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Is Futurization the Culprit for the Violent Fluctuation in China's Apple Spot Price?

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Abstract: China aims to utilize the futures market to stabilize agricultural product price fluctuation by quantifying the effects of risk transfer and price discovery. However, the role of futurization has been questioned and even posited as the cause of drastic fluctuations in spot market prices. This research aims to clarify the impact of futurization on the price fluctuation of agricultural products and to provide policy reference for the development of the agricultural futures market through the research. Here, we examine the spot price data for apples and use Interrupted time-series analysis (ITSA) and GARCH models to estimate the impact of apple futures on the volatility of spot prices. Our findings demonstrate that the launch of China's apple futures did not increase the volatility of apple spot prices; that is, futurization was not the cause of skyrocketing apple spot prices. In the long term, our results suggest that futures will help reduce the volatility of apple spot prices and that the introduction of futures will ultimately reduce the price volatility of agricultural products.

Keywords: apple; futures; spot price volatility; agricultural products

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1. Introduction

Risk transfer and price discovery are traditionally cited as the two main functions of the futures market [1,2]. Risk transfer refers to futures contracts by the hedger to transfer price risk to others, while price discovery describes the use of futures prices to price spot market transactions [3]. As it has been posited that futures markets stabilize commodity prices [4], China established its own futures market in 1990. As of November 2020, there were 90 futures and options on the Chinese futures market spanning the fields of energy and chemical industry, metals, agricultural products, and finance. The industry's total assets, net assets, and customer equity reached CNY 922.46 billion, CNY 127.24 billion, and CNY 774.12 billion, respectively [5]. The number of future trading products and the industry in which the option products belong are the key to developing the futures market. The diversification, differentiation, and innovation of future products can meet the needs of different investors. The gradual expansion and improvement of China's future trading varieties will help optimize the entire market's resources and promote the futures market's sustainable development [6]. Simultaneously, the sustainability of the market activity of new varieties is a prerequisite and necessary guarantee for the functioning of the futures market. Efficient market activity can promote the real formation of future prices, thereby realizing the function of price discovery and providing an important reference for spot pricing [7]. Agricultural products are among the earliest and most actively traded commodities in China. The first agricultural wholesale market, the Zhengzhou Grain Wholesale Market (ZGWM), was established with the assistance of the Chicago Board of Trade (CBOT) in December 1990 [8]. The goal of the agricultural futures market was to help eliminate seasonal price fluctuations, thereby minimizing price volatility [9–11]. China established their agricultural product futures market to prevent sharp fluctuations

in agricultural product prices, which thereby provides agricultural product producers, operators, and agricultural product demanders with tools to discover prices, avoid risks, and reduce spot market volatility [12].

However, some believe that futurization has promoted a large investment into the commodity futures market, distorting the price formation mechanism [13]. For example, many speculative traders do not hold underlying commodity contracts, such that the core of the transaction is only the future contract, rather than the target of the commodity. This transforms the bulk commodities' future transaction into a financial transaction [14]. Furthermore, after the futurization of commodities, the correlation between future prices and typical financial assets increased in both supply and demand. This suggests that, in some cases, futurization may in fact aggravate the volatility of spot commodity prices [15]. Empirical studies have demonstrated that if prices were mainly affected by inventory rather than consumption, futures markets' introduction would increase spot price volatility [16]. Future markets have been shown to incite producers to take more significant risks, thereby increasing spot price volatility [17], and drastic changes in future trading volume have caused certain commodities' spot prices (such as corn, soybeans, sugar, wheat, cotton, pigs, and cattle) to fluctuate [18]. As a representative example of the futures market amplifying the level of spot price volatility, Seigel and Kosuga successfully manipulated the onion futures market through stockpiling, creating sharp fluctuations in the onion's spot price. In this case, the US Congress deemed that "the benefits of hedging are difficult to offset the adverse effects of the violent and unreasonable price fluctuations caused by futures trading" and passed the "Onion Futures Act" (Public Law 85-839) in 1958. The onion, therefore, became the first banned futures variety in American history [9].

The debate over agricultural futures in China is derived from apple futures. On 22 December 2017, apple futures were officially listed on the Zhengzhou Commodity Exchange. This was the world's first listed fresh fruit futures, with a first-day closing price of CNY 7800/ton. However, apple futures soon increased sharply: by 2018, the highest closing price exceeded CNY 12,000/ton, and the maximum trading volume was more than 2.8 million lots [19]. In sharp contrast, only six warehouse receipts were delivered on 17 May 2018 after the first day of listing apple futures, totaling a mere 120 tons of apples valued at CNY 1.08 million [20]. The severe deviation between the delivery volume and the future trading volume indicates that an abundance of speculative funds entered the apple futures market. News reports indicated that speculators ignored exchange risk warnings and purposefully increased apple future prices [21,22], while bearish traders suffered heavy losses due to a "short squeeze" [23].

