Fluctuation traits of Litchi wholesale price in China

F F Yan1, W E Qi1, 2, 3 and X Ouyang1

1 Department of Economics and Management, South China Agricultural University, Guangzhou, Guangdong, 510642, China
2 National Litchi & Longan Industry’s Technology System, Guangzhou, Guangdong, 510642, China
E-mail: qiwene@scau.edu.cn

Abstract. This paper chose the wholesale price of litchi as research object based on the daily data of 11 main sales markets in China -- Beijing, Chengdu, Guangzhou, Hefei, Jiaxing, Nanjing, Shanghai, Shenyang, Changsha, Zhengzhou and Chongqing from April 1, 2012 to September 30, 2016. After analyzing the fluctuation characteristics with BP filter method and H-P filter method, and the fluctuation trends of litchi wholesale price in China obtained by BP filter are roughly consistent with the trends obtained by H-P filter. The main conclusions are as follows: there is strong cyclicality in the fluctuation of litchi wholesale price; the period of fluctuations of litchi wholesale prices are not repeatable; litchi wholesale price fluctuates asymmetrically in one fluctuation cycle.

1. Introduction
In 2016, there were about 1,853,377 acres of planting area of litchi all over the world. And there were 1,546,952 acres in China, accounting for 80% of the world's litchi planting area and ranked 1. In 2016, there were about 2,012,900 tons of litchi all over the world. And the total output of litchi in China is 1,702,100 tons, accounting for 84.56% of the whole world. Therefore, it is of great importance to study the Chinese litchi industry as it plays a decisive role in the world economy. According to the Statistics Database of PRC, planting area of litchi ranks 5, just following citrus, apples, pears and grapes, the top four economic agro-products in China. Therefore, it is of practical significance to study litchi industry.

Besides, in term of the property, litchi is a kind of typically perishable fruit, so it has a short shelf-period; and litchi is vulnerable to some factors such as season, climate conditions, supply and demand, so there tends to be great risk of litchi market and big fluctuations of litchi price, affecting the profits of litchi producers, consumers and other stakeholders in the supply chain. Therefore, it is of great significance to analyze the fluctuation characteristics of litchi price, because it can guide farmers and relative producers to arrange the production, grasp the rhythm of the operation and increase their income -- beef up the benefits of consumers.

There are four main planting provinces in China, namely Hainan, Guangdong, Guangxi Zhuang Autonomous Region and Fujian. Litchi is one of the main cash crops in these provinces. Litchi industry provides employment and survival opportunities for stakeholders in Hainan, Guangzhou, Guangxi and Fujian. According to incomplete statistics, there are 3,288 households engaged in litchi cultivation in the four provinces, and each household possesses approximately 9.23 acres of litchi garden for average. Litchi production is mainly for sale, so farmers rarely eat their own. According to
rough calculation, in 2016, the total turnover in litchi wholesale market was up to 300 billion RMB. That is why litchi industry makes a great contribution to Chinese Gross Domestic Product. Litchi sales in China mainly concentrate in six areas in China -- the Northeast market, the North market, the Central market, the South market, the East market and the Southwest market, covering more than 90% of the litchi sales markets in China. Therefore, when studying the price fluctuation of litchi in China, it is representative to choose litchi whole price of the Northeast market, the North market, the Central market, the South market, the East market and the southwest market as research object.

In recent years, a large number of literatures have studied the characteristics of price fluctuation. The main conclusions are as follows: the prices of agro-products fluctuate differently with different varieties [1]; in spatial transmission, the price of agro-products has significant heterogeneity [2]; and agricultural price transmission is asymmetric, namely the price swings like “rocket and feather” [3-22]. The theoretical contribution of this paper is that it expanded the economic research of litchi industry in China. As litchi is different from food crops and some vegetables or other bulk fruit like bananas, apples, grapes and pears which are necessity goods in our daily life, litchi has not been placed in an important position all the time, which leads to an absence of litchi price data on the market. Therefore, when studying the prices of agro-products fluctuate differently with different varieties [1]; in spatial transmission, the price of agro-products has significant heterogeneity [2]; and agricultural price transmission is asymmetric, namely the price swings like “rocket and feather” [3-22].

The theoretical contribution of this paper is that it expanded the economic research of litchi industry in China. As litchi is different from food crops and some vegetables or other bulk fruit like bananas, apples, grapes and pears which are necessity goods in our daily life, litchi has not been placed in an important position all the time, which leads to an absence of litchi price data on the Statistics Database of PRC and makes the researches on litchi industry be not profound enough in academic community. But as is explained above, it is certainly worth focusing more on the litchi industry, especially the fluctuation of litchi price. So, this paper tries to analyze the price fluctuation by BP filter and H-P filter so as to enrich the research content of litchi economy and verify the theory of asymmetric transmission, because the analysis is based on the theory of asymmetric transmission.

The practical contribution of this paper is to provide corresponding measures to avoid management risk in litchi industry, to resist the impact of price fluctuation and to ensure that the litchi industry can get a healthy and sustainable development by analyzing the characteristics of price fluctuation in litchi market.

From the perspective of data, most data types on agro-product price fluctuation are quarterly data, monthly data or weekly data, while it is rare to use daily data to analyze the price volatility. This paper uses daily data to study the fluctuation characteristics of wholesale price in the litchi markets, discloses the traits hidden in the quarterly data, monthly data or weekly data by average the daily volatility, which might be another contribution of this paper. In addition, this paper uses both BP filter and H-P filter to analyze the price fluctuation. Because there is no requirement for the length of the economic time series using H-P filter. However, on the one hand, it is relatively free to choose the parameters for H-P filter method, resulting in uncertainty of the economic fluctuations after H-P filter. On the other hand, the unrelated economic sequence may have a significant correlation after H-P filter [23], and if the economic time series exhibits smoothness after first order difference, may induce pseudo-periodic phenomena [24]. While BP filter method has a high requirement for the length of the economic time series, that is, there is limitation for small sample sequence, but it can overcome the problem of parameter selection problem of H-P filter, because BP filter method requires the level stable or first order stable of the economic sequence. Therefore, in order to make more accurate analysis of litchi wholesale price fluctuation, this paper uses BP filter and H-P filter and compares the results of the two filters and speculates that litchi wholesale price may be weakly dependent on filter models.

The design of this paper is as follows:
- First, use BP filter method to analyze litchi wholesale price of 11 sales markets;
- Second, analyse the samples by H-P filter;
- Third, compare the analysis of BP filter and H-P filter on price fluctuations of litchi wholesale;
- At the end, analyze the possible reasons of price fluctuations.

