The Research of Apple Price Fluctuations and Influencing Factors
——A Case Study of Hebei Province

Yufei Gan[*]

School of Economics and Management, Beijing Jiaotong University, China, 100044
[*]Corresponding author. Email: 19120694@bjtu.edu.cn

ABSTRACT

This paper aims to explore the fluctuation characteristics of Apple price and analyze the important factors affecting the fluctuation of Apple price. Hebei province is one of the major Apple producing provinces in China. First of all, this paper analyzes the general situation of Apple industry in Hebei Province, and on this basis describes the characteristics of Apple price fluctuation in Hebei Province. Then it adopts quantitative methods to analyze the influencing factors and forecast the price of Apple, and uses the price data of Apples in different electric business platforms to analyze the influence of brand, variety, average fruit size, logistics level and the origin on the price of Apples. This paper will use the method of multiple regression models to study, which is easy to operate and has a certain prediction effect. Through the analysis of relevant data, the results show that the main factors affecting the price of Apples in China are varieties, logistics level and producing area. Therefore, it is necessary to improve the forecast of Apple production, implement the strategy of Apple brand differentiation, establish a perfect information service sharing platform and support the development of varieties and industries with regional characteristics, so as to improve the anti-risk ability of Apple production and promote the stable development of Apple price market.

Keywords: Apple price, Influenting factors, Multiple regression.

1. INTRODUCTION

Apple plays a very important role in the world fruit trade. Apple is also one of the fruits that our country attaches the most importance to the development of production. It is the largest fruit produced and consumed in our country. The popularization of Apple consumption also makes its price fluctuations directly affect people's daily life, and at the same time relates to the income of fruit farmers**. [1]**

In recent years, the long-term unstable state of international agricultural product prices has caused a certain impact on our country's agricultural product prices. Affected by the price fluctuations of fresh food Apples in the world and the market environment in our country, the price of Apple in our country has abnormally fluctuated.[2] The high frequency and large price fluctuations have affected the production and operation of fruit farmers and distributors, and the normal fruit consumption of residents has been disturbed. The abnormal fluctuation of fruit prices seriously affects the enthusiasm of fruit farmers, and is not conducive to the normal and healthy operation of our national economy and rural economy. Therefore, both domestic and foreign researchers have conducted relevant studies on the factors affecting the price fluctuation of agricultural products.

This article mainly takes Hebei Province, one of the main producing provinces of the Apple industry, as an example to study the fluctuation characteristics of Apple prices and the factors that affect their fluctuations. In order to obtain general rules, this paper will collect relevant data and information about Apple prices in different e-commerce platforms, using the multiple regression model to explore the characteristics of changes in related economic variables and their mathematical influences.

Table 1. Cost composition of Apples in Hebei province from 2001 to 2011

Years	Cost of production(RMB/hm2)	Land cost (RMB/hm2)	Material and service costs(RMB/hm2)	Labor costs(RMB/hm2)
2001	10543.05	1077.30	5392.05	5151.00
2002	10456.20	987.45	5789.70	4666.50
2003	12603.00	1222.80	7845.00	4758.00
2004	16691.25	1254.60	8291.25	8400.00
2005	16234.65	1908.60	7634.70	8599.95
2006	16969.05	1797.60	8480.55	8488.50
2007	20520.15	2389.20	11232.15	9288.00
2008	24088.65	2595.90	12524.85	11563.80
2009	27046.50	2835.45	13161.15	13885.35
2010	31010.10	3532.50	13070.85	17939.25
2011	38012.10	4702.65	17431.50	20580.60
Mean	20279.52	2209.46	10077.61	10301.90

Data source: "Compilation of National Agricultural Product Cost and Benefit Information" (2001~2011)

2. GENERAL SITUATION OF APPLE INDUSTRY DEVELOPMENT AND PRICE MARKET IN HEBEI PROVINCE

2.1. General Situation of Apple Industry Development in Hebei Province

According to relevant statistics in 2011, the annual output and planting area of Apples in Hebei Province ranks fourth in our country. In recent years, the superior production areas in Hebei province have been constantly optimizing Apple varieties and improving the production technology to attract talents to extend the industrial chain and enrich the deep processing of products. The output of Apples has been increasing in recent years, and the quality of fruits is also getting higher and higher.