It is interesting to note that after the launch of apple futures, the spot price of apples also experienced increases and abnormal fluctuations. According to data from the public service platform of China's agricultural product business information, the price of Red Fuji apples in the national wholesale market increased from CNY 6.61/kg in 2017 to CNY 14.28/kg in 2019, and then fell sharply to CNY 4.55/kg. Some people think that futurization is the cause of the continuous rise and drastic fluctuations in the spot price of the apple.

According to data from the United States Department of Agriculture (USDA), China is among the main apple consumers. In 2019, China's total apple consumption was about 41.115 million tons, accounting for 50.467% of the world's apple consumption. At the same time, China is also among the most important producers of apples. In 2019, the total output of apple in the country was about 41 million tons, accounting for 54.065% of the world's total output. Therefore, the apple price changes in China and the launch of apple futures will arouse strong attention. Additionally, China's futures market is an emerging market, and its own market supervision system has certain deficiencies. Agricultural products enter the futures market, and their financial characteristics are strengthened, which may lead to a large number of speculative behaviors [15] and sharp fluctuations in the prices of agricultural products [13,24]. This has aggravated people's fears that the agricultural futures market would be manipulated. Additionally, agricultural products provide basic food and raw materials for people's life and production. Unstable

agricultural product prices may cause serious social problems, and the impact of futures on agricultural product price fluctuations is a matter of great concern [25]. In China's emerging economy, the question of whether the futurization of agricultural products has positive or negative impact has direct implications for China's futures market policy making and implementation. Here, we use Interrupted time-series analysis (ITSA) and GARCH models to estimate the impact of apple futures on the volatility of spot price using data collected by the Ministry of Agriculture and Rural Affairs of China. We aim to both to contribute to the existing relevant literature on the relevance of the futures market and the spot market while also providing a reference for the development of China's futures market.

2. Literature Review

Whether the futures market stabilizes or amplifies spot price fluctuations is currently matter of great debate [12,26]. Some posit that the futures market amplifies the level of spot price fluctuations and price volatility, for instance, if prices were mainly affected by inventory rather than consumption [16]. The futures market may stimulate producers to take greater risks, further increasing price volatility [17]. Drastic changes in futures trading volume can also cause the spot prices of commodities such as corn, soybeans, sugar, wheat, cotton, hogs, and cattle to fluctuate [18]. The flagship example of the futures market amplifying the level of spot price volatility is onion futures in the United States, concern over which eventually led to the banning of onion futures trading (The Onion Futures Act, Public Law 85-839) [9]. Ban on futures trading in India has led to greater volatility in the spot market [27], and Bohl research shows that the regulator's efforts to curb speculation in the futures may adversely affect the commodity market's price discovery process [28].

On the other hand, rational speculators gain income by buying high and selling low, which may be a mechanism to slow down price fluctuations [4]. An analysis of the US onion price data from 1930 to 1958 suggests that the price volatility of onions actually showed a downward trend after the introduction of futures trading in the 1940s [9]. Gray compared the fluctuations of onion prices across various time periods and found that by allowing participants to buy during the onion harvest and sell them in the future, the futures market helped reduce the level of onion price fluctuations [10]. As such, the onion futures market could be used to guide production plans and smooth the sharp price fluctuations caused by agricultural products' seasonality. A later analysis of onion prices from 1930 to 1968 found no significant change in the spot prices of onions by year, season, season, or month [29].

Other products have also been introduced to the futures market. Analysis of pork belly and beef data before and after the futurization showed that the random fluctuations in the two years after the futures were significantly lower two years before futurization [30]. Here, futures trading was thought to have accelerated the speed of information transmission, expanded the scope of information dissemination and the degree of saturation of information in the region, and reduced the information asymmetry between futures and spot market participants [30]. This means that reaching price is more likely to represent the relationship between supply and demand while also reducing price fluctuations. Data on US live cattle futurization demonstrate that although the there was no significant decrease in the annual rate of live cattle prices after futurization, the monthly and weekly rates did drop significantly [11]. The futurization of live cattle is believed to improve market information and reduce transaction costs and marketing costs through risk transfer and promotion of the response to expected market conditions. Similar results have been obtained for wheat [31] and potatoes [32].

Research also suggests that the impact of agricultural futures markets on spot price is minimal. A comprehensive study of the relationship among corn, wheat, soybeans, soybean meal, feed, live cattle futures prices, and spot prices showed that these commodities' prices were almost always formed in the spot market rather than in futures contracts [33]. The contribution of futures contracts to price discovery was less than 10%, suggesting that futures are not responsible for large fluctuations in spot price. Other work analyzing the relationship among the futures of corn, soybeans, sugar, wheat, and other agricultural

products and spot prices also showed that the futures did not contribute to spot price volatility [34]. Johan et al. suggested that the effect of the futures market on spot market volatility is affected by the degree of coupling between two markets: weakly coupled spot and futures markets (e.g., those exhibiting high commodity storage costs, few speculators, or very risk aversion) have lower spot price volatility. However, as the coupling strength increases, this trend reverses such that the futures market will eventually magnify the spot price volatility [26]. Overall, the relationships between futurization and the spot market price are highly complex.