2. Research methods

2.1. Variable selection and sample source
Similar to most of the fresh agro-products, although there are new sales channels such as e-commerce, the main channels of litchi sales are still the traditional wholesale and retail. Usually, litchi distributors procurement litchi goods through the wholesale sites, the wholesale markets or contracting orchard directly in the origins, and then transport them to the wholesale markets for sale, and then retail them to terminal consumers via various retail methods. Therefore, the wholesale price is the most important indicators in the circulation of litchi, and is a barometer in litchi market. Changes in the wholesale price will directly lead to Domino effect of the wholesale price of the upstream origins and the retail price of the downstream. Therefore, this paper chooses litchi wholesale price as the main variable.

The data of this paper are derived from “Basic Database of National Litchi & Longan Industry’s Technology System”, which covers data in 11 major sales market of litchi including Northeast China market (Shenyang), North China market (Beijing), Central China market (Changsha, Zhengzhou), South China market (Guangzhou), East China market (Shanghai, Jiaxing, Nanjing and Hefei) and Southwest market (Chongqing, Chengdu). In this paper, we selected the daily data of litchi wholesale price from April 1, 2012 to September 30, 2016. The total number of samples is 5195.

2.2. Model establishment

On the study of price fluctuation of agro-products, previous literature usually used the original time series, but few used the trend data after decomposing original series into trend parts, seasonal parts and irregular parts. The common method to decompose data is seasonal adjustment method, which is only suitable for monthly data or quarterly data but not daily data. So, this article does not use the season adjustment method, but use the filter method directly to study the litchi wholesale price fluctuations. The main filter methods of decomposing price of agro-products are H-P filter [25-27] and BP filter. In order to get more accurate results, this paper uses both BP filter method and H-P filter method to analyze litchi wholesale price and compare the results of these two methods.

Baxter and King[28] proposed BP filter method based on spectral analysis of the decoupling method, also known as spectral analysis, the modelling idea: time sequence \( X = \{x_1, x_2, ..., x_t\} \), \( T \) is the length of time series \( X \). The main idea of spectrum analysis sees the fluctuation of the economic time series \( X \) as the results of several different frequencies, and tries to find out the most explanatory of the fluctuation of the economic event sequence \( X \) in these different frequencies.

Hodrick and Prescott [29] proposed an H-P filter method to study the fluctuation of the economic sequence. The idea of this method is similar to that of BP filter, except that the H-P filter method considers the fluctuation of the economic time series as the superposition of the growth component and the periodic component. The use of the method has a long history, especially in actuarial science. The conceptual framework of the H-P filter method is as follows: A given economic time series \( \{Y_t\} \) is the summation of the growth component \( \{Y_t^g\} \) and the periodic component \( \{Y_t^p\} \), then the specific expression is:

\[
Y_t = Y_t^g + Y_t^p
\]  

(1)

The smoothing method of the H-P filter method for the economic time series \( \{Y_t\} \) fluctuation is the square sum of the second order difference of the economic event sequence. Then the periodic component \( \{Y_t^p\} \) of the economic sequence \( \{Y_t\} \) is separated from the growth component \( \{Y_t^g\} \). Since the conceptual framework of the method is long-term, the average of the long-term periodic component \( \{Y_t^p\} \) tends to zero. Based on above conditions, growth ingredients are as follows:

\[
\min_{\{Y_t^p\}_{t=1}^T} \left\{ \sum_{t=1}^T Y_t^{p2} + \lambda \sum_{t=1}^T [ (Y_t^g - Y_{t-1}^g) - (Y_{t-1}^g - Y_{t-2}^g) ]^2 \right\}
\]  

(2)

3. Empirical analysis

3.1. Descriptive statistics
The descriptive statistics are as follows (see table 1):

- The average whole price of litchi is 19.10 CNY/kg in Beijing, 20.43 CNY/kg in Chengdu, 18.40 CNY/kg in Guangzhou, 16.28 CNY/kg in Hefei, 14.98 CNY/kg in Jiaxing, 17.81 CNY/kg in Nanjing, 20.92 CNY/kg in Shanghai, 13.51 CNY/kg in Shenyang, 17.66 CNY/kg in Changsha, 15.54 CNY/kg in Zhengzhou, 17.46 CNY/kg in Chongqing.
- As for litchi’s highest price, it is 70.00 CNY/kg in Beijing, 60.00 CNY/kg in Chengdu, 40.00 CNY/kg in Guangzhou, 60.00 CNY/kg in Hefei, 66.00 CNY/kg in Jiaxing, 61.40 CNY/kg in Nanjing, 80.00 CNY/kg in Shanghai, 30.00 CNY/kg in Shenyang, 60.00 CNY/kg in Changsha, 50.00 CNY/kg in Zhengzhou, 60.00 CNY/kg in Chongqing.
- In terms of litchi’s lowest price, it is 7.96 CNY/kg in Beijing, 3.80 CNY/kg in Chengdu, 5.00 CNY/kg in Guangzhou, 7.80 CNY/kg in Hefei, 7.00 CNY/kg in Jiaxing, 6.00 CNY/kg in Nanjing, 8.00 CNY/kg in Shanghai, 6.40 CNY/kg in Shenyang, 6.00 CNY/kg in Changsha, 8.00 CNY/kg in Zhengzhou, 2.60 CNY/kg in Chongqing.

### Table 1. Descriptive statistics of litchi price.

| Sales Market | Observations | Mean  | Standard Deviation | Minimum | Maximum |
|--------------|--------------|-------|--------------------|---------|---------|
| Beijing      | 517          | 19.10 | 8.57               | 7.96    | 70      |
| Chengdu      | 306          | 20.43 | 10.38              | 3.80    | 60      |
| Guangzhou    | 735          | 18.40 | 6.75               | 5.00    | 40      |
| Hefei        | 314          | 16.28 | 7.36               | 7.80    | 60      |
| Jiaxing      | 550          | 14.98 | 5.96               | 7.00    | 66      |
| Nanjing      | 298          | 17.81 | 10.13              | 6.00    | 61.4    |
| Shanghai     | 633          | 20.92 | 10.69              | 8.00    | 80      |
| Shenyang     | 247          | 13.51 | 3.96               | 6.40    | 30      |
| Changsha     | 781          | 17.66 | 9.30               | 6.00    | 60      |
| Zhengzhou    | 354          | 15.54 | 7.82               | 8.00    | 50      |
| Chongqing    | 460          | 17.46 | 7.84               | 2.60    | 60      |