At present, the main Apples grown in Hebei Province are Fuji and Guoguang varieties. In terms of brand building, Hebei Province relies on the strength of science and technology to continuously explore and develop, and has formed advantageous brands such as "Fu Gang", "Shun Fu" and "Wu Yuan", which have certain influence and achieved ideal economic benefits. Among them, the area where Fugang Apple is located has sufficient sunlight, large temperature difference between day and night, rich water vapor, and has inherent climate advantages. In addition, it also has the advantages of neutral and acidic gneiss soil, which makes Fugang Apple superior in quality. [3]

According to the data in the "China Statistical Yearbook 2013", at the end of 2013, the orchard area in Hebei Province reached 1051.8 thousand hectares, and the Apple plantation area reached 235.7 thousand hectares, accounting for 22.5% of the total orchard area. With the development and maturity of Apple cultivation technology and a large amount of cost investment, the output of Apples in Hebei Province has continued to increase in recent years. The Apple industry is also a pillar industry in the agricultural development process of Hebei Province.
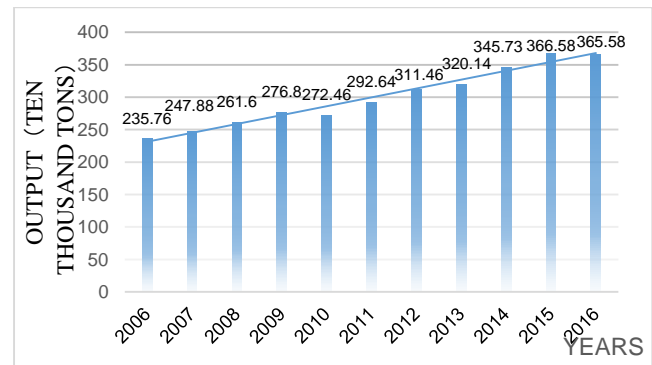

Figure 1 Apple production in Hebei Province from 2006 to 2018

Data source: China National Bureau of Statistics Network (http://www.stats.gov.cn/)

2.2. General Situation of Apple Price Fluctuation in Hebei Province

Affected by various factors such as the world price of fresh fruits, technical level, natural disasters, market supply and demand, logistics level, etc., Apple prices have fluctuated to a certain extent in recent years. Taking Hebei Province as an example, figure 2 shows

the monthly price trend of Apples in the wholesale market of Qiaoxi Vegetable Center in Shijiazhuang, Hebei Province from February 2011 to October 2015. It can be seen from figure 2 that the price of Apples in Hebei Province fluctuated significantly from February 2011 to October 2015, and the overall price trend was rising. Seasonal changes were prominent, with higher prices in summer and lower prices in winter. Therefore, the fluctuation of Apple prices in Hebei Province showed a seasonal upward trend.
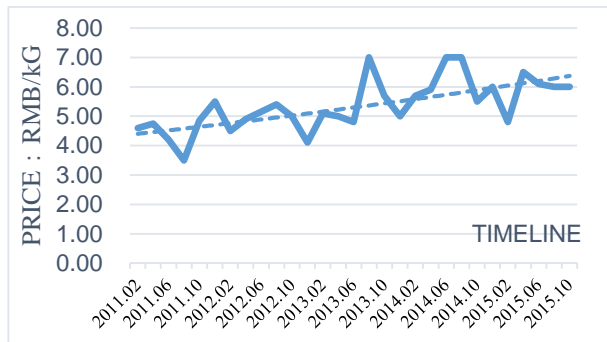

Figure 2 Monthly Apple price trends in Hebei province from 2011 to 2015

Data source: Sina agriculture net (http://nongye.sina.com.cn/)

3. INFLUENCING FACTORS OF APPLE PRICE FLUCTUATION IN HEBEI PROVINCE
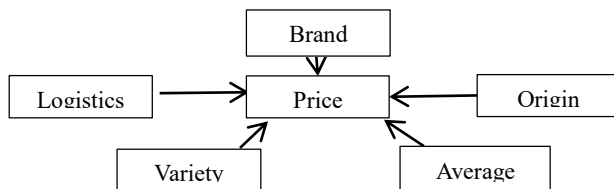
3.1. Analysis Framework

Figure 3 Theoretical analysis framework

Based on the above analysis, this paper does not considers the influence of natural disasters, market supply and demand, technical level, labor cost and other external factors on Apple prices for the time being. In order to find a general rule, this paper will select Apple price data from different e-commerce platforms to analyze the influence of brand, variety, average fruit diameter, logistics level and origin on Apple prices.