With the on-going development of China's agricultural product futures market, the impact of the futures market on the spot market has recently become a topic of great interest. International agricultural product futures prices have been found to impact China's agricultural product spot prices and fluctuations [35,36], and the development of the domestic futures market also impacts spot price. Yang et al. showed a long-term equilibrium relationship between corn and sugar futures and the spot market [37]. The futures market transaction volume has a significant positive feedback information transmission effect on the spot market. Hou found that the futures price of soybean meal had a cointegration relationship with the spot price, and the futures price had a noticeable guiding effect on the spot price [38]. Li and Li found that the trading volume of agricultural futures impacted garlic and mung bean prices [39]. Other concerns revolve around the influence of establishing the futures market itself on the spot price. Pang and Liu investigated the impact of the launch of soybean meal, sugar, corn, and other agricultural products futures on spot prices [12]. The launch of agricultural products futures on spot prices was found to reduce the volatility of respective spot markets. Lin and Yang also found that the listing of egg futures converged the difference between the bulk transaction price and the retail price, helping to stabilize the spot price [40].

Overall, the results from these studies are inconsistent, making it hard to form recommendations for China's agricultural futures economy. China's apple futures have been on the market for more than three years. While the media have reported more on the apple's futures, and the public is also very concerned, we have yet to rigorously assess the impact of this launch on the apple spot price. Here, this article explores the relationship between the apple's spot price volatility and futures, assessing whether futures are the main reason for the surge in the apple's spot price.

3. Methods

3.1. Data

We obtained the average price of Red Fuji apples in the national wholesale market collected by the Chinese Ministry of Commerce through the Bric Agricultural Database. These values are used as a proxy variable for the spot price of apples. The update frequency of the apple's spot price data is daily and belongs to daily data. The time span of spot price data is six years, from 1 January 2015 to 31 December 2020. The apple price is the Chinese Ministry of Commerce's collection of apple prices in the wholesale markets of various provinces and regions in China. It then calculates the average price to obtain the daily price of red Fuji apples in the national wholesale market.

According to the above daily apple spot price data, Equations (1) and (2) were used to calculate the weekly volatility of the apple price used in this research. To calculate weekly volatility, we estimated the standard deviation of daily returns [41,42]:

$$Volatility = \sqrt{\frac{\sum_{t=1}^{n} (R_t - \overline{R})^2}{n-1}} * \tau \quad (1)$$

Here, τ is the length of the time interval set as the length of each week, which is analyzed using weekly volatility. R_t is daily returns, and $\overline{R}$ is the mean of daily returns. R_t is calculated as:

$$R_t = \ln\left(\frac{p_t}{p_{t-1}}\right) \quad (2)$$

where p_t and p_{t-1} are apples' spot prices on day t and $t-1$, respectively.

3.2. Analysis

As a quasi-experimental design, Interrupted time-series analysis (ITSA) is mainly used to assess interventions' impact when randomized controlled trials are not feasible (Figure 1) [43–46]. ITSA creates a time series data model that allows the researcher to compare the trend changes of dependent variables before and after the intervention [47]. It is widely used in public policy [44,48,49], regulatory measures [50], biomedical experiments [51], and other fields of effect evaluation. This study aims to examine the effect of futurization on the fluctuation of the apple's spot price. The apple is the only fresh fruit product that is futures-oriented in China, and other fresh fruit products are not suitable as a control group for apples. Therefore, this study first used ITSA for empirical analysis. The ITSA model is shown in Equation (3). The dependent variable P_t represents the apple's spot price volatility at time t; T_t is the time variable, and its values are 1, 2, 3 ... ... n, corresponding to the time point of each sample data; ε_t is the random disturbance term; and X_t is the dummy variable for the implementation of the intervention. If the apple is not futures (prior to the official listing on 22 December 2017), X is assigned a value of 0, and if the apple is futures, a value of 1. The coefficient β_0 represents the intercept, which is the apple's spot price at the beginning of the time series. β_1 is the slope before the intervention, reflecting the changing trend of the apple spot price before futurization. β_3 is the degree of change in the trend of apple spot price before and after futurization. $\beta_1 + \beta_3$ is the slope after the futurization, representing the apple spot price's changing trend after the futurization.

$$P_t = \beta_0 + \beta_1 T_t + \beta_2 X_t + \beta_3 T_t * X_t + \varepsilon_t \quad (3)$$

The significance of each coefficient in the ITSA model is shown in Figure 1.