### 3.2. BP filter method

BP filter [28] requires the sample size to be large and the sample data be covariance stationary process or unit root process when the full sample length asymmetric filter is selected. Therefore, the sample data should be tested for stationary before BP filter. In this article, we use Eviews8.0 to test the stability of litchi wholesale price in China. The test results are shown in table 2: The original sequences of the litchi wholesale prices in Hefei, Chengdu, Guangzhou, Jiaxing, Nanjing, Shanghai, Shenyang, Changsha, Zhengzhou and Chongqing are stationary, while the original data in Hefei are not stationary sequence but conform to the requirement of the whole sample length asymmetric filtering after the first order difference. The original sequences of the wholesale price of litchi in Beijing, Chengdu, Guangzhou, Jiaxing, Nanjing, Shanghai, Shenyang, Changsha, Zhengzhou and Chongqing is I(1), while in Hefei is I(0) which need to be adjusted before using the full sample asymmetric BP filter. The methods used for detrending mainly contain removing the average, removing the linear trend and adjusting the drift. Considering that there may be mean value of the original data, this paper chooses the trend method removing the average to adjust.

Applying cycle factor based on BP filter method and "Crest-Crest" method, this paper divides wholesale price fluctuation of litchi into some cycles, as shown in table 3: from April 1, 2012 to September 30, 2016, litchi wholesale price in Beijing can be divided into 12 cycles; Chengdu into 10 cycles; Guangzhou into 23 cycles; Hefei into 10 cycles; Jiaxing into 15 cycles; Nanjing into 10 cycles;
Shanghai into 15 cycles; Shenyang into 10 cycles; Changsha into 21 cycles; Zhengzhou into 5 cycles; Chongqing into 10 cycles.

**Table 2. Stability Test of litchi price in China.**

| Sales Market | Test form       | ADF statistics | P value | ADF conclusion | KPSS statistics | 1% critical value | KPSS conclusion |
|--------------|----------------|----------------|---------|----------------|-----------------|-------------------|-----------------|
| Beijing      | C(C,T,0)       | -6.4148        | 0.0000  | Y              | 0.0855          | 0.739             | Y               |
| Chengdu      | C(C,T,0)       | -6.3110        | 0.0000  | Y              | 0.0563          | 0.739             | Y               |
| Guangzhou    | C(C,T,0)       | -6.0026        | 0.0000  | Y              | 0.2900          | 0.739             | Y               |
| Hefei        | C(C,T,0)       | -6.6364        | 0.0000  | Y              | 0.8897          | 0.739             | N               |
| Jiaxing      | C(C,T,2)       | -5.0810        | 0.0000  | Y              | 0.0860          | 0.739             | Y               |
| Nanjing      | C(C,T,0)       | -5.2688        | 0.0000  | Y              | 0.1266          | 0.739             | Y               |
| Shanghai     | C(C,T,0)       | -7.7335        | 0.0000  | Y              | 0.4526          | 0.739             | Y               |
| Shenyang     | C(C,T,0)       | -7.5403        | 0.0000  | Y              | 0.0735          | 0.739             | Y               |
| Changsha     | C(C,T,0)       | -6.9880        | 0.0000  | Y              | 0.1022          | 0.739             | Y               |
| Zhengzhou    | C(C,T,0)       | -3.8623        | 0.0026  | Y              | 0.1229          | 0.739             | Y               |
| Chongqing    | C(C,T,0)       | -7.0794        | 0.0000  | Y              | 0.1160          | 0.739             | Y               |
| DHefei       | C(C,T,0)       | -15.2062       | 0.0000  | Y              | 0.0221          | 0.739             | Y               |

D represents the first order difference for the time series. In the test form (C, T, L), C is the intercept term, T is the trend term, L is the lag order, Y means stationary, and N means non-stationary. The lag order is measured by the AIC criterion and the SIC criterion, and the maximum lag order applies the default setting.

3.3. H-P filter method

The main idea of H-P filter is to decompose the original time series into trend components and cyclic components [29]. After decomposing, we can get the H-P filter results of litchi wholesale price in China as follows:

Applying cycle factor based on H-P filter method and "Crest-Crest" method, we can divide the wholesale price fluctuation of Chinese litchi into different cycles according to different sales marktes, as shown in table 3: from April 1, 2012 to September 30, 2016, litchi wholesale price in Beijing can be divided into 12 cycles; Chengdu into 8 cycles; Guangzhou into 23 cycles; Hefei into 8 cycles; Jiaxing into 15 cycles; Nanjing into 10 cycles; Shanghai into 15 cycles; Shenyang into 8 cycles; Changsha into 21 cycles; Zhengzhou into 5 cycles; Chongqing into 13 cycles.

**Table 3. Cycle comparison between BP filter and H-P filter.**

| Sales markets | BP filter | H-P filter | Sales Market | BP filter | H-P filter |
|---------------|-----------|------------|--------------|-----------|------------|
| Beijing       | 12        | 12         | Shanghai     | 15        | 15         |
| Chengdu       | 10        | 8          | Shenyang     | 10        | 8          |
| Guangzhou     | 23        | 23         | Changsha     | 21        | 21         |
| Hefei         | 10        | 10         | Zhengzhou    | 5         | 5          |
| Jiaxing       | 15        | 15         | Chongqing    | 10        | 13         |
| Nanjing       | 10        | 10         |              |           |            |
After Comparing the filtering results of BP filter method and H-P filter method of the 11 sales markets below (see tables 4-14), we can find the cycle divided by BP and H-P are almost the same except in Chengdu and Shenyang whose cycles divided by BP filter are a little higher than that of H-P filter, Chongqing whose cycles divided by BP filter are a little less than that of H-P filter.