3.2. Selection of Indicators Affecting Apple Price Fluctuation

3.2.1. Cost Factor

Cost refers to the cost covering the entire production, circulation and sales process, mainly including production costs, logistics costs, transaction costs, risk costs, labor costs, etc.[4] From the table 1, it can be seen that the production cost of Apples in Hebei Province from 2001 to 2011 showed an overall upward trend. The increase in cost was one of the important factors leading to the increase in the price of Apples in Hebei in recent years. The level of logistics costs affects the level of logistics to a certain extent, so the second half of this article will extract the logistics factors in the cost elements to analyze the impact of Apple prices on the e-commerce platform. [5]

3.2.2. Supply Factor

The theory of supply and demand in economics makes it clear to us that the price is determined by both supply and demand [6]. Once the supply or demand of a commodity changes, it will lead to fluctuations in the output and price of the commodity. From the perspective of supply, the supply and cost of Apple depend to a certain extent on the brand effect of a local brand. The demand for strong brand awareness is large, so the number of production will increase. Therefore, this article will also consider the brand as a possible influence on Apple One of the reasons for price fluctuations.

3.2.3. Demand Factor

Demand refers to people's desire to be able to buy a certain commodity or service [7]. With the improvement of people's quality of life and income level, people generally pay more attention to the appearance quality, variety, taste and purchasing experience of Apples. When choosing Apples, more people are willing to buy high-quality Apples, and the demand for high-quality Apples with good varieties will increase, so the corresponding Apple prices will rise to a certain extent. Therefore, this paper will extract the average fruit diameter, producing area and variety elements of Apples, and discuss their influence on the price to some extent.

3.2.4. Other Influencing Factors

In recent years, the increase of extreme weather in the world has an important impact on Apple production, disrupting the stable supply of Apples and having a relatively large impact on the market price. In addition, the rising prices of agricultural means of production, the risks of Apple planting and management, the local policies of the country, market fluctuations, technical level, transportation infrastructure, seasons and the prices of substitutes all have a certain degree of influence on Apple prices. Because the above indicators are difficult to quantify, this paper does not consider the impact of these factors on Apple prices. [8]

4. EMPIRICAL ANALYSIS

4.1. Data Sources and Research Methods

The samples studied in this paper are the visiting data of fruit and vegetable market in Chang'an District, Shijiazhuang City, Hebei Province at the end of December 2017, as well as the Apple price, origin, average fruit size, brand, variety and logistics level of each major ecommerce. The online data used are from Jingdong and Taobao respectively. This paper uses two kinds of statistical analysis software, Eviews8.0 and SPSS21.0, and compares and analyzes the actual value and predicted value of Apple price after modeling. The econometric method is used to explore the characteristics of the changes of related economic variables and their mathematical relations.

4.2. Model Setting and Variable Description

Based on the above analysis of factors that may affect Apple price, this paper assumes that there is a significant correlation between Apple price and its origin, average fruit size, brand, variety and logistics level. In order to further test the influence direction and degree of each influencing factor on Apple price, this paper adopts multiple linear regression model to analyze and forecast, and the model expression is as follows:

$$Y=\beta_0+\beta_1 LOGt+\beta_2 AFSt+\beta_3 VAt+\beta_4 NCt+\beta_5 BRt+\beta_6 PLt+\varepsilon:$$

Among them: $\varepsilon\, N\,(0, \sigma2)$ (1)

'Y' in the equation represents the price of Apple; 'LOGt' stands for logistics level; 'AFSt' represents the average fruit diameter; 'Vat' stands for Apple variety; 'NCt' stands for the net weight of Apples (net weight is a necessary factor in the data collection process, and there is a positive correlation between net weight and price in the actual purchase process. For the accuracy of the results, this paper only includes net weight in the expression, and does not analyze it as the main factor affecting price fluctuation); 'BRt' represents the brand of the product; 'PLt' stands for the origin of Apples; 'ε' stands for random disturbance term, which is used to express variables such as fluctuation of world fresh food price, natural disasters, diseases and insect pests, technical level, policy and substitute price, which are difficult to quantify and have less influence.

4.3. Parameter Estimation and Test of the Model

4.3.1. Model Checking

Inputting all the data, using the above regression model, applying SPSS21.0 software, and we can get the following analysis results:

Table 2. Goodness of Fit Check

Model	R	R Square	Adjusted R Square	Standard estimate error
1	0.853[a]	0.727	0.712	16.945

a. Predictor variables :(constants), logistics1, net content, variety, brand, size, place

R=0.853 in Table2 indicates that 85.3% of the information of the dependent variable can be explained by the independent variable. The goodness of fit of the entire model meets the requirements and the effect is good.