In order to ensure the robustness of the ITSA model research result, we additionally utilized generalized autoregressive conditional heteroscedasticity (GARCH) models to assess spot price volatility before and after implementing the apple futures policy. The GARCH model was obtained by Bollerslev through extended constraints based on the ARCH model [52,53]. Here, we used past price changes and past variances to calculate fluctuations and forecasts future changes [54]. The advantage for this method is that we can effectively eliminate excessive peaks in the data, reduce the estimated parameters, and predict the future variance [52]. The GRACH model has been widely used in the financial field. We used the GARCH (1, 1) model of Kristjanpoller and Minutolo, Choudhry, and Aragó and Nieto [55–57]. (1, 1) in the GARCH (1, 1) model refers to the GARCH term with a lag order of 1 (the first term in brackets) and the ARCH term with a lag order of 1 (the second term in brackets). The ordinary ARCH model is only a special case of the GARCH model, so in many cases, the results obtained by using the GARCH (1, 1) model are more reliable and accurate than the ARCH model [58].

$$\text{Volatility}_t = \beta_4 + \beta_5 \text{Volatility}_{t-1} + \omega_t,\ \omega_t \sim N\left(0, \sigma^2\right) \quad (4)$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \omega_{t-1}^2 + \varphi_1 \sigma_{t-1}^2 + \gamma D_t \quad (5)$$

$$D_t = \begin{cases} 0,\ t < 2017.12.22 (\text{Before the launch of Apple Futures}) \\ 1,\ t \geq 2017.12.22 (\text{After the launch of Apple Futures}) \end{cases}$$

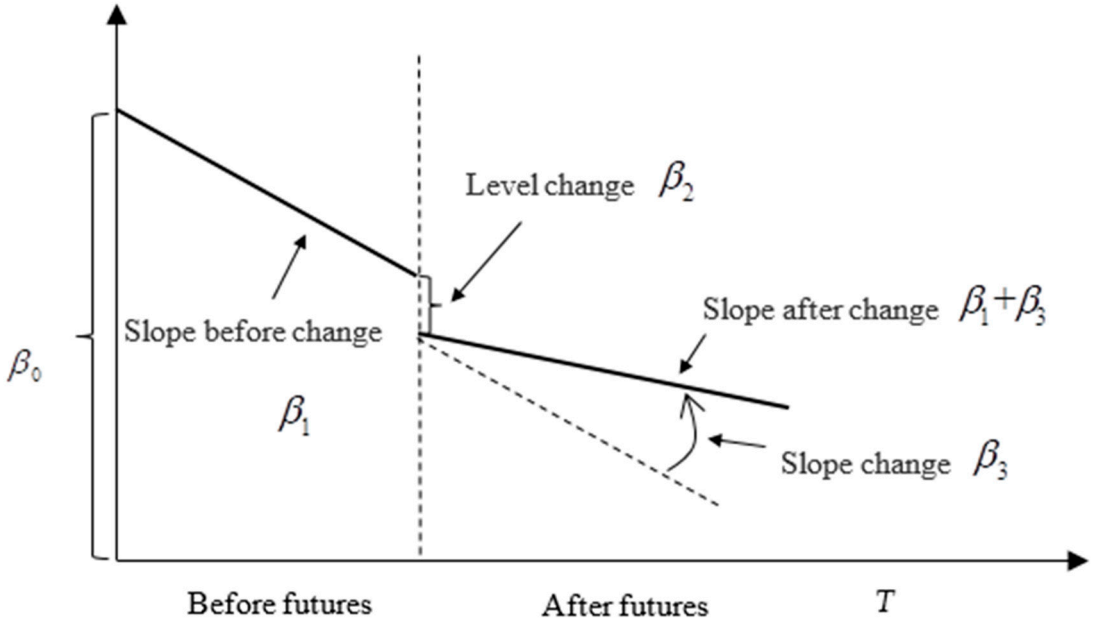

Figure 1. Interrupted time-series analysis (ITSA) schematic.

In the mean value Equation (4), Volatility$_t$ is the volatility of the apple spot price in t period. Volatility$_{t-1}$ is the volatility of one-period lagging; ω_t is the residual term in period t. In the variance Equation (5), σ_t^2 is conditional variance in the period of t, and the variance is predicted based on the data in the $t-1$ period. α_0 is constant. ω_{t-1}^2 is the ARCH term, which refers to the residual square of one period lagging in the mean value equation. This represents the volatility of information of period $t-1$. α_1 is the ARCH coefficient; here, the larger α_1 is, the faster the price volatility responds to market changes. σ_{t-1}^2 is the GARCH term, which represents the forecast variance of the $t-1$ period. φ_1 is the coefficient of the GARCH term, where larger φ_1 s correspond to longer durations of fluctuation. To test the impact of the apple's futures on the spot price, the dummy variable D_t is added to (3). $D_t = 0$ indicates that the time is before apple futures implementation, and $D_t = 1$ represents that the time is after implementation. We can judge whether the introduction of apple futures will affect the fluctuation of spot price and the direction of the fluctuation through the positive and negative signs of the coefficient γ of dummy variable D_t and its significance. If γ is significant, it indicates that apple futures will impact the volatility of the apple's spot price. If $\gamma > 0$, the introduction of apple futures increases the volatility of the apple's spot price; when $\gamma < 0$, the introduction of apple futures reduces the volatility of the apple's spot price.

