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# Research on Interactive Relationship between Food Consumption and Economic Growth based on VEC model

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**Abstract.** Under the background of urbanization, the development requirements of higher quality and high efficiency have been put forward for rural residents' food consumption. Promoting the transformation of rural residents' food consumption pattern is also conducive to the improvement of residents' income level and economic development level. But at this stage, there are some problems, such as low-income level, obstructed consumption channels, unreasonable consumption structure and so on. In this context, through the establishment of VEC model of food consumption and economic growth, the interactive relationship between the two is analyzed, and the impulse response analysis is made to conduct in-depth research, aiming at improving the pattern of food consumption of rural residents in the context of urbanization and putting forward corresponding development proposals.

**Keywords:** Food consumption, Economic growth, VEC model, Interactive relationship.

## 1. Introduction

Under the background of urbanization, the income level of urban and rural residents is constantly improving, and the consumption demand of urban and rural residents is being paid more attention to quality and efficiency. The connotation of consumption is further extended to a deeper level of coordination and promotion in the rules of law, fairness, justice, security, environment and other aspects[1]. Taking the reform and opening up policy in 1978 as a starting point, the consumption expenditure per capita of rural households in that year was 116 yuan, and the Engel coefficient was 67.7%. By contrast, in 2017, the Engel coefficient in rural China reached 31.2%, which was nearly half of that in 1978. According to Engel's law, with the increase of household income, the proportion of expenditure on food is decreasing, consumption will be diversified, and food consumption will gradually increase. Under the background of urbanization, continuously improving the quality of food consumption of rural residents and meeting the needs of rural residents for high-quality food will be conducive to improving the consumption happiness of rural residents. Therefore, mastering the interactive relationship between food consumption and economic growth is of great significance to the improvement of the consumption mechanism and the stable operation of economy. Song Dongwen took the catering industry as an example to analyze the relationship between food consumption and economic growth, and found that in recent decades, economic development has promoted the development and growth of food consumption, and the development and growth of food consumption has promoted economic development [2]. Studies by Jie Chunying and Zhao Wenwu show that, due to the different levels of economic development, the characteristics of the food consumption structure among different countries and regions are different. The proportion of sugar food consumption in developing countries and regions is higher than that in developed regions, while the proportion of fat is slightly lower than that in developed countries and regions. The difference in protein ratio between developing countries and developed countries is not significant. There is no significant difference between countries and regions with two levels of development [3]. Therefore, in the context of maintaining economic development, it is imperative to continuously improve the proportion of the food consumption structure, promote industrial development and food quality optimization, and strive to improve the consumption level of residents. On the other hand, the rapid flow of population also promotes the transformation of the concept of food consumption and the values of urban residents [4]. Zhou Jinchun and Qin Fu also pointed out that income has a direct impact on food consumption of both urban and rural residents, and it is affected by economic

development, price, urbanization, marketization and commercialization, etc. [5]. So what is the interactive relationship between food consumption and economic growth? Is there a long-term balance between food consumption and economic growth? On the basis of reviewing the existing literature, the author studies the measurement methods such as VEC model, unit root test, co-integration test and impulse analysis, which are of great significance to the improvement of rural residents' food consumption level under the background of urbanization.

## 2. Research Design

### 2.1 Sample Selection and Data Sources

The case data used in this paper mainly comes from China Statistical Yearbook. The sample interval is 1998 - 2017. The data is processed logarithmically, and all the processes are analyzed and processed in E-views 8.0 software.

### 2.2 Variable Selection

#### 2.2.1 Variable of Economic Growth

Gross Domestic Product (GDP) refers to the total value of all products and services produced by all permanent resident units in a country (or region) within a specified period, which is usually considered as a measure of the economic situation of a country (or region), it can be used to describe and analyze macroeconomic changes. Therefore, this paper chooses GDP as the variable of economic growth. Before the analysis, in order to eliminate the heteroscedasticity and volatility in economic data, logarithms of related data series are taken and recorded as GDP.

#### 2.2.2 Food Consumption Variables

There is a close relationship between food consumption and economic growth. The sequence diagram shows that there is a significant positive correlation between the two. The change of food consumption will indirectly affect the national living expenditure, the national financial revenue, the purchasing power of residents, the balance of supply and demand in the market and the ratio between consumption and economic growth. On the other hand, it can reflect the changes in economic activities of a country (or region). Therefore, this paper uses the expenditure on food, tobacco and alcohol consumption of rural residents per capita as an analysis variable, which can effectively reflect the status of food consumption in the domestic economic development [6]. Before establishing the model, in order to eliminate the heteroscedasticity and related volatility in variable data, the variable series of food consumption data are logarithmically processed and recorded as FC.