According to the variance analysis table in Table 3, the sum of squares decomposition result shows that the total sum of squares is 108500.292, of which the regression sum of squares accounts for a relatively large proportion, reaching 78924.705.

The value of the test statistic F is 45.811, which exceeds the critical value F0.05 (6,103). The test is significant. The probability P=0.000, indicating that the entire multiple linear regression model is statistically significant. [9]

4.3.2. Co-integration Test

In the real economic operation, the time series are usually not stable. Therefore, we need to verify whether the causal relationship described by the regression equation is a false regression through the method of co-integration test in this research and practice. In order to understand the degree of correlation between observations at different intervals, this article will use ADF test to judge the stationarity of residuals, so as to judge whether there is a co-integration relationship between each influencing factor and price. The test results are shown in the table 4.

For the non-stationary series, the original series needs to be first-order difference. The statistical results of DPLACE show that its ADF value is less than the critical value of 5% of the significance level. Therefore, it can be seen that the first-order difference form of this sequence does not have a unit root and belongs to a stationary sequence.

Through the above unit root test, it can be concluded that the p-value test of each variable is less than 5% significant level, so each influencing factor has a long-term stable relationship with the Apple price. Therefore, the quantitative relationship between regression analysis and other methods can be used to further analyze variables.

Table 3. ANOVAª

	Model	Sum of square	Degree of freedom	Mean square	F	Significance
1	Regress	78924.705	6	13154.118	45.811	.000ᵇ
	Residual	29575.587	103	287.142		
	Total	108500.292	109			

a. Dependent variable: price
b. Predictor variables:(constants), logistics1, net content, variety, brand, size, place

Table 4. Stationarity test of Apple price time series

Variables	Inspection form	ADF statistics	P value	Co-integration test result with Apple price
LOGT	(C,T,K)	-2.7839	0.0064	Long-term stable relationship
SIZE	(C,T,K)	-3.2251	0.0491	Long-term stable relationship
PLACE	(C,T,K)	-2.3159	0.1850	unstable
VARIETY	(C,T,K)	-4.2974	0.0008	Long-term stable relationship
NETCONTENT	(C,T,K)	-9.1061	0.0000	Long-term stable relationship
DPLACE	(C,T,K)	-4.5754	0.0067	Long-term stable relationship

Note: In the test form, 'C' represents constant term, 'T' represents trend term and 'K' represents the best lag order, which is automatically determined by the system.
Data source: Eviews software calculated by unit root test

Table 5. Coefficient

Model		Non-standardized coefficient		Standard coefficient	t	Sig.
		B	Standard error			
1	(constant)	-10.638	30.276		-.351	.726
	logistics	-9.553	3.603	-.141	-2.651	.009
	size	.299	.374	.044	.799	.426
	place	-3.445	1.134	-.199	-3.037	.003
	variety	8.457	3.861	.143	2.190	.031
	Net content	7.494	.501	.793	14.944	.000
	brand	-.172	.115	-.081	-1.499	.137

a. Dependent variable : price

4.3.3. Model Parameter Estimation

The study uses SPSS21.0 as a statistical tool to estimate the regression coefficients in the model through the least square method. The standard error is a measure of sampling error. Therefore, the smaller the standard error, the stronger the overall representativeness of the sample. After the estimation, the hypothesis test results of whether each factor is significant are shown in Table 5. The empirical results in the table show that the sign of the coefficient before each explanatory variable is not consistent with the theoretical hypothesis and analysis.

It can be seen from Table 5 that the sig values of the four factors of net weight, variety, place of production and logistics level are all less than 0.05, indicating that the coefficient of the corresponding factor is not significantly estimated to be 0, that is, the contribution to the model is significant. Therefore, these factors have a significant impact on the price of Apples. Among them, the net weight and fruit diameter are positively correlated with the price, which means that the price of Apples increases as the net weight increases and the fruit diameter increases. The logistics impact is 9.553, indicating that the level of logistics has the most

significant effect on the price of Apples, and the final multiple regression equation is:

$$Y=-10.638-9.553LOG_t+0.299AFS_t+8.457VA_t+7.494NC_t-0.172BR_t-3.445PL_t. \quad (2)$$

