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Analysis of the agriculture trade openness impact on the rural household's food consumption in China

Difei ZHAO, Zhenyuan LIU

School of Economics and Management, Fuzhou University, Fuzhou, China

Abstract: Granted that the traditional measure methods in calculating trade openness always trigger results of singleness and twisted outcomes, the aim of the paper is to recalculate the Chinese produce trade openness after 1978, using new measure methods consisting of the trade reliance and shares. After calculation and contrasting, obvious differences have been found between the new and traditional methods. The results of the traditional measure methods turn out to be severely underestimated, whereas the new ones are more specific to reveal the extent of the Chinese produce trade openness, along with demonstrating the function of the Chinese produce in world trade market. Based on the results, utilizing the panel data, the LA/AIDS model and price elasticity, the paper analyses the changes that rural food prices were influenced by the agricultural produce trade openness, and the changes of rural food expenditure and consumption.

Key words: food trade, price elasticity, rural food price

After joining the WTO, China's agricultural market openness degree has been increasingly growing, and the trade volume has been continuously improved. China's total imports and exports of agricultural products was 237.348 billion dollars in 2012, accounting for 6.98% of the world's total imports and exports of agricultural products, and its dependence of agricultural products on the foreign trade reached 16%. China is the third-largest agricultural trade nation in the world. In the first three quarters of 2013, the import volume of grain, cotton, oil, sugar and other bulk farm-products continued to maintain a high level, the imports of mean increased significantly, the exports of vegetables reversed the downward trend in 2012, and the exports of aquatic products continued to grow.

The growth in trade brings about the connected effects between the international and domestic prices. In recent years, China's rural food price index and the international food price index have shown a synchronously rising trend, and the fluctuation range also presented a high degree of consistency (Figure 1). With 2005 as the base period, the international food price index and the China's rural food price index have risen by 59.7% and 62.8%, respectively.

At present, many domestic scholars have studied the linkage relationship between the international and domestic agricultural product price, showing

Figure 1. Trends of the China's rural food price, the international food price and the dependence of agricultural products on foreign trade (2005 = 100)

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that the fluctuations in the international price will affect the domestic prices. Huang et al. (2011) carried out a long-term and short-term analysis for the international and domestic prices of wheat, rice, corn, soybean and cotton with the error correction model and the co-integration analysis, and they believed that the international prices of soybean, cotton and corn were easily transmitted to the domestic market mainly because of the high degree of openness of such products; in contrast, the international prices of rice and wheat had an insignificant impact on the domestic prices. The study of Li et al. (2012) also indicated that the international prices were the Granger causes of changes in the domestic prices, but not vice versa. In addition, the international forward price of agricultural products will also affect the price of the domestic agricultural products. In this regard, Tan et al. (2012) analysed the relationship between the forward price of international commodities and the market wholesale price of China's agricultural products with the Johansen test and the Granger causality test, and the results indicated that the former had a significant influence on the latter, and the effect was more significant with the increase of lag period.

The accompanying problem is that the fluctuation in the domestic agricultural product price that is conducted from the international market is bound to affect the consumption of domestic farmers, thereby influencing the farmers' welfare, because farmers are both the producers and the consumers of agricultural products. Huang et al. (1999) simulated the impact of joining the WTO on the agricultural production, the farmers' consumption and the welfare level in China with the CAPSIM model, and the simulation results showed that due to entry into the WTO, the domestic degree of self-sufficiency of land-intensive products declined, and the self-sufficiency rate of grain would decline. Consequently, the employment of the crop production departments would be further reduced, so that, with the crop production as the main source of income, the farmers would be the direct and intermediate victims. Moreover, the coastal wealthier farmers benefit more than the poorer farmers. The benefit of the poverty-stricken families from joining the WTO is less than the average level of rural areas, and far below the wealthier rural households, so the rural households in the Western and Northern regions will be hurt. Li and Li (2000) pointed out that the reasons for the low level of the farmers' food consumption expenditure lay in the income of farmers, and the substance of agricultural price volatility was the insufficient food consumption needs. He (2001) indicated that the income difference is the most important factor of restricting the food consumption expenditure of farmers through the comparison between the food consumption of urban and rural residents. Zhu and Zhong (2005) added the proportion of grain acreage in the total sown area in the empirical practice, and the results also showed that the farmer's food consumption level depended largely on their income and purchasing power. However, the effect of income on the farmers' food consumption is conditional. Only when the per capita annual consumption expenditures reached 3500 Yuan, would the growth of income lead to the decrease of food consumption (Huang 1995). The consumption expenditure elasticity and the self-price elasticity of grain, cooking oil and eggs were small, while the consumption elasticity and self-price elasticity of meat, aquatic products and vegetables were relatively elastic (Zhang et al. 2012). Therefore, the dietary structure of farmers can be changed by increasing the farmers' income levels and adjusting food prices. To this end, Hong (2009) analysed the impact of the trade openness on the welfare of farmers in China on the basis of the changes in agriculture products with respect to prices. The research results showed that the full trade openness was in favour of upgrading the consumption structure of rural residents, thereby improving the welfare of farmers. As for the foreign relative studies, most scholars concern on the trade openness influences on the welfare and benefits of the native agricultural sectors and households. The latest most significant and relative studies can be concluded as follows: Le (2014) attaches the improvements of the Vietnamese rural household welfare to trade openness with the regression analysis on the Vietnam Household Living Standard Surveys (VHLSSs) which leads to institutional reforms. Meanwhile, Mourao (2014) attempts to clarify the complex relation between trade openness and the agricultural sector in Belarus, concluding that trade openness worsens the farmers' welfare in developed countries. The dispute above makes our study based on the Chinese food consumption more significant.