4. Results

4.1. Descriptive Statistics

To study whether there are short-term and long-term effects of the impact of futures on apples' spot price, we chose six time periods for analysis and used 0.5 years before and after the futures as a unit span for classification: (1) a relatively short-term period of 0.5 years before and after futures (1 July 2017 to 30 June 2018); (2) 1 year before and after the futures (1 January 2017 to 31 December 2018); (3) 1.5 years before and after the futures (1 July 2016 to 30 June 2019); (4) 2 years before and after the futures (1 January 2016 to 31 December 2019); (5) 2.5 years before and after the futures (1 July 2015 to 30 June 2020); and (6) a relatively long period of 3 years before and after futurization (1 January 2015 to 31 December 2020)

Table 1 shows the descriptive statistics of the apple's spot prices and volatility in various periods. The average spot price of apple differed little across the six time periods (Table 1). However, the variation and volatility in the apple's spot price were highest in the

two years before and after futurization (Table 1). The mean of volatility was the highest at 0.0928, and Std. Dev. was also the highest at 0.0556.

Table 1. Descriptive statistics of apple's spot price and volatility.

Period	Apple's Spot Price				Apple's Spot Price Volatility			
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
1 July 2017 to 30 June 2018	6.7288	0.2944	6.1000	7.5000	0.0881	0.0383	0.0380	0.2106
1 January 2017 to 31 December 2018	6.8315	0.3769	6.0819	7.8700	0.0821	0.0349	0.0188	0.2106
1 July 2016 to 30 June 2019	7.2126	1.3231	5.6059	14.2300	0.0852	0.0348	0.0188	0.2106
1 January 2016 to 31 December 2019	7.4163	1.7392	4.5500	14.2800	0.0928	0.0556	0.0145	0.3743
1 July 2015 to 30 June 2020	7.3979	1.5859	4.5500	14.2800	0.0863	0.0532	0.0101	0.3743
1 January 2015 to 31 December 2020	7.4334	1.5134	4.5500	14.2800	0.0810	0.0510	0.0101	0.3743

Figure 2 intuitively reflects the trend of the apple's weekly average spot price and volatility during the six years from 2015 to 2020. Overall, the apple's spot price and volatility were relatively stable before and after futurization, except for a significant rise and fall in 2019 (Figure 2). The highest price was about CNY 14 /kg, and then the price dropped sharply to about CNY 4.55/kg in 2019.

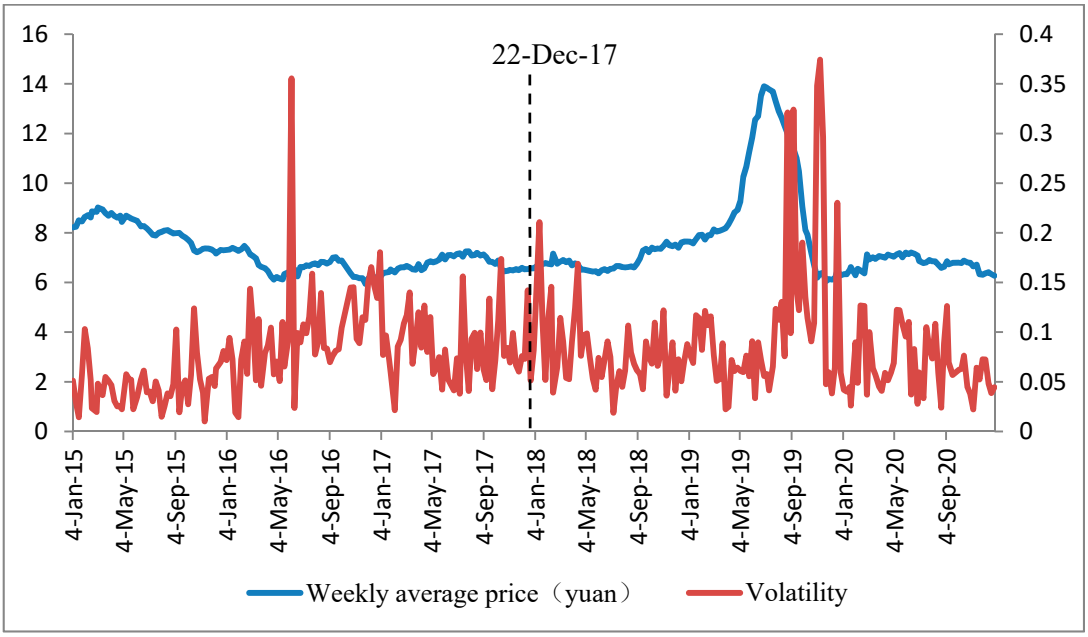

Figure 2. Apple spot price and volatility trends.

4.2. Result of ITSA

We used the Durbin Watson's statistic (DW) to detect autocorrelation in the data [59,60]. Existing research shows that if there is autocorrelation, methods such as Prais–Winsten and Generalized Least Squares Estimation (GLSE) can be used [46,47]. DW values of the six time periods are very close to two, suggesting that there is no autocorrelation in the sequence (Table 2).

Table 2. Interrupted time series analysis.