**Table 4.** Cyclical characteristics of price fluctuations in Beijing.

| Cycle # | Wavelength (day) | Pitch | The position of the trough in the wavelength |
|---------|------------------|-------|--------------------------------------------|
|         | BP               | H-P   | BP H-P 6 8                                 |
| Cycle 1 | 7 20             | 4 10 6 | 8                                             |
| Cycle 2 | 8 30             | 2 44 3 | 18                                            |
| Cycle 3 | 9 50             | 1 46 4 | 40                                            |
| Cycle 4 | 8 50             | 0.5 20 | 4 30                                          |
| Cycle 5 | 7 10             | 2 12 5 | 6                                             |
| Cycle 6 | 6 30             | 1 14 4 | 16                                            |
| Cycle 7 | 10 40            | 6 2 3  | 21                                            |
| Cycle 8 | 8 80             | 2 6 4  | 10                                            |
| Cycle 9 | 9 20             | 10 8 5 | 12                                            |
| Cycle 10| 7 40             | 3 12 4 | 22                                            |
| Cycle 11| 12 40            | 35 14 4| 22                                            |
| Cycle 12| 10 50            | 11 12 6| 40                                            |

**Table 5.** Cyclical characteristics of price fluctuations in Chengdu.

| Cycle # | Wavelength (day) | Pitch | The position of the trough in the wavelength |
|---------|------------------|-------|--------------------------------------------|
|         | BP               | H-P   | BP H-P 15 10 5 15                           |
| Cycle 1 | 20 25            | 15 4 5 | 15                                           |
| Cycle 2 | 21 50            | 8 16 11 | 40                                           |
| Cycle 3 | 43 15            | 18 5 37 | 5                                             |
| Cycle 4 | 19 50            | 25 26 12 | 40                                           |
| Cycle 5 | 47 20            | 39 7 40 | 6                                             |
| Cycle 6 | 18 30            | 27 26 14 | 17                                           |
| Cycle 7 | 35 28            | 33 15 25 | 15                                           |
| Cycle 8 | 25 40            | 34 20 19 | 21                                           |
| Cycle 9 | 36 30            | 30 31 |                                               |
| Cycle 10| 19 31            | 31 15 |                                               |

**Table 6.** Cyclical characteristics of price fluctuations in Guangzhou.

| Cycle # | Wavelength (day) | Pitch | The position of the trough in the wavelength |
|---------|------------------|-------|--------------------------------------------|
|         | BP               | H-P   | BP H-P 11 10 4 10                           |
| Cycle 1 | 15 22            | 5 4 11 | 10                                           |
Cycle 2 19 34 3 26 15 12
Cycle 3 25 39 21 12 5 19
Cycle 4 17 32 7 16 13 15
Cycle 5 34 40 11 18 6 24
Cycle 6 30 48 13 32 22 23
Cycle 7 39 20 15 20 19 8
Cycle 8 45 45 25 25 23 35
Cycle 9 20 21 17 15 15 12
Cycle 10 40 9 27 2 31 5
Cycle 11 22 28 13 21 16 17
Cycle 12 33 16 10 10 31 10
Cycle 13 23 14 6 3 2 7
Cycle 14 24 15 7 4 8 8
Cycle 15 22 39 24 33 10 14
Cycle 16 33 23 6 7 10 10
Cycle 17 47 31 16 29 11 23
Cycle 18 43 18 28 2 39 9
Cycle 19 40 17 27 1 36 8
Cycle 20 20 31 2 20 2 2
Cycle 21 24 50 6 16 22 24
Cycle 22 35 16 17 8 10 10
Cycle 23 39 62 4 24 35 41

Table 7. Cyclical characteristics of price fluctuations in Hefei.

| Cycle # | Wavelength (day) | Pitch | The position of the trough in the wavelength |
|---------|------------------|-------|---------------------------------------------|
|         | BP   | H-P  | BP   | H-P  | BP   | H-P  |
| Cycle 1 | 29   | 18   | 5    | 3    | 6    | 10   |
| Cycle 2 | 64   | 36   | 25   | 7    | 9    | 16   |
| Cycle 3 | 13   | 28   | 19   | 2    | 8    | 17   |
| Cycle 4 | 23   | 32   | 13   | 15   | 10   | 18   |
| Cycle 5 | 32   | 30   | 12   | 11   | 9    | 20   |
| Cycle 6 | 19   | 32   | 9    | 14   | 10   | 20   |
| Cycle 7 | 17   | 26   | 8    | 6    | 8    | 22   |
| Cycle 8 | 15   | 28   | 6    | 5    | 7    | 23   |
| Cycle 9 | 19   | 20   | 23   | 15   | 15   | 12   |
| Cycle 10 | 33  | 32   | 20   | 14   | 28   | 18   |
### Table 8. Cyclical characteristics of price fluctuations in Jiaxing.

| Cycle # | Wavelength (day) | Pitch | The position of the trough in the wavelength |
|---------|------------------|-------|---------------------------------------------|
|         | BP | H-P | BP | H-P | BP | H-P |
| Cycle 1 | 24 | 18 | 7 | 4 | 15 | 8 |
| Cycle 2 | 19 | 20 | 4 | 8 | 8 | 9 |
| Cycle 3 | 21 | 36 | 9 | 16 | 14 | 16 |
| Cycle 4 | 39 | 30 | 11 | 20 | 13 | 12 |
| Cycle 5 | 30 | 24 | 16 | 8 | 6 | 18 |
| Cycle 6 | 27 | 50 | 10 | 26 | 17 | 15 |
| Cycle 7 | 53 | 22 | 21 | 20 | 20 | 20 |
| Cycle 8 | 22 | 42 | 18 | 6 | 12 | 19 |
| Cycle 9 | 41 | 30 | 4 | 7 | 18 | 16 |
| Cycle 10 | 30 | 28 | 6 | 4 | 15 | 18 |
| Cycle 11 | 29 | 32 | 3 | 8 | 17 | 18 |
| Cycle 12 | 30 | 22 | 6 | 2 | 20 | 11 |
| Cycle 13 | 50 | 25 | 23 | 17 | 30 | 12 |
| Cycle 14 | 58 | 55 | 17 | 16 | 23 | 21 |
| Cycle 15 | 31 | 34 | 11 | 6 | 13 | 14 |

### Table 9. Cyclical characteristics of price fluctuations in Nanjing.

| Cycle # | Wavelength (day) | Pitch | The position of the trough in the wavelength |
|---------|------------------|-------|---------------------------------------------|
|         | BP | H-P | BP | H-P | BP | H-P |
| Cycle 1 | 25 | 32 | 20 | 14 | 13 | 18 |
| Cycle 2 | 9 | 22 | 6 | 15 | 5 | 16 |
| Cycle 3 | 40 | 18 | 16 | 4 | 33 | 10 |
| Cycle 4 | 27 | 10 | 8 | 12 | 12 | 5 |
| Cycle 5 | 50 | 20 | 14 | 5 | 41 | 14 |
| Cycle 6 | 25 | 25 | 28 | 12 | 21 | 20 |
| Cycle 7 | 10 | 30 | 17 | 7 | 6 | 18 |
| Cycle 8 | 33 | 34 | 16 | 29 | 7 | 14 |
| Cycle 9 | 10 | 40 | 18 | 22 | 7 | 22 |
| Cycle 10 | 11 | 30 | 4 | 12 | 8 | 18 |