### 2.3 Model Building

The time series of economic research is usually accompanied by many variables, so VAR (Vector Autoregression Model) is widely used in the analysis of national economic research. Generally, VAR model system involves a lot of coefficients, which cannot be estimated and calculated directly by analyzing model coefficients. It is necessary to use Granger causality test, impulse response function and variance decomposition to operate. For another special case, if there is a single-integer relationship of the same order among non-stationary time series combinations, and Johansen co-integration test shows that there is a long-term relationship between variables, so it is more appropriate to establish VEC model.

If there is no co-integration relationship between FC of food consumption and GDP of economic growth, unit root test, Granger causality test and vector autoregressive VAR model can be constructed step by step. If there is a co-integration relationship between the two variables, we need to build a vector error correction model (VEC) to explore the interaction between food consumption and economic growth. Relevant literature shows that VEC model is a VAR model with co-integration constraints and that there are some similarities between them. According to the above, the error correction model between the two variables of food consumption and economic growth is expressed as follows:

$$\Delta GDP_t = \alpha_0 ECM_{t-1} + \sum_{i=1}^{n} \alpha_1(i)\ \Delta GDP_{t-1} + \sum_{i=1}^{n} \alpha_2(i)\ \Delta FC_{t-1} + \varepsilon_t$$

In the model, $a_0$ is the error correction coefficient, $ECM_{t-1}$ is the error correction term in the co-integration relationship between food consumption FC and economic growth GDP, and N is the lag order in the model. The reason for the establishment of this model is that if the two variables of food consumption FC and economic growth GDP are stationary time series and do not pass the test of co-integration relationship, the difference between the variables can be directly stationary and the ordinary VAR model can be established; if the two variables are non-stationary time series and pass the test of co-integration relationship, the VAR model can be improved. Considering the co-integration relationship between the two variables, not only the VAR model between stationary variables should be established, but also the error correction term should be added to the VAR model consisting of two variables after differential stationarity and the error correction model should be further constructed.

For the time series consisting of two variables of food consumption and economic growth, considering that the time series data may be non-stationary, this paper intends to use error correction model to quantitatively analyze the interaction between food consumption and economic growth. After establishing the error correction model, the model should be identified and checked to determine whether it really conforms to the original setting of the model and has economic significance. First, ADF unit root test is carried out to test whether there is a monolithic relationship between the two. Then, the co-integration relationship between food consumption and economic growth is analyzed by co-integration test. If there is co-integration relationship, more in-depth research and analysis are needed. The whole inspection process is completed through Eviews 8.0 software.

## 3. Analysis of Test Results

### 3.1 Unit Root Test of Food Consumption and Economic Growth

Unit root test is usually a hot topic in time series data analysis. For non-stationary time series, it is usually transformed into stationary time series, and then the method of stationary time series is used for subsequent analysis and research. The unit root test of time series is to examine whether the time series is stationary or not. If there is unit root in non-stationary time series, the difference method can be chosen to eliminate the unit root so as to obtain stationary time series. There are many kinds of unit root test methods, including ADF unit root test, PP unit root test, NP unit root test and so on.

In this paper, ADF unit root test is used to test GDP and FC respectively. The test results are shown in Table 1.

Table 1. ADF Unit Root Test Results

| Variable | Test Form (C, T, K) | ADF statistics | Test critical value | Prob | Conclusion |
|---|---|---|---|---|---|
| Gross domestic product | (C, 0, 3) | -2.473824 | -3.920350 | 0.1394 | Uneven |
| $\Delta GDP$ | (C, 0, 0) | -2.450654 | -3.857386 | 0.1430 | Uneven |
| $\Delta^2 GDP$ | (C, 0, 1) | -5.362368 | -2.717511 | 0.0000 | Stable |
| FC | (C, T, 3) | -2.814829 | -4.667883 | 0.2124 | Uneven |
| $\Delta FC$ | (C, 0, 1) | -2.963777 | -3.886751 | 0.0588 | Uneven |
| $\Delta^2 FC$ | (C, T, 1) | -8. 640898 | -4.667883 | 0.0000 | Stable |

Note: In the test form (C, T, K), C, T and K represent constant term, trend term and lag order respectively.

