prominent, and the methods based on traditional economic models are inadequate in explaining the fluctuations of commodity futures prices. Behavioral finance explains the formation and fluctuation of futures prices by relaxing the assumptions of traditional commodity futures pricing theories. Based on investors' irrationality (or bounded rationality) and arbitrage restrictions, behavioral finance explains the formation and fluctuation of futures prices from the perspectives of market participants' irrational behavior, investors'

sentiments, cognitive biases, etc. However, studies on futures price volatility in behavioral finance is developing slowly and there is still a long way to go.

3. Empirical Studies

3.1 Empirical Studies from the Perspective of Traditional Finance

The classic commodity futures theories mainly explain the formation and fluctuation of futures prices from the perspective of 'risk premium' and 'convenient income' through the fundamental factors such as commodity inventory, trading volume, open position, basis (spot price) and macroeconomic and financial variables.

Firstly, the inventory is regarded as an important factor that affects commodity futures prices. Fama and French [18], Ng and Pirrong [19] use the adjusted basis data as the proxy variable of commodity inventory, while Geman and Nguyen [20] and Feng [21] use direct inventory to test the Theory of Storage and discover the important role of commodity inventory in stabilizing price expectations and reducing the fluctuation of futures prices.

Secondly, the trading volume and open interest of the futures market are important indicators to reflect the trading activities. Cornell [22] was the first to study the volume-price relationship in the futures market and found that the trading volume was positively correlated with the price changes. Hong and Yogo [23] believe that the positions contain more information about future economic activities and changes in asset prices and are supported by evidence in tests that include 14 agricultural futures. In addition, Bessembender and Seguin[24]believe that the open position can be used as an agent variable for unknown trading or hedging activities, and introduce the trading volume and open position of agricultural futures into the GARCH model at the same time. It is found that the positive unexpected trading volume shock causes greater price volatility than the negative shock; The expected position is negatively correlated with the fluctuation of futures prices.

Thirdly, the basis predicts the expected risk premium and explains fluctuations in futures prices. Szymanowska et al. [25] discompose the risk premium of commodity futures and find that the basis factor provides strong

evidence to explain the spots premium and futures premium. In addition, the single-factor model (basis momentum factor) of Boons and Prado [26] and the three-factor model (market factor, basis and basis momentum) of Feng et al have confirmed the positive prediction effect of basis factor on the yield.

In addition, some scholars also study interest rates, foreign exchange rates, stock market factors, and economic policy uncertainty and other factors on the volatility of agricultural futures prices. In addition, the seasonal, climatic and date factors in the agricultural products futures market are also the specific factors that affect the price fluctuations of agricultural products futures.

3.2 Empirical Studies from the Perspective of Behavioral Finance

From the perspective of behavioral finance, the relevant agricultural futures theories mainly explains the formation and fluctuation of agricultural futures prices from the perspectives of bounded rationality (or irrationality) and bounded arbitrage, mainly through investors' emotions and irrational behavior.

To begin with, investor sentiment is an important factor affecting the volatility of agricultural futures prices. Wang [27] believes that sentiments index, an investor based on the trader's position (a sentiment index constructed using open contracts), can interpret the trader's behavior more intuitively than the net position; The study found that the sentiment of large speculators predicted the continuous fluctuation of prices and the sentiment of large hedges predicted the reversal of prices. Subsequently, Wang [28] uses the position data of agricultural products futures market as an agent variable of sentiment, and finds its impact on price and its volatility through empirical tests. Based on Wang's studies, Bahloul and Bouri use trader position data to construct a sentiment index that is incorporated into the EGARCH model. The empirical results show that producers' sentiments, merchants' sentiments, processors and consumers sentiments are positively correlated with price volatility, which may undermine market stability. The monetary managers' sentiments reduce the market fluctuations and stabilize the futures market. With the development of commodity financialization,

the impact of sentiments on commodity futures is more and more significant. In China's agricultural futures markets, Lv [13] uses the change rate of trading volume as an agent variable of investor sentiment, and finds that there is a positive regression relationship between the change rate of soybean futures price and the change of investor sentiments. Based on the influence mechanism of information and traders' sentiments on the price volatility of agricultural futures, Chen and Tan [29] introduce trading volume and open interest as proxy variables of traders' sentiments into the EGARCH model, and find that emotional traders had an amplification effect on the price volatility of futures market.

In addition, some other studies examine the impact on futures price volatility from the perspective of irrational behaviors such as herding behavior and noise traders' behavior. Pindyck and Rotemberg [30] find the irrational features of the common movement of commodity prices and attributed it to the herding behavior. Some scholars have studied the important role of irrational behavior factors driven by noisy trading and cognitive biases. The DSSW model believes that noise traders in financial markets will overreact to market news and other investors' behavior, which was confirmed by the empirical studies of Xiao and Wu [11] and Ji [12].