### Table 10. Cyclical characteristics of price fluctuations in Shanghai.

| Cycle # | Wavelength (day) | Pitch | The position of the trough in the wavelength |
|---------|------------------|-------|---------------------------------------------|
|         | BP | H-P | BP | H-P | BP | H-P |
| Cycle 1 | 39 | 40 | 24 | 23 | 23 | 15 |
| Cycle 2 | 14 | 40 | 10 | 25 | 8 | 25 |
Table 11. Cyclical characteristics of price fluctuations in Shenyang.

| Cycle # | Wavelength (day) | Pitch | The position of the trough in the wavelength |
|---------|------------------|-------|---------------------------------------------|
|         | BP H-P | BP H-P | BP H-P |
| Cycle 1 | 20 18 | 3 2 | 5 8 |
| Cycle 2 | 10 30 | 4 2 | 7 12 |
| Cycle 3 | 20 28 | 3 9 | 5 10 |
| Cycle 4 | 27 22 | 18 5 | 10 10 |
| Cycle 5 | 21 23 | 11 4 | 16 8 |
| Cycle 6 | 9 20 | 12 1 | 4 10 |
| Cycle 7 | 10 36 | 5 8 | 5 22 |
| Cycle 8 | 20 28 | 4 6 | 14 18 |
| Cycle 9 | 32 | 5 | 5 |
| Cycle 10 | 30 | 8 | 20 |

Table 12. Cyclical characteristics of price fluctuations in Changsha.

| Cycle # | Wavelength (day) | Pitch | The position of the trough in the wavelength |
|---------|------------------|-------|---------------------------------------------|
|         | BP H-P | BP H-P | BP H-P |
| Cycle 1 | 18 18 | 7 6 | 15 12 |
| Cycle 2 | 28 26 | 3 3 | 9 10 |
| Cycle 3 | 31 34 | 18 18 | 16 7 |
| Cycle 4 | 30 28 | 22 22 | 21 20 |
| Cycle 5 | 27 24 | 5 1 | 9 9 |
| Cycle 6 | 35 50 | 4 10 | 14 23 |
| Cycle 7 | 81 72 | 7 24 | 41 35 |
| Cycle 8 | 21 20 | 31 21 | 11 10 |
| Cycle # | Wavelength (day) | Pitch | The position of the trough in the wavelength |
|---------|-----------------|-------|---------------------------------------------|
|         | BP H-P          | BP H-P| BP H-P                                      |
| Cycle 1 | 57 50           | 7 45  | 7                                          |
| Cycle 2 | 50 68           | 29 44 | 40                                          |
| Cycle 3 | 11 38           | 28 22 | 8                                          |
| Cycle 4 | 59 32           | 16 6  | 9                                          |
| Cycle 5 | 145 72          | 13 20 | 60                                          |

Table 13. Cyclical characteristics of price fluctuations in Zhengzhou.

| Cycle # | Wavelength (day) | Pitch | The position of the trough in the wavelength |
|---------|-----------------|-------|---------------------------------------------|
|         | BP H-P          | BP H-P| BP H-P                                      |
| Cycle 1 | 11 42           | 12 12 | 9 25                                      |
| Cycle 2 | 10 58           | 7 5   | 4 18                                      |
| Cycle 3 | 51 44           | 14 10 | 46 31                                    |
| Cycle 4 | 9 26            | 8 5   | 7 12                                    |
| Cycle 5 | 26 40           | 11 8  | 15 32                                    |
| Cycle 6 | 14 22           | 9 6   | 5 9                                     |
| Cycle 7 | 35 30           | 18 9  | 31 23                                    |
| Cycle 8 | 26 19           | 16 2  | 22 12                                    |
| Cycle 9 | 10 21           | 11 7  | 7 13                                    |
| Cycle 10| 12 23           | 15 5  | 5 10                                    |
| Cycle 11| 29 9            |       | 17                                         |
| Cycle 12| 16 10           |       | 7                                          |
| Cycle 13| 20 13           |       | 14                                         |
According to the results above, we can get information about the wavelength, the pitch and the position of the trough in the wavelength of fluctuation of litchi wholesale price in China.

- In terms of wavelength: in Beijing, the longest wavelength obtained by BP filter method is 12 days falling in the eleventh cycle while 80 days by H-P filter, the shortest wavelength is only 6 days obtained by BP filter while 10 days by H-P filter; in Chengdu, the longest wavelength obtained by BP filter method is 43 days falling in the third cycle while 50 days by H-P filter, the shortest wavelength is 18 days falling in the sixth cycle while 15 days by H-P filter; in Guangzhou, the longest wavelength obtained by BP filter method is 45 days falling in the eighth cycle while 62 days by H-P filter and the shortest is only 9 days falling in the eighth cycle while 9 days by H-P filter; in Hefei, the longest wavelength obtained by BP filter method is 32 days falling in the second cycle while 32 days by H-P filter, the shortest wavelength is 15 days falling in the first cycle while 10 days by H-P filter; in Jiaxing, the longest wavelength obtained by BP filter method is 58 days falling in the fourth cycle while 55 days by H-P filter, the shortest wavelength is 19 days falling in the second cycle while 18 days by H-P filter; in Nanjing, the longest wavelength obtained by BP filter method is 50 days falling in the fifth cycle while 40 days by H-P filter, the shortest wavelength is 9 days falling in the second cycle while 10 days by H-P filter; in Shanghai, the longest wavelength obtained by BP filter method is 132 days falling in the fifth cycle while 76 days by H-P filter, the shortest wavelength is only 8 days falling in the eighth cycle while 16 days by H-P filter; in Shenyang, the longest wavelength obtained by BP filter method is 32 days falling in the ninth cycle, the shortest wavelength is 9 days falling in the sixth cycle; in Changsha, the longest wavelength obtained by BP filter method is 81 days falling in the seventh cycle, the shortest wavelength is 13 days falling in the seventeenth cycle; in Zhengzhou, the longest wavelength obtained by BP filter method is 145 days falling in the fifth cycle while 72 days by H-P filter, the shortest wavelength is only 11 days falling in the third cycle while 32 days by H-P filter; in Chongqing, the longest wavelength obtained by BP filter method is 35 days falling in the seventh cycle while 58 days by H-P filter, the shortest wavelength is 9 days falling in the fourth cycle while 16 days by H-P filter.