Period	D. W. Statistic	Level Change	Slope before Change	Slope Change	N
1 July 2017 to 30 June 2018	1.9957	0.0183 (−0.0236)	0.0005 (−0.0010)	−0.0021 (−0.0014)	52
1 January 2017 to 31 December 2018	1.9050	0.0162 (−0.0172)	−0.0001 (−0.0004)	−0.0006 (−0.0005)	105
1 July 2016 to 30 June 2019	1.9950	0.0122 (−0.0154)	−0.0004 * (−0.0002)	0.0001 (−0.0003)	155
1 January 2016 to 31 December 2019	2.0523	−0.0266 (−0.0169)	−0.0000 (−0.0002)	0.0006 (−0.0004)	207
1 July 2015 to 30 June 2020	2.0944	−0.0243 * (−0.0138)	0.0003 *** (−0.0001)	−0.0002 (−0.0002)	259
1 January 2015 to 31 December 2020	2.1071	−0.0191 (−0.013)	0.0004 *** (−0.0001)	−0.0004 *** (−0.007)	310

Note: In the three columns of level change, slope before change, and slope change, the first line is the coefficient, and the standard error is in parentheses. * and *** denote the statistical significance at 10% and 1% levels, respectively.

We detected no change in the relationship or level in the 0.5-, 1-, 1.5-, and 2-year periods. The result shows that if we only focus on this period, the launch of apple futures did not change the level and trend of the apple's spot price volatility. However, when we extend the research time to 2.5 years before and after the futurization, the level change is −0.0243 ($p < 0.1$), indicating that at the time of futurization, the apple's spot price volatility decreased by 0.0243. In the 3 years before and after the futurization, the slope change was −0.0004 ($p < 0.01$), indicating that after the futurization, the price volatility of the apple's spot price decreased. Although level change is not statistically significant, the coefficient is still negative. The empirical results show that the futurization does not increase the volatility of the apple's spot price. Moreover, in the long term, the trend of price volatility declined.

Overall, there were no significant changes in price volatility after futurization (Figure 3a–f). Although the futures are 0.5, 1, and 1.5 years, the level change and slope change of the three time periods are not statistically significant. Still, after the futurization, the apple's spot price volatility tends to decrease (Figure 3a–d). By extending the research time to 2.5 and 3 years before and after futurization, it can be found intuitively that at the time of futurization, the volatility of the apple's spot price decreased (Figure 3e,f). This shows that after the launch of apple futures, price volatility visually tends to slightly decline, even across longer time frames.

4.3. Result of GARCH

Before performing GARCH model estimation, we first performed white noise and *Q*-statistic tests on the residual sequence ω_t in the mean equation [12,61] and an LM test on the residuals to determine an ARCH effect [62]. If the sequence does not have the ARCH effect, the GARCH model cannot be used to analyze the data. In terms of volatility, only the 2, 2.5, and 3 years before and after periods had good residuals; residual series passed the white noise and *Q*-statistic tests; and the residual square series had the ARCH effect (Table 3). Henceforth, we used only these periods for GARCH (1, 1) modelling.

Table 3. Results of various tests.

Period	White Noise Test		*Q* Statistical Test					LM Test		
	Portmanteau Statistic	*p* Value	Lag (1)	Lag (2)	Lag (3)	Lag (4)	Lag (5)	Lag (1)	Lag (2)	Lag (3)
1 July 2017 to 30 June 2018	24.633	0.216	0.157	2.429	3.637	3.638	5.084	0.146	2.251	2.839
1 January 2017 to 31 December 2018	56.117	0.047	0.047	1.486	1.542	3.512	3.568	0.045	1.418	1.461
1 July 2016 to 30 June 2019	59.269	0.025	0.311	1.120	1.457	3.076	3.175	0.309	1.155	1.460
1 January 2016 to 31 December 2019	16.757	0.999	13.116 ***	18.054 ***	18.561 ***	18.571 ***	18.571 ***	12.867 ***	14.649 ***	14.632 ***
1 July 2015 to 30 June 2020	23.469	0.983	15.941 ***	22.584 ***	23.635 ***	23.643 ***	23.643 ***	15.697 ***	18.256 ***	18.182 ***
1 January 2015 to 31 December 2020	29.148	0.898	17.447 ***	26.332 ***	27.422 ***	27.473 ***	27.490 ***	17.229 ***	21.261 ***	21.195 ***

Note: In the white noise test, *p*-value > 0.1, and it is white noise; in the LM test, the chi2 value is significant, and there is an ARCH effect. *** denote the statistical significance at 1% levels, respectively.