In unit root test, the original hypothesis is that the original sequence has a unit root, that is to say, the sequence is not stationary. The results of the unit root test in Table 1 show that the original hypothesis of unit root at the 5% significance level cannot be rejected. After the second-order difference, both GDP and FC series can reject the original hypothesis of non-stationary at the 1% significance level. Therefore, it can be preliminarily concluded that the two variables of GDP and FC are second-order monolithic, i.e. I (2). It can also be said that the variables of GDP and FC are non-stationary, but the second-order difference is stationary after that. Therefore, there is a long-term co-integration relationship between GDP and FC.

### 3.2 Determining the Optimal Lag Order L of VAR Model

One of the important problems in VAR model is how to determine the optimal lag order, which should be considered in many ways. It is necessary to have a sufficient number of lag terms and a sufficient number of degrees of freedom. Generally, the selection of lag order can be judged by LR (likelihood ratio test), AIC information criterion (Chichi information criterion) and SC criterion (Schwartz criterion). Considering a variety of factors, the author draws up the maximum lag order from Table 2. The results in Table 2 show that the optimal lag order is 1 for five indicators. Therefore, according to the results of Table 2, it is considered that among the five of the test indicators of the best lag order the best lag order is 1, so the VAR (1) model is constructed.

Table 2. Testing results of optimal lag order for VAR model

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | 6.953908 | NA | 0.001977 | -0.550434 | -0.451504 | -0.536793 |
| 1 | 78.24888 | 118.8249* | 1.13e-06* | -8.027653* | -7.730862* | -7.986730* |
| 2 | 80.64867 | 3.466371 | 1.38e-06 | -7.849852 | -7.355201 | -7.781647 |

Note: * Represents rejection of the original hypothesis at the 5% significant level.

### 3.3 Stability Test of the Model

The AR unit root diagram is used to analyze the stability of VAR model. The points in the unit circle represent the reciprocal modulus of AR characteristic roots. If all these points fall in the unit circle, the constructed VAR model is stable, and vice versa, the VAR model is non-stationary. The VAR model constructed in this paper has two characteristic roots in total. From Figure 1, we can see that all the points fall in the unit circle, that is, the reciprocal modulus of each characteristic root is in the unit circle, and that there is no root above the unit circle. It shows that the reciprocal modulus of all characteristic roots in the VAR (1) model is less than 1, so the VAR model is stable. In the previous paper, the optimal lag order Lag=1 has been determined, and then Johansen test is used to determine whether there is a co-integration relationship between economic growth and food consumption variables.

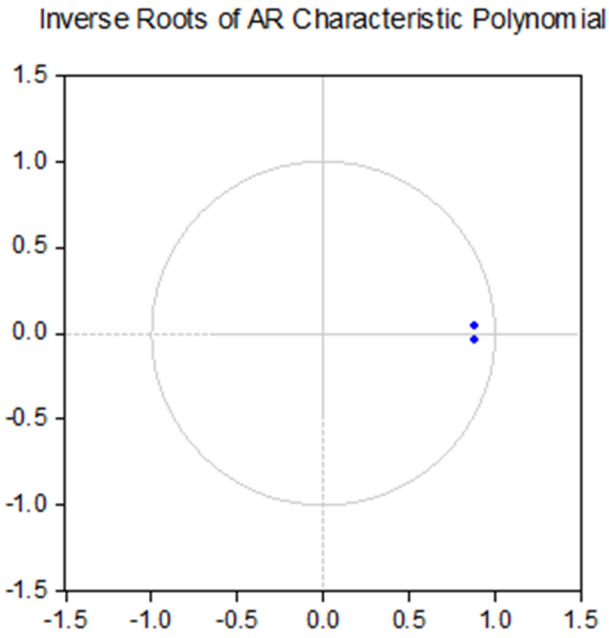


Fig. 1 Unit circle diagram of the reciprocal modulus of AR characteristic roots

### 3.4 Johansen Co-integration Test and Long-term Equilibrium Equation

Generally speaking, both food consumption and economic growth have their corresponding long-term fluctuation laws. If we can prove the co-integration between them, we can conclude that there is a long-term, stable and balanced relationship between them. Previously, it had been proved that the two variables of economic growth and food consumption were second-order monolithic. Next, we can test whether there is a relationship between the two variables by co-integration test. Using Johansen's co-integration test method, we set up that there is no intercept term and that there is no trend term in the co-integration equation. The final test results are as follows. Johansen's co-integration test results show that at the critical value test level of 5%, trace statistics are 57.580 > 12.321, 0.119 < 4.130, indicating that the original hypothesis can be rejected, and there is a long-term co-integration relationship between them. The same results can be obtained from the maximum feature statistics: 57.461 > 11.225, 0.119 < 4.130. Based on this, from the long-term trend, there is a long-term co-integration relationship between the two variables.