4. Conclusions

In general, studies on agricultural futures prices volatility originate from the commodity futures pricing theories. The traditional economic theories are based on the assumptions of rational expectation and full arbitrage. And these theories explain the formations and fluctuations of futures prices through risk premiums, inventories, costs, convenient yields and other factors. This work provides a reference for guiding market participants to understand the operation mechanism of the futures market and reasonably control risks. However, with the increasing investment attribute of commodity futures market, it is difficult to effectively explain the fluctuation of commodity futures prices based on traditional economic theories and models. Behavioral finance broadens the theoretical studies on commodity futures by relaxing the assumptions of commodity futures pricing from the perspective of traditional

finance, based on investors' irrationality (or bounded rationality) and arbitrage restrictions, and explaining the formations and fluctuations of commodity futures prices from the perspective of human nature finance such as irrational behavior of market participants, investors' sentiments and cognitive biases. However, due to the difficulty of quantitative measurements, it is relatively slow to study the operating mechanism of agricultural futures prices from the perspective of behavioral finance, and the relevant empirical studies focus on the important impact of emotional factors. In the future, with the growth and improvement of the agricultural products futures market in China, more irrational factors will be incorporated into the studies framework, the pricing mechanism suitable for the futures market in China will be explored, and the influencing factors on the prices and fluctuations of agricultural products futures will be explored from the perspective of human nature finance. This will not only help market participants to reasonably use derivatives to avoid market risks and prevent systemic risks, but also help agricultural futures to play an important role in boosting rural revitalization in multi-level capital markets, serving the real economy and ensuring food security.

References

[1] Keynes J M. treatise on money. 1930.

[2] Hicks J R. Value and Capital. 1939.

[3] Houthakker H S. Can speculators forecast prices? The Review of Economics and Statistics, 1957, 39(2): 143-151.

[4] Cootner P H .Speculation and Hedging. Food studies Institute Studies, 1967,7:43-55.DOI:10.1002/978111826640 3.ch3.

[5] Hirshleifer D. Hedging pressure and futures price movements in a general equilibrium model. Econometrica: Journal of the Econometric Society, 1990: 411-428.

[6] Kaldor N. Speculation and economic stability. The review of economic studies, 1939, 7(1): 1-27.

[7] Working H. The theory of price of storage. The American Economic Reviw, 1949, 39(6): 1254-1262.

[8] Geman H, Smith W O. Theory of storage, inventory and volatility in the LME base metals. Resources Policy, 2013, 38(1): 18-28.

[9] Working H. A theory of anticipatory prices. The American Economic Review, 1958, 48(2): 188-199.

[10] De Long J B, Shleifer A, Summers L H, et al. Positive feedback investment strategies and destabilizing rational speculation. The Journal of Finance, 1990, 45(2): 379-395.

[11] Xiao Hui, Wu Chongfeng. A Comparative Study on the Microstructure of Spot Market and Futures Market. Journal of management sciences in china, 2009, 12(01):93-100+136.

[12] Ji Junwei, Fu Qiang, Zhang Xingmin. Noise Trading and Progressive Efficiency of Shanghai Copper Futures. Management Review, 2019, 31(02): 17-35. DOI: 10.14120/J.Cnki.Cn11-5057/F.2019.02.006.

[13] Lv Dong-hui, YANG Yin-sheng, GUO Hong-peng, et al. An Empirical Study on the Cognitive Bias of Chinese Soybean Futures Investors. Agricultural Economic Issues, 2004(11):20-23+79.

[14] Lv Dong-hui, YANG Yin-sheng, Wang Xu. Study on the Formation Mechanism of Agricultural Products Futures Prices. Agricultural Technology and Economics, 2005(02):19-23.

[15] Wang Shuping, Kuang Xiong, Wu Zhenxin. Mathematical model analysis of the effect of overconfidence psychology on futures prices. China Management Science, 2010, 18 (01): 39-45. DOI: 10.16381/J. Cnki. ISSN 1003-207X.2010.01.024.

[16] Baker M, Wurgler J. Investor sentiment and the cross-section of stock returns. The journal of Finance, 2006, 61(4): 1645-1680.

[17] Chen J, Hong H, Stein J C. Breadth of ownership and stock returns. Journal of financial Economics, 2002, 66(2-3): 171-205.

[18] Fama E F, French K R. Business cycles and the behavior of metals prices. The Journal of Finance, 1988, 43(5): 1075-1093.

[19] Ng V K, Pirrong S C. Fundamentals and volatility: Storage, spreads, and the dynamics of metals prices. Journal of Business, 1994: 203-230.

[20] Geman H, Nguyen V N. Soybean inventory and forward curve dynamics.

Management Science, 2005, 51(7): 1076-1091.

[21] Feng Yulin, Tang Ke, Kang Wenjin. studies on the Pricing Mechanism of China Commodity Futures Market. Financial studies, 2022(12):19.

[22] Cornell B. The relationship between volume and price variability in futures markets. The Journal of Futures Markets (pre-1986), 1981, 1(3): 303.

[23] Hong H, Yogo M. What does futures market interest tell us about the macroeconomy and asset prices? Journal of financial economics, 2012, 105(3): 473-490.

[24] Bessembinder H, Seguin P J. Price volatility, trading volume, and market depth: Evidence from futures markets. Journal of financial and Quantitative Analysis, 1993, 28(1): 21-39.

[25] Szymanowska M, De Roon F, Nijman T, et al. An anatomy of commodity futures risk premia. The Journal of Finance, 2014, 69(1): 453-482.

[26] Boons M, Prado M P. Basis-momentum. The Journal of Finance, 2019, 74(1): 239-279.

[27] Wang C. Investor sentiment and return predictability in agricultural futures markets. Journal of Futures Markets: Futures, Options, and Other Derivative Products, 2001, 21(10): 929-952.

[28] Wang C. The behavior and performance of major types of futures traders. Journal of Futures Markets: Futures, Options, and Other Derivative Products, 2003, 23(1): 1-31.

[29] Chen Biaojin, Tan Ying. Information, Trader Mood and Fluctuation of Agricultural Products Futures Price in China. Financial Economics studies, 2017, 32(02):66-75.

[30] Pindyck R S, Rotemberg J J. The excess co-movement of commodity prices. The Economic Journal, 1990, 100(403): 1173-1189.