According to the determined multiple regression equation, the price is inversely proportional to the logistics level. For every 1% increase in the logistics level, the price of Apples decreases by 9.553. For every 1% increase in net weight, the price of Apples increases by 7.494. There is an inverse relationship between the price and the change in the production area of the Apple. According to the code of the province of the production area in the study, it can be concluded that the Apples in the provinces of Gansu, Henan, Jiangsu, Shandong, Shanxi, Shaanxi, Sichuan and Xinjiang under the assumption that they are not affected by other factors, the price is decreasing sequentially. The role of variety and price changes in the same direction. According to the codes 1-Bingtangxin, 2-Red Fuji, 3-Florida, it can be concluded that the prices of the three species are higher than those of Red Cattle when other factors remain unchanged. Fuji is higher than the sugar heart varieties of Apples. In addition, the Apple fruit diameter is directly proportional to the price. For every 1% increase in the average Apple size, the Apple price increases by 0.299.

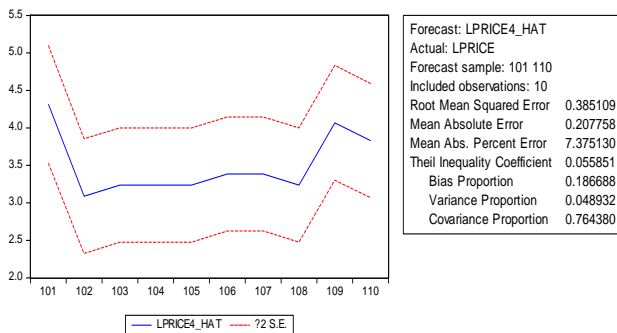### 4.3.4. Model Predictions and Conclusions

Figure 4 Price prediction chart

Forecasting the price of agricultural products has always been a hotspot and difficulty in agricultural research.[10] Figure 4 shows the price forecast of 100-110 Apples according to the data of the first 100 Apple price samples. Through this figure, we can see the comparison between the actual value and the estimated value. The dotted line in the figure is twice the forecast standard deviation. The data on the right evaluation table shows that the Theil inequality coefficient is less than 10%, and the bias deviation ratio is not high, which is 18.7%. The variance proportion (variance proportion) coefficient is less than 5%, and the covariance proportion (covariance proportion) is close to 1.

The above results are enough to show that the model fits the real data well. The predicted value of the Apple price is very close to the actual value. The model has good prediction accuracy on the price prediction, and the model is highly available and can be used to predict the price of Apples.

To sum up, the study took Hebei Province as an example to analyze the volatility of Apple prices deeply. After removing macroscopic factors such as natural disasters, market supply and demand, and policies, the six-variable multiple regression model was used to analyze domestic Apple prices. After analyzing and forecasting, and drawing the following conclusions: From the perspective of the forecast model, there are many factors that affect the price of Apples in China, which are mainly affected by the variety, origin and logistics level. Secondly, the Apple brand has a certain degree of influence on the price of Apples. The Apple variety and average fruit diameter did not have a significant impact on the price fluctuation of the Apple market in China. Therefore, there is a certain gap between the research results and the theoretical analysis hypothesis.

5. SUGGESTIONS TO PREVENT THE SHARP FLUCTUATION OF APPLE PRICES IN HEBEI PROVINCE

According to the results of this paper, some related suggestions and countermeasures are put forward for better understanding of Apple price fluctuation, controlling the range of price fluctuation and maximizing the protection of fruit farmers' income in the future, hoping to be helpful and useful for the research of Apple price fluctuation.

5.1. Reduce Circulation Costs, Simplify Circulation Links, and Improve Logistics Efficiency

At present, the circulation chain of my country's fruit and vegetable agricultural products is too long, and the circulation system is relatively complicated and other issues have a direct impact on the cost of fruit and vegetable agricultural products. [11] One effective and direct method of price control is to control costs. The estimated results of the multiple regression model established in this study also show that logistics has a significant impact on Apple prices. Therefore, the future development of Apple industry should pay more attention to reducing the complicated links in product circulation, improving logistics efficiency, improving the circulation system to a greater extent, innovating circulation modes, such as standardizing transportation and sales processes, encouraging various active and effective direct sales modes, and giving some preferential policies to circulation enterprises by the government. [12]

5.2. Implement Differentiated Business Strategy, Expand the Scale of Apple Cultivation, and Improve the Level of Apple Branding and Standardization

The empirical results of this study have clearly shown that there is a significant correlation between the production area and Apple price fluctuations. Therefore, we should focus on the development of varieties with regional characteristics, actively promote standardized and standardized production, and drive the overall improvement of Apple yield and quality and the growth of fruit farmers' benefits. At the same time, we should also focus on brand maintenance, enhancing brand competitiveness, broadening Apple's sales channels, increasing Apple's wholesale and expanding domestic demand.