According to the results, a standardized co-integration parameter vector is obtained, so the co-integration equation between food consumption and economic growth can be shown as follows:

$$GDP = 1.635FC$$

According to the equation, the long-term elasticity of food consumption to economic growth is 1.635. That is to say, in the long run, when food consumption changes by 1%, the economic growth will change by 1.635% in the same direction.

Table 3. Johansen co-integration test results

| Null hypothesis | Eigenvalue | Trace | 5% critical value | P value | Max-Eigen | 5% critical value | P value |
|---|---|---|---|---|---|---|---|
| None * | 0.951407 | 57.57994 | 12.32090 | 0.0000 | 57.46114 | 11.22480 | 0.0000 |
| At most 1 | 0.006233 | 0.118796 | 4.129906 | 0.7765 | 0.118796 | 4.129906 | 0.7765 |

### 3.5 Constructing VEC Model

The VEC error correction model essentially adds an error correction term to the VAR model established based on the different sequences. Johansen's co-integration test shows that there is a long-

term stable equilibrium relationship between food consumption and economic growth and an internal equilibrium mechanism. Therefore, the author added vector error correction based on VAR (1) model to explore the short-term fluctuation and long-term equilibrium relationship between food consumption and economic growth and to establish error correction model:

$$\Delta GDP_t = 0.077 ECM_{t-1} - 0.625 \Delta GDP_{t-1} + 0.367 \Delta FC_{t-1}$$

Among them, ECM is expressed as an error correction term calculated according to the co-integration equation, which indicates the error of the variable deviating from the long-term equilibrium relationship. Before the error correction term, the adjustment coefficient is used to reflect the speed at which the current change of the variable returns to the long-term equilibrium relationship or eliminates the non-equilibrium error. The estimated results of the error correction model are as follows.

Table 4. Error Correction Model Estimation Results

| ErrorCorrection: | $\Delta GDP$t | $\Delta FC$t |
|---|---|---|
| $ECM$t -1 | 0.077186 | 0.033433 |
| | [ 2.69151] | [ 0.75897] |
| $\Delta GDP_{t-1}$ | 0.642535 | 0.274192 |
| | [ 2.35837] | [ 0.65517] |
| $\Delta FC_{t-1}$ | -0.366618 | 0.206627 |
| | [-2.12818] | [ 0.78085] |
| | 0.503656 | 0.228444 |
| Adj. R-squared | 9.625231 | 3.516699 |
| F-Statistic | 39.87800 | 32.15183 |
| Log likelihood | -4.097555 | -3.239092 |
| | -3.949160 | -3.090697 |

Note: ECM is the error correction term, and the value of t test in parentheses.

Table 4 shows that the current period is affected by the first order and the first order of lag. The short-term elasticity of food consumption to economic growth is 0.367, i.e. food consumption increases by 1%, and the short-term pull to economic growth is about 0.367%.

### 3.6 Granger Causality Test

From this study and literature review, it is concluded that food consumption plays a certain role in economic growth, that is to say, there are logical consistency and correlation between the two. In view of the co-integration relationship between the two variables, the Granger causality test based on VEC model is constructed, and the appropriate lag period is selected. The test results of VEC model between GDP and FC are as follows:

Table 5. Granger causality test based on VEC model

| Variable | Original hypothesis | Chi-sq | Freedom | P value |
|---|---|---|---|---|
| Gross domestic product | D (FC) | 4.529138 | 1 | 0.0333 |
| | ALL | 4.529138 | 1 | 0.0333 |
| FC | D (GDP) | 0.429252 | 1 | 0.5124 |
| | ALL | 0.429252 | 1 | 0.5124 |

In Table 5, based on Graner causality test results under VEC model, it shows that there is a direct causal relationship between GDP and FC variables. Food consumption is the Granger cause of economic growth at the 5% significant level, but not vice versa. It shows that the economic growth is affected by food consumption to a certain extent, that is, the improvement of food consumption level will promote the development of economic level, adjust the economic structure to a certain extent, and promote the improvement of national economic level. China's economic development started

late, but it has developed rapidly, and the income level of residents has increased continuously. However, the economic activities of food consumption still have certain limitations, which put forward requirements for high-quality and high-level food, and the level of food consumption needs to be further improved.