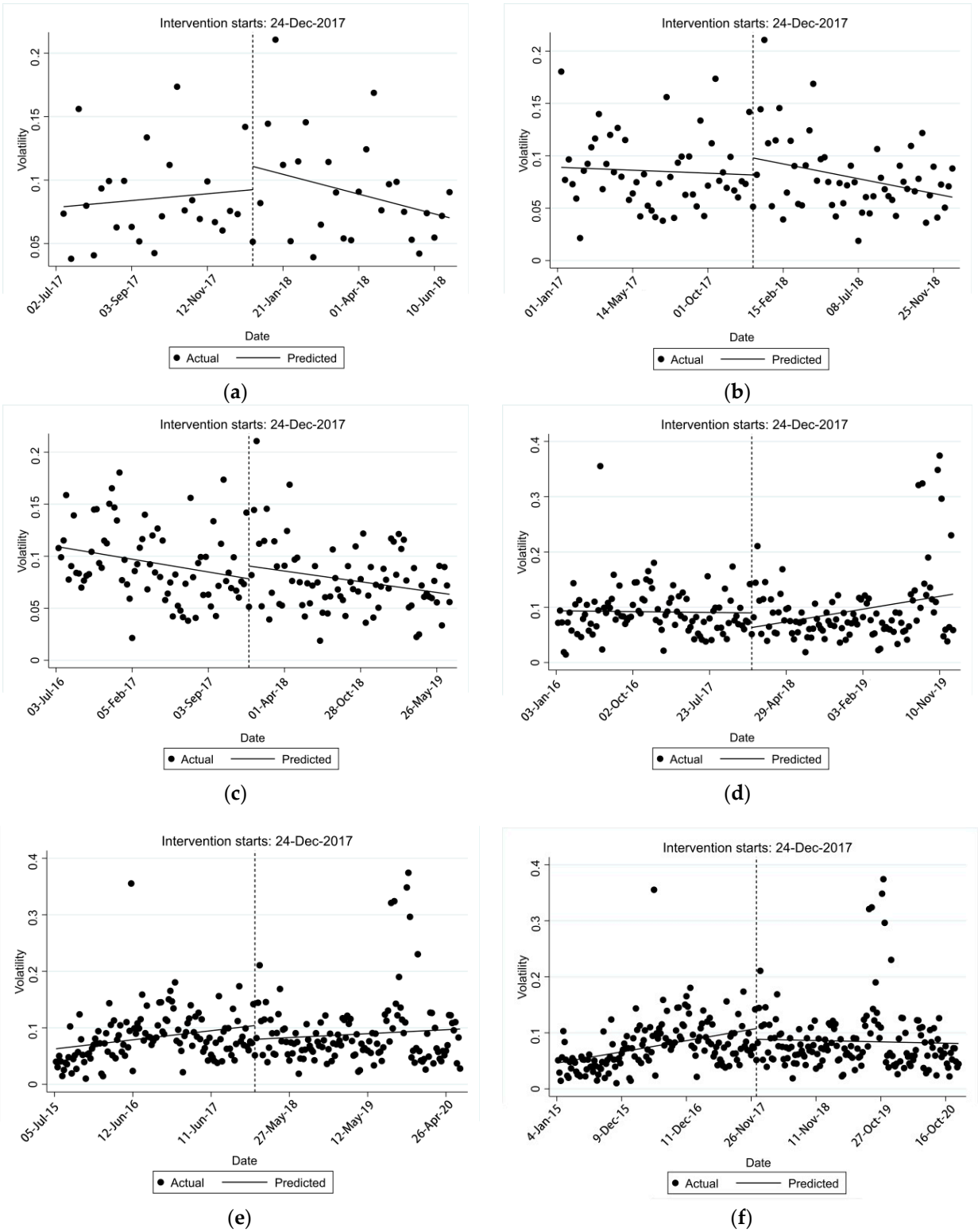

Figure 3. ITSA analysis chart for each time period: (**a**) 1 July 2017 to 30 June 2018; (**b**) 1 January 2017 to 31 December 2018; (**c**) 1 July 2016 to 30 June 2019; (**d**) 1 January 2016 to 31 December 2019; (**e**) 1 July 2015 to 30 June 2020; (**f**) 1 January 2015 to 31 December 2020.

There is no effect of futurization on apples' spot price in the two years before and after futurization (Table 4). It can be seen that two years before and after the futures, the degree of influence γ of futurization on the apple's spot price was not statistically

significant. However, when the inspection time was extended to 2.5 and 3 years before and after the futures, respectively, the futurization degree of influence γ of the apple's spot price began to be statistically significant, and both were less than zero ($\gamma = -0.2010$, $p < 0.1$; $\gamma = -0.2842$, $p < 0.05$). This shows that in a longer time frame, futurization will reduce the apple's spot price fluctuation. This result is consistent with the analysis result of the ITSA model, indicating that the empirical result has good robustness.

Table 4. GARCH model analysis.

Period	Mean Equation Intercept	Impact on Current Volatility	Constant of Variance Equation	Arch (1)	Garch (1)	Influence Level of Futuresization
1 January 2016 to 31 December 2019	0.0583 ***	0.3337 ***	−8.2159 ***	0.1000 ***	0.8184 ***	−0.1777
1 July 2015 to 30 June 2020	0.0494 ***	0.3914 ***	−8.0506 ***	0.1158 ***	0.7672 ***	−0.2010 *
1 January 2015 to 31 December 2020	0.0384 ***	0.4741 ***	−8.3004 ***	0.1591 ***	0.7539 ***	−0.2842 **

Note: *, **, and *** denote the statistical significance at 10%, 5%, and 1% levels, respectively.