5.3. Improve the Storage Capacity of Apples and Slow Down The Seasonal Fluctuation Risk of Apples

Apple prices are subject to seasonal fluctuations. For this reason, Hebei Province must improve the storage equipment and layout of fruit cold storage, such as strengthening the construction of cold storage and establishing special processing and distribution centers. Standardizing the production and storaging process to ensure the taste and freshness of the fruit to the greatest extent.

6. LIMITATIONS AND PROSPECTS

Although this study provides some references for agricultural product price fluctuations, there are still some shortcomings that need to be improved. (1) When studying the trend of Apple price fluctuations in Hebei Province, the data obtained are limited. This article only selects Apple prices at the Vegetable Central Wholesale Market in Chang'an District, Shijiazhuang city, Hebei Province. Although they are representative, the selected data don't represent the price of Apples throughout Hebei Province. Therefore, the research is not systematic and comprehensive enough. (2) This article takes Apple prices in different e-commerce platforms as the research object. When selecting influencing factors, the average fruit diameter does not guarantee the accuracy of the data. For the fuzzy interval of 70mm-80mm of the data given in the platform, the research uniformly takes the intermediate value 75mm to process. So it may affect the accuracy of the final result. (3) The research only selects some representative Apples, so in fact it doesn't represents all kinds of Apple varieties. The research of influencing factors in this paper is based on the availability of data to select some indicators for modeling analysis, and lacks of other macro factors that are difficult to quantify. [13] Therefore, if more indicators can be quantified next, the

research on the factors affecting Apple price fluctuations will be more comprehensive, and it is believed that the issue of Apple price fluctuations will be more instructive.

REFERENCES

[1] Zhao Yunlong. Research on pineApple price volatility characteristics and influencing factors in my country [D]. Heilongjiang Bayi Land Reclamation University, 2016.

[2] Sun Weishang. Research on Apple Price Fluctuation and Its Influencing Factors in Shaanxi Province [D]. Northwest Sci-Tech University of Agriculture and Forestry, 2014.

[3] Sun Zhijun. Research on the competitiveness of the Apple industry in Hebei Province [D]. Hebei Agricultural University, 2013.

[4] Nicholas Apergis, Anthony Rezitis. Food price volatility and macroeconomic factor volatility: heat waves or meteor showers [J]. Applied Economics Letters, 2003, 10(3):155-16

[5] Hebei Farmer News "Analysis of the Situation and Problems of Apple Production and Marketing in Hebei Province in 2018"(https://kuaibao.qq.com/s/20181101B112YI00?refer=spider)

[6] Xiang Yulin. Research on the characteristics, laws and influencing factors of fruit price fluctuations in my country [D]. Huazhong Agricultural University, 2015.

[7] Dong Xiaoxia, Li Zhiqiang.An Empirical Analysis of the Influencing Factors of Grape Price in my country——Based on the Research of Provincial Panel Data [J]. China Prices, 2008(08):16-19.

[8] Mitra S, Boussard J. A simple model of endogenous agricultural commodity price fluctuations with storage [J]. Agricultural Economics, 2012, 43(1):1-15.

[9] Wang Jichang. Analysis and Forecast of Egg Price Based on Multiple Linear Regression Model [J]. Modern Economic Information, 2015(23):333.

[10] Liu Xiaoqing, Zhang Yumeng. The price forecast analysis of edible fungi based on the ARIMA model——Taking Pleurotus eryngii as an example [J]. Ecological Economy (Academic Edition), 2012(02): 298-300.

[11] Yao Guanxin, Gu Qing, Zhang Dongmei. Research on the Influencing Factors of Price Fluctuation of Fruits and Vegetables Based on VAR——Taking Apple as an Example [J]. China Collective Economy, 2015(06): 38-40.

[12] Ma Yuhai. Research on the Problems and Countermeasures in the Development of my country's Agricultural Products Logistics [J].

Anhui Agricultural Sciences, 2012, 40(32): 15926-15927+15932.

[13] Uma J. Lele. Market Integration: A Study of Sorghum Prices in Western India[C]. Journal of Farm Economics1967.