### 3.7 Impulse Response Function Analysis

In order to analyze the response of food consumption to the shock of one unit standard deviation of economic growth, the impulse response function is established on the basis of the VEC model constructed in the previous paper. Fig. 2 is about the impulse response function curve of GDP and FC in VEC system component orthogonalization innovation shock.

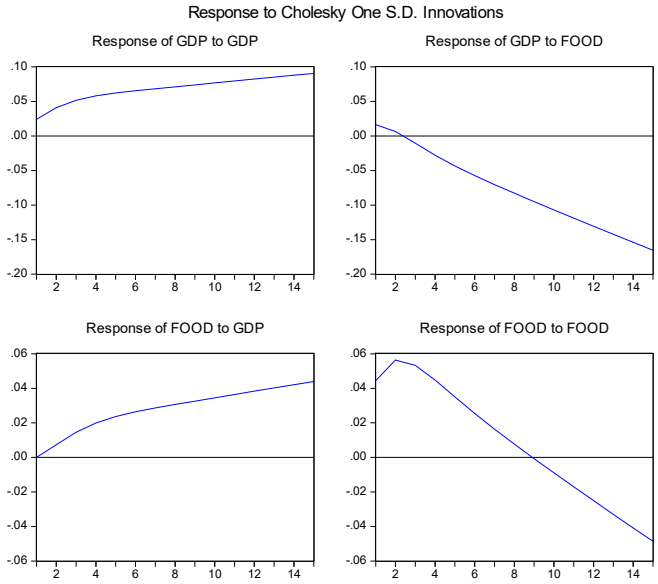


Fig 2. Impulse Response Function Curve Based on VEC Model

From Figure 2, we can see that the first phase of economic growth has produced a rapid positive response after being shocked by food consumption. From the fourth phase, the response has gradually increased, the speed has slowed down and gradually stabilized, and in the long run it will stabilize at about 0.420. Generally speaking, the positive impact of food consumption will have a positive effect on economic growth, and in the long run, the positive effect will be significant. Economic growth will have a strong long-term negative effect on food consumption. When a unit of economic growth shocks occurs, food consumption in the current period decreases and shows a continuous and rapid decline. With the continuous improvement of the economic level, the income level of residents has gradually increased, and the expenditure on food consumption has also been reduced. Generally speaking, the larger the expenditure on major food consumption is, the poorer a country (region) is; the smaller the consumption of major food is, the richer a country (region) is.

Generally speaking, the impulse response function of VEC model reflects the interaction between food consumption and economic growth, which conforms to the long-term relationship reflected by previous co-integration, and conforms to the current development reality to some extent.

### 3.8 Variance Decomposition

Impulse response analysis is the result of the impact of a variable on a variable in different periods. Variance decomposition is the part of predictive variance of variables at different time points that can be decomposed into different shock explanations. The characteristics of different shocks can be analyzed by data.

Table 6. Variance decomposition table

| | Gross domestic product | | FC | |
|---|---|---|---|---|
| | Period GDP | FC | GDP | FC |
| 1 | 67.89045 | 32.10955 | 0.000000 | 100.0000 |
| 2 | 87.86233 | 12.13767 | 1.034110 | 98.96589 |
| 3 | 92.05773 | 7.942272 | 3.212394 | 96.78761 |
| 4 | 87.34262 | 12.65738 | 6.200589 | 93.79941 |
| 5 | 79.74432 | 20.25568 | 9.799694 | 90.20031 |
| 6 | 71.99832 | 28.00168 | 13.89404 | 86.10596 |
| 7 | 64.99033 | 35.00967 | 18.38965 | 81.61035 |
| 8 | 58.89237 | 41.10763 | 23.15378 | 76.84622 |
| 9 | 53.64862 | 46.35138 | 27.97579 | 72.02421 |
| 10 | 49.14692 | 50.85308 | 32.56639 | 67.43361 |
| 11 | 45.27329 | 54.72671 | 36.60212 | 63.39788 |
| 12 | 41.92693 | 58.07307 | 39.80086 | 60.19914 |
| 13 | 39.02260 | 60.97740 | 41.99348 | 58.00652 |
| 14 | 36.48946 | 63.51054 | 43.15606 | 56.84394 |
| 15 | 34.26894 | 65.73106 | 43.39221 | 56.60779 |