- Pitch shows the distance between the peak and the trough of litchi price, the lager the value of pitch is, the greater litchi price fluctuates. So as for pitch, in Beijing, the maximum value of the pitch obtained by BP filter method appears in the eleventh cycle indicating that litchi wholesale price in this period fluctuates largely, while in the eleventh cycle by H-P filter, the minimum value appears in the fourth cycle obtained by BP filter meaning that litchi wholesale price fluctuates largely in this period. while in the fourth cycle by H-P filter; in Chengdu, the maximum value of the pitch obtained by BP filter method appears in the fifth cycle indicating that litchi wholesale price in this period fluctuates largely, while in the fifth cycle by H-P filter, the minimum value appears in the second cycle obtained by BP filter meaning that litchi wholesale price fluctuates largely in this period, while in the second cycle by H-P filter; in Guangzhou, the maximum value of the pitch obtained by BP filter method appears in the eighteenth cycle indicating that litchi wholesale price in this period fluctuates largely, while in the eighth cycle by H-P filter, the minimum value appears in the twentieth cycle obtained by BP filter meaning that litchi wholesale price fluctuates largely in this period. while in the twentieth cycle by H-P filter; in Hefei, the maximum value of the pitch obtained by BP filter method appears in the second cycle indicating that litchi wholesale price in this period fluctuates largely, while in the second cycle by H-P filter, the minimum value appears in the first cycle obtained by BP filter meaning that litchi wholesale price fluctuates largely in this period. while in the first cycle by H-P filter; in Jiaxing, the maximum value of the pitch obtained by BP filter method appears in the seventh cycle indicating that litchi wholesale price in this period fluctuates largely, while in the seventh cycle by H-P filter, the minimum value appears in the eleventh cycle obtained by BP filter meaning that litchi wholesale price fluctuates largely in this period, while in the eleventh cycle by H-P filter; in Nanjing, the
maximum value of the pitch obtained by BP filter method appears in the sixth cycle indicating that litchi wholesale price in this period fluctuates largely, while in the sixth cycle by H-P filter, the minimum value appears in the tenth cycle obtained by BP filter meaning that litchi wholesale price fluctuates largely in this period, while in the tenth cycle by H-P filter; in Shanghai, the maximum value of the pitch obtained by BP filter method appears in the fourteenth cycle indicating that litchi wholesale price in this period fluctuates largely, while in the fourteenth cycle by H-P filter, the minimum value appears in the seventh cycle obtained by BP filter meaning that litchi wholesale price fluctuates largely in this period, while in the seventh cycle by H-P filter; in Shenyang, the maximum value of the pitch obtained by BP filter method appears in the fourth cycle indicating that litchi wholesale price in this period fluctuates largely, while in the fourth cycle by H-P filter, the minimum value appears in the second cycle obtained by BP filter meaning that litchi wholesale price fluctuates largely in this period, while in the second cycle by H-P filter; in Changsha, the maximum value of the pitch obtained by BP filter method appears in the eighth cycle indicating that litchi wholesale price in this period fluctuates largely, while in the eighth cycle by H-P filter, the minimum value appears in the second cycle obtained by BP filter meaning that litchi wholesale price fluctuates largely in this period, while in the second cycle by H-P filter; in Zhengzhou, the maximum value of the pitch obtained by BP filter method appears in the second cycle indicating that litchi wholesale price in this period fluctuates largely, while in the second cycle by H-P filter, the minimum value appears in the first cycle obtained by BP filter meaning that litchi wholesale price fluctuates largely in this period, while in the first cycle by H-P filter; in Chongqing, the maximum value of the pitch obtained by BP filter method appears in the ninth cycle indicating that litchi wholesale price in this period fluctuates largely, while in the ninth cycle by H-P filter, the minimum value appears in the second cycle obtained by BP filter meaning that litchi wholesale price fluctuates largely in this period, while in the second cycle by H-P filter.

- After calculating the location of the trough in the wavelength, we can find that the position of the trough in the fluctuation period of litchi wholesale price in China is not in the middle of this cycle. Usually, the wholesale price of Chinese litchi in the same fluctuation cycle falls faster from the first peak to the trough than the rate of price rising from the trough to the second peak of the descent cycle faster, which means Chinese litchi wholesale price fluctuates asymmetrically.

4. Conclusion
This paper analyzed the fluctuation characteristics of litchi wholesale price in China from April 1, 2012 to September 30, 2016 by BP filter and H-P filter. The main conclusions are as follows:

- The choice of the filter method has a weak influence on the division of the price fluctuation period;
- The fluctuations of wholesale price of litchi have strong cyclicality;
- The fluctuations of wholesale price of litchi are non-repeatable;
- The fluctuations of wholesale price of litchi are like "rocket and feather", which prove the asymmetric transmission theory of price.

4.1. Different filter methods weakly affect cycle divisions
The divisions of wholesale price cycle numbers of Beijing, Changsha, Guangzhou, Zhengzhou, Shanghai, Jiaxing, Nanjing and Hefei are nearly consistent between BP filter and H-P filter. The divisions of litchi wholesale price cycle numbers of Shenyang, Chongqing and Nanjing are not the same. The reasons for these differences may be the differences in the requirements of the different filter methods, or the existence of some unique features in litchi wholesale price fluctuations of Shenyang, Chongqing and Nanjing.
4.2. Litchi prices fluctuate cyclically

In the market of litchi, the wholesale prices of Shenyang, Beijing, Changsha, Zhengzhou, Guangzhou, Shanghai, Jiaxing, Nanjing, Hefei, Chongqing and Chengdu litchi have obvious cyclical fluctuations. The possible factors of cyclical fluctuations are mainly affected by external shocks, the specific performance in the following two aspects:

- Climatic factors. Because there are high temperature, high humidity, summer rain and winter dry subtropical monsoon climate in litchi planting areas. To explain cycle characteristics of climatic factors, this paper takes the maximum temperatures and minimum temperatures (see figure 1) in 11 litchi sales markets from January 1 2012 to December 31, 2016 as an example.

![Figure 1. Maximum and minimum temperatures from 2012 to 2016.](image)

- Money supply. The theory of monetarism mainly concerns on the change of money supply to the price transmission. When the money supply changes, the price of the money is transferred to the non-agro-products, so that the overall price level of the whole society changes and is further transmitted to the agro-products. The impact of changes in the amount of money in short term more intense on prices of agro-products than non-agricultural products. The data released by the Bureau of Statistics show: from 2012 to 2016, the Chinese money supply experienced a continual augment (see figure 2, Unit: Billion RMB). According to the theory of
monetarism, the change in the supply of money in the short term tends to have an impact on the prices of agro-products. In fact, the cyclical fluctuations of litchi price are caused not by the changes of money supply itself, but the percentage of money supply changes. The following analysis shows how the percentage change in money supply causes periodic fluctuations in litchi wholesale price.