5. Discussion

Prior research suggests that futurization may increase the price fluctuations of agricultural products [15,16,18]. In the policy debate, some people also speculate that establishing the futures market will increase commodity prices' instability [9]. There is a general concern that the commodity prices will fluctuate abnormally after introducing futures, causing many to argue that commodity futures trading should be prohibited [9]. Particularly in the first few years of the futures launch, the market can often be subjected to repeated manipulation. These concerns have biased the Chinese public opinion against the listing of agricultural futures [21,23]. However, our research on apple spot price data suggests that the launch of agricultural futures will not cause abnormal spot price fluctuations. In fact, our findings indicate that launching a futures market will help stabilize commodity price fluctuations in the long term. This is consistent with the conclusions of Friedman [4], Powers [30], Netz [31], and others. In this case, futurization did not amplify the volatility of commodity prices but rather reduced and stabilized overall volatility. Even in the long term, the futures market has the function of stabilizing the price volatility of agricultural products to a certain extent. Overall, our work supports that there is little cause to be concerned about the impact of futurization on agricultural products' spot prices.

Futures trading varieties are the lifeblood of the futures market. The market needs to add new futures trading varieties to meet the needs of commodity traders and investors. The gradual expansion and improvement of futures market varieties can benefit the sustainable development of its futures market [6]. For this reason, the introduction of apple futures varieties will help the development of current agricultural product futures, and China can continue to launch new agricultural product futures to enrich and improve trading varieties. On the other hand, the apple fresh fruit processing industry chain is lengthened, and the recycling and efficient utilization of apple waste residues will promote the sustainable development of the apple industry and increase the value of apple [63]. This can stimulate the degree of activity in the apple futures market, which is also conducive to realizing the apple price discovery function and price stability function in the futures market.

In 2020, China will surpass the United States to become the world's largest consumer goods retail market [64]. Due to China's huge number of consumers, China is fast becoming a significant participant in world bulk commodity markets [65]. Agricultural production is the foundation of the entire Chinese economy. As such, large and abnormal agricultural commodities price fluctuations will significantly affect farmers' incomes and production initiatives. Any negative impact would not only be limited to China but could also expand to affect the global economy. As agricultural bulk commodities' price fluctuations are directly related to the stability of a country's macroeconomy, stabilizing the price of bulk commodity fluctuations is a critical task for China's economic management department [66].

China's agricultural product futures is an emerging market with a short development time. Its own market supervision system is not yet mature, which may lead to a large number of speculators engaging in speculation [15]. Moreover, when agricultural products become futures trading products, they will strengthen their own financial characteristics, causing both the futures and spot prices of commodities to fluctuate significantly [13,24]. People are worried that unscrupulous institutions and investors will manipulate the agricultural futures market and disrupt the futures market's original order and function. As such, our work suggests that China should launch new agricultural product futures to establish a healthy agricultural product futures market and improve the corresponding market system. In this way, the Chinese futures market can better play the role of risk aversion, price discovery, and price stabilization, helping China and the global economy to maintain stable growth.

Additionally, the increase in apple futures price will increase consumers' price expectations for commodity purchases and change consumers' buying preferences [67,68]. The changes in consumer purchasing preferences will lead to market demand elasticity changes, which will affect food prices and future market conditions. The market's response to this will affect futures prices [69]. Consumers' attitudes and preferences towards financial products will also have an impact on financial markets. Moreover, the instability of financial products such as futures, coupled with other factors, may lead to increasing food costs and continued price fluctuations [70]. It can be seen that commodity prices are not only determined by futures but also related to consumer behavior. Therefore, for China's goal of stabilizing commodity prices and continuing to develop the futures market, government departments also need to understand consumer preferences and their response to changes in commodity prices.

6. Conclusions

Here, we used the average price of Red Fuji apples in the national wholesale market collected by the Chinese Ministry of Commerce in the Bric database as research data. We also assessed the impact of futurization on agricultural spot price volatility using ITSA and GARCH modeling. Analysis of apple spot price data found that only large fluctuations occurred in 2019, and both the rise and fall were very sharp. Excluding the changes in 2019, the apple's price fluctuations in the six years from 2015 to 2020 tended to be generally stable. Our results demonstrate that: (1) the launch of China's apple futures did not increase the volatility of the apple's spot price, indicating that futures are not the cause of the soaring apple's spot price; and (2) futurization helped reduce the apple's spot price volatility in the long term (2+ years). Overall, our work shows that futures do not increase the price volatility of agricultural products and may even reduce volatility in the long term.

After the launch of China's apple futures, the apple's spot price fluctuated significantly. Among them, the sharp rise in the apple's spot price aroused widespread public concern. Some speculated that futurization was the main culprit for the abnormal fluctuations in the apple's spot price. However, this study's conclusions refute this viewpoint and instead suggest that China can further introduce new agricultural product futures and improve the agricultural product futures market.

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