Table 6 is the variance decomposition table under the two-variable VEC model of economic growth and food consumption. The results show that in the short run, the contribution of economic growth itself is the most important in the mean square error decomposition of economic growth forecast, which reaches 92.06% in the third year. In the long run, the contribution of food consumption is increasing gradually, from 7.94% in the third year to 65.73% in the fifteenth year. In the mean square error decomposition of food consumption prediction, the contribution of food consumption itself is the most important. In the first seven years, the contribution of food consumption itself is about 80%, but in the long run, the contribution of economic growth is increasing, from 1.03% in the second year to 43.39% in the fifteenth year. From the decomposition results of mean square error, we can conclude that the impact of food consumption on economic growth is higher than that of economic growth on food consumption. It can also be said that the relationship between food consumption and economic growth will become increasingly close.

## 4. Conclusion

In this paper, ADF unit root test, co-integration test, error correction model, Granger causality test, impulse correspondence test and variance decomposition test are used to study the interactive relationship between food consumption and economic growth in China from 1998 to 2017. The conclusions are as follows:

1. There is a long-term co-integration relationship between food consumption and economic growth. The long-term elasticity of food consumption to economic growth is about 1.635, that is, in the long run, when food consumption changes by 1%, the economic growth will change by 1.635% in the same direction, showing a positive correlation effect. Through the error correction model, it can be concluded that the short-term elasticity of food consumption to economic growth is about 0.367, that is, the short-term elasticity of food consumption to economic growth is about 1%, and the short-term (within a year) stimulates economic growth by 0.367%. Because food consumption has a special edible nature, it has a strong pull on economic growth; Granger causality test results show that there is a one-way Granger causality between food consumption and economic growth. That is to say, the improvement of food consumption can promote economic growth to a certain extent, and good food consumption policies can effectively promote healthy economic growth; in contrast, economic growth has a reverse effect on food consumption, because economic growth can bring about an increase in household income, people are more willing to spend money on higher-level needs when meeting basic food requirements needs. In the meantime, the amount spent on food consumption also decreases in the proportion of the total consumption [7]. From the contribution of impulse response

analysis and prediction mean square error, the impact of food consumption on economic growth is far greater than that of economic growth on food consumption.

2. Existing research shows that under the background of urbanization, there are insufficient development problems, such as low income level of rural residents, obstructed consumption channels, unreasonable consumption structure, inadequate sense of high-quality products for farmers, low supervision of the consumption environment, poor consumption safety of farmers and so on.

3. On the basis of analysis, this paper puts forward corresponding suggestions: 1) to develop the rural industry continuously, to provide income security for rural residents to obtain higher quality food consumption; 2) to continuously cultivate agricultural subjects to provide source guarantee for rural residents to produce safer food; 3) to continuously develop industrial integration, to provide technical guarantee for rural residents; 4) to continuously strengthen functional clothing; 5) we should provide service guarantee for rural residents to obtain more satisfactory food consumption. 6), we should continuously promote the construction of governance and provide governance guarantee for rural residents to obtain food consumption pattern.

## References

[1]. Zou Hong. Improving farmers'ssense of gain in consumption in rural revitalization [N]. Sichuan Daily, 2018-09-12 (007).

[2]. Song Dongwen. A Brief Analysis of the Relationship between Food and Beverage Consumption and Economic Development [J]. Market Modernization, 2008 (01): 329-330.

[3]. Xie Chunying, Zhao Wenwu, Xu Hailiang, An Yiming. Analysis of the relationship between changes in world food consumption and economic development [J]. World Agriculture, 2012 (11): 8+1-7.

[4]. Zhang Yaxin. Study on the Evolution Law of Food Consumption of Urban and Rural Residents in China [J]. China Price, 2017 (08): 83-85.

[5]. Zhou Jinchun, Qin Fu. Influencing factors and enlightenment of food consumption of urban and rural residents in China [J]. Survey of the world, 2006 (07): 42-44.

[6]. Zhu Xiaofeng. Food safety and economic development [J]. Academia, 2002 (01): 64-77.

[7]. Yin Shijiu, Wu Linhai. Empirical Analysis of the Relationship between Organic Food Consumption and Economic Growth of EU Residents [J]. International Business (Journal of University of Foreign Economic and Trade), 2009 (01): 49-55.