Figure 3 shows: from 2012 to 2016, the percentage of change of money supply in China (Unit: %) shows cyclical fluctuations, these cyclical fluctuations transmit to the price of non-agro-products, and then the price fluctuations of non-agro-products transmit to the price fluctuations of agro-products. Cereals, vegetables, pork, mutton and other agro-products are necessity goods, and rational consumers would adjust their behavior in the consumption of agro-products based on their own preferences and budget constraints. On the one hand, the rural residents who are engaged in cultivation and breeding necessity goods are more elastic to needs than rural residents who are not. So, if the budget is constant, their consumption on necessities would not change much (mainly by self-sufficiency or small purchase), while the consumption of litchi changes just a little, this part of the litchi consumers are litchi price maintainers. On the other hand, the demand of rural residents who are not engaged in cultivating and breeding necessity goods and urban residents is more elastic than those who are engaged in cultivating and breeding necessity goods. Therefore, if the budget is constant, the shift of consumption of their necessities is relatively large (mainly by large purchases), and the consumption of litchi would be reduced. This part of the consumers is the causers of litchi price fluctuations.

To sum up, the cyclical fluctuations in the percentages of changes of money supply in China transmit to non-agro-commodity price fluctuations, and then the price fluctuations of non-agro-products transmit to the daily necessity agro-products, and at the end necessity agro-products cyclical price fluctuations transmit to litchi and other non-essential agro-products cyclical price fluctuations.

4.3. Litchi wholesale price cyclical fluctuate non-repeatable
The fluctuation periods of litchi wholesale price in Shenyang, Beijing, Changsha, Zhengzhou, Guangzhou, Shanghai, Jiaxing, Nanjing, Hefei, Chongqing and Chengdu are not repeatable. The reasons for the cyclical non-repeatability of the wholesale price fluctuations are uncertain factors. The main uncertainties may be as follows:

- Natural disaster. Natural disaster, always sudden, which would cause some sudden change in litchi supply. For example, from July to August in 2012, frequent high temperatures continued in southern China; in late July "Vicente", "Sura", "Da Wei", "Swallow", "Kai Tak" and "Libra" Typhoon landed in sequence, and brought heavy rain. In the annual cycle of growth and development, litchi needs abundant water, but in the late development of fruits, heavy rain
would deduce cracked fruit and produce fruit-drop. In 2013, low temperature in China's inland areas, the maturity of the producing areas across China was earlier than expected at the beginning of the year. Although litchi flowering was good, some of the producing areas suffered from continuous rainy weather during the flowering period. The fruits dropped severely, fruiting rate decreased. But due to appropriate application for technologies from Technology Demonstration Garden, flowering situation was good in most Demonstration Garden, and fruiting rate was higher than general level in local, causing an increase in litchi production in 2012, making the supply and quality of litchi improve over the previous year, and resulting in wholesale prices rising in varying degrees. In May 2014, Guangdong and Hainan were stricken by storms; "Madame", "Wilson", "Seagull" and "Phoenix" and other typhoons spread to Fujian and other origins, coincided with the fruiting period of early maturing litchi, so the fruits hit down by the storms. In October 25, 2015, Strong typhoon "Rainbow" landed Potou District in Zhanjiang, with big intensity, wide range, strongly destructive power, broke litchi branches and leaves; unfortunately, just as the flower-bud-differentiation period of early maturing litchi, thus produced lower fruiting rate. In 2016, "5.20" special heavy rain in Xinyi, Guangdong Province, caused a serious disaster, knocked off the fruits of early maturing litchi. In late October, "Hippocampus" landed in Guangdong, decreased the litchi fruiting rate. It can be seen that the types of abnormal climates, the time and place of occurrence, the frequency, the duration time, the different range of radiation, the degree of influence, and the rescue strategy of the grower cause changes of litchi supply. So the litchi price presents non-repeated cycle fluctuations. The wholesale price fluctuations from 2012 to 2016 were relatively frequent and uncertain, so some fluctuation cycle of litchi wholesale price is divided into several different small cycles.

- Concentrated litchi production. For the case of litchi, a kind of small agro-products, because of concentrated origins in four geographically adjacent provinces, namely Hainan, Guangdong, Guangxi and Fujian. Once the litchi origins suffered from natural disasters, there would be a sharp decline in production, so the litchi purchase price deviated from the expected fluctuation cycles, and then formed more deviation of the wholesale price fluctuation cycles than normal years through vertical transmission.

- Domestic high-quality litchi sales collectively. High quality domestic litchi sales together compressed importing quantity of litchi. In 2014, litchi sold together in Guangdong, Guangxi and Fujian, with good quality and taste, made Sino-Vietnamese fruit merchants undertake serious loss of importing litchi, and litchi imports from Vietnamese decreased. So, the domestic litchi total supply reduced, and demand for domestic litchi increased, leading to prices rising of litchi in China.

- Factors and paths are complex. The factors that affect the price fluctuation of litchi are numerous and the path of influence is complicated. Therefore, the periods of litchi wholesale price fluctuation may be close, but the factors that play a leading role will change with time. And new influencing factors will appear. Therefore, these two factors lead to the origins and sales markets of litchi price fluctuations to be non-repeatable.

4.4. Litchi wholesale price fluctuates like "rocket and feather"

- In Beijing, Chengdu, Guangzhou, Hefei, Jiaxing, Nanjing, Shanghai, Shenyang, Changsha, Zhengzhou and Chongqing, the wave pitches of litchi wholesale price fluctuations are asymmetric. The conclusion on "rocket and feather" asymmetric price transmission is consistent with the existing research. Litchi prices show "rockets and feathers" asymmetric fluctuations, and the main reasons are as follows: import foreign litchi. The price of domestic litchi is easily be impact on by importing foreign litchi. China imported litchi from Thailand, Malaysia, Vietnam and Myanmar in 2016. Among them, the export litchi from Vietnam to China was almost the same high quality as that of domestic litchi, but its orchards, packaging factories and warehouses must be registered in the Department of Agriculture in the origin
country. The Pesticide content must go through the inspection and approval of agricultural administration system, and abide by the standard pesticide use management plan. In addition, packaging must comply with ISPM 15 standard, and PPD staff must conduct a rigorous inspection. As a result, Vietnamese litchi is favoured by Chinese consumers, even if their sales prices in China are much higher than that of domestic litchi, which leads to asymmetrical fluctuations in domestic litchi price.

- Alternative effect. The domestic litchis of major producing areas are mainly sold from April to May, and a small number of varieties in some producing areas continued to be sold in September. During the period, there are alternative products: mango and mangosteen in April; in strawberry in May; cherry in late May to mid-June; apricot in late May to mid-July; plum and peaches in July; watermelon in August; grape in September. As over the same period, alternative products are in abundance, along with diversified and changeable consumer preferences, so there is a hysteresis litchi between demand signal to send for consumers and consumption signal to receive for supply side, so price fluctuations are asymmetric.

- Bargain power. Bargain power of litchi suppliers, wholesalers and consumers in the supply chain are differences. On the one hand, litchi wholesalers’ bargain power is lower than consumers. The wholesale price of litchi is mainly the result of the price game between litchi consumers and wholesalers (assuming there is only one wholesaler in the litchi wholesale market). And litchi wholesalers generally possess lower education than litchi consumers, so litchi wholesalers’ bargain power lower than consumers in nature. On the other hand, the opportunity cost reduces the bargain power of litchi wholesalers. Because there is large number of alternative products during the same period, such as Vietnam litchi, watermelon, melon, etc. If litchi wholesalers are unwilling to sale litchi to consumers, then consumers will choose alternative products, considering the constraints of perishable traits of litchi. The opportunity cost to abandon the sale action is too big. So, to bear the profit reduction and the lower acquisition is more rational than to choose full loss. According to above two points, litchi consuming is increasing, and litchi demand curve shifts to the upper right, which makes the litchi wholesale price fluctuate.

Acknowledgments
This work is supported by the earmarked fund for China Agriculture Research System (Grand No. CARS-33-16).

References
[1] Lobos A G and Berbel J 2008 Volatilidad de precios internacionales recibidos por los productores de kiwis y manzanas frescas chilenas Revista Brasileira De Fruticultura 30 133-9
[2] Gómez-Limón J A and Berbel J 2000 Multicriteria analysis of derived water demand functions: A Spanish case study Agri. Syst. 63 49-72
[3] Griffith G R and Piggott N 1994 Asymmetry in beef, lamb and pork farm-retail price transmission in Australia Agri. Econ. Agri. Economists 10 307-16
[4] Powers N J 1995 Sticky short-run prices and vertical pricing: Evidence from the market for iceberg lettuce Agribusiness 10 57-75
[5] Goodwin B K and Harper D C 1999 Price transmission, threshold behavior, and asymmetric adjustment in the U.S. pork sector J. Agri. Appl. Econ. 32 543-53
[6] Aguiar D R D and Santana J A 2002 Asymmetry and rigidity in farm to retail price transmission: Evidence from Brazil Agribusiness 18 37-48
[7] Serra T and Goodwin B K 2010 Price transmission and asymmetric adjustment in the Spanish dairy sector Applied Economics 35 1889-99
[8] Meyer J and Cramon-Taubadel S 2004 Asymmetric price transmission: A survey J. Agri. Econ. 55 581-611
[9] Popovics P and Toth J 2006 Price transmission and asymmetric price development in the vertical structure of the milk industry in Hungary Econ. Rev. 53 349-64
[10] Benkaabia M and Gil J M 2007 Asymmetric price transmission in the Spanish lamb sector Europ. Rev. Agri. Econ. 34 53-80
[11] Jr O C and Sherwell P 2007 Alternative approaches in detecting asymmetry in farm-retail price transmission of fluid milk Agribusiness 23 313-31
[12] Ioanna R and Yannis P 2008 Asymmetric price transmission in the Greek agri-food sector: Some tests Agribusiness 24 16-30
[13] Ihle R and Amikuzuno J 2010 Assessing seasonal asymmetric price transmission in ghanaiian tomato markets with the johansen estimation method Courant Research Centre: Poverty, Equity and Growth - Discussion Papers 53
[14] Xia T and Li X H 2010 Consumption inertia and asymmetric price transmission J. Agri. Resour. Econ. 35 209-27
[15] Amikuzuno J and Ogundari K 2012 The contribution of agricultural economics to price transmission analysis and market policy in sub-Sahara Africa: what does the literature say? Proc. Int. Conf. 86th on Agribusiness (Coventry, UK: Warwick University)
[16] Nakajima T 2012 Asymmetric price transmission in the U.S. soybean exports International J. Agri. Res. 6 368-76
[17] Loy J P, Holm T and Steinhagen C 2012 Vertical price transmission in differentiates product markets: A disaggregated study for milk and butter 89 613-30
[18] Rezitis A N and Stavropoulos K S 2014 Price volatility and rational expectations in a sectoral framework model of the Greek meat market Agri. Econ. 42 419-35
[19] Taghvae V M and Hajiani P 2014 Price transmission mechanism in the Iran chicken market using the tcem, ecm-eg and gets models Modern Economy 5 939-50
[20] Barahona J F, Trejos B, Lee J W, Chulaphan W and Jatuporn C 2014 Asymmetric price transmission in the livestock industry of Thailand ACPBEE Procedia 8 141-5
[21] Alam M J, McKenzie A M, Begum I A, Buysse J, Wailes E J and Huylenbroeck G V 2016 Asymmetric price transmission in the deregulated rice markets in Bangladesh: Asymmetric error correction model Agribusiness 32 498-511
[22] Ilyasov J, Götz L, Kamiljon A, Dorosh P and Glauben T 2016 Market integration and price transmission in Tajikistan's wheat markets: Rising like rockets but falling like feathers? Ifpri Discussion Papers
[23] Harvey A C and Jaeger A 1998 Detrending, stylized facts and the business cycle J. Appl. Econ. 8 609-25
[24] Cogley T and Nason J M 1995 Effects of the hodrick-prescott filter on trend and difference stationary time series implications for business cycle research Real Busi. Cycles 626-51
[25] Bunnoon P, Chalermymont K and Limskakul C 2013 Multi-substation control central load area forecasting by using hp-filter and double neural networks (hp-dnns) International J. Electric. Power Ener. Syst. 44 561-70
[26] He Y X, Wang B, Wang J H, Xiong W and Xia T 2013 Correlation between Chinese and international energy prices based on a hp filter and time difference analysis Ener. Policy 62 898-909
[27] Xu W J, Gu R, Liu Y Z and Dai Y W 2015 Forecasting energy consumption using a new gm–arma model based on hp filter: The case of Guangdong province of China Econ. Modelling 45 127-35
[28] Baxter M and King R G 1999 Measuring business cycles: approximate band-pass filters for economic time series Rev. Econ. Statis. 81 575-93
[29] Hodrick R J and Prescott E C 1997 Postwar U.S. business cycles: An empirical investigation J. Money Credit Banking 29 1-16