It can be seen from the above that the current domestic scholars carry out analyses on the food consumption of farmers through analysing the mechanism of effects of international agricultural product price transmission on the income of farmers from the perspective of farmers as producers. And there are relatively few literatures for analysing the farm-

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ers' consumption and welfare problems from the perspective of consumers. Furthermore, when analysing the domestic and international transmission mechanism, many scholars calculate the trade openness of agricultural products directly with the foreign trade dependence degree. This paper analyses the limitations of the foreign trade dependence degree in details, corrects such limitations with the methods of Squalli and Wilson (2006), and re-builds the index for the trade openness of agricultural products. In addition, an empirical study is carried out for the trade openness of agricultural products, China's rural food price, the farmers' food consumption expenditures and the consumption quantities.

LIMITATIONS OF CALCULATING METHODS FOR TRADITIONAL TRADE OPENNESS

Traditional foreign trade dependence degree method and index method

Foreign trade dependence degree method

Mr. Kiyoshi Kojima first proposed measuring the trade openness of a country with the foreign trade dependence degree, and the calculation with this method is simple and intuitive, which became the main method for measuring the trade openness of 1960s and 1970s and is still in use now. However, this method ignores other influencing factors, such as the economic scale, the population size, the exchange rate policies, and trade policies and so forth. Edwards (1998) found that even if a country had a severely distorted trade, it may also have a higher foreign trade dependence degree. Therefore, this method cannot truly reflect the degree of a country's trade openness. Based on this, the scholars corrected the foreign trade dependence degree mainly in the following aspects:

(1) Corrections according to the economic scales, trade forms and exchange rate, including two aspects: first, correcting the traditional foreign trade dependence degree on the basis of differences in the economic scales (Frankel 2000; Li et al. 2004); second, proposing the GDP converted to the purchasing power parity to eliminate the effects of changes in the exchange rate (Alcala and Ciccone 2004).

(2) Corrections of the inherent defects of the calculation formula of the traditional foreign trade dependence degree. As the GDP does not include imports, and the foreign trade dependence degree equals the ratio of a country's import-export volume and the country's GDP, so the molecule is not fully included in the denominator, on the basis of which, the foreign dependence degree calculated is deviant. In this regard, Shen (2005) puts forward using the economic aggregate (the sum of gross output and imports) as the denominator instead of the GDP from the input-output point of view, so as to solve the differences in the molecular value and the denominator value. Qiang (2007) thought that the economic aggregate method of Shen Lisheng still cannot get rid of the possibility that the foreign trade dependence degree is greater than 1, so it cannot serve as a reasonable and complete calculation formula for the foreign trade dependence degree. Pei and Peng (2006) considered that the dependence of a country on international markets included both the dependence of products on the international market demands and the dependence of domestic production on raw materials on the international markets and imports of intermediate products. Thus, the foreign trade dependence degree = (added value of exports + imported raw materials, amount of intermediate products)/(GDP + raw imported raw materials, amount of intermediate products). Whatever the method, the main data are dependent on the input-output table, but the China's input-output table is compiled once every five years, and the data are not readily available. Therefore, this method has not yet been universally applied in the empirical research.

(3) Comprehensive correction. Bao et al. (2003) measured the China's trade openness respectively with the foreign trade dependence degree, the actual tariff rates, the black market transaction costs of the foreign exchange, the Dollars Index, and the corrected foreign trade dependence degree (Patrick 1998), and added the labour, capital investment, and human capital as control variables in order to study the relationship between the trade openness and economic growth. The regression results showed that only the foreign trade dependence degree can better reflect the relationship between trade the openness and China's economic growth. Hu (2004) corrected the Dollars Index and the traditional foreign trade dependence degree, and regressed the fixed bargaining fee, the black market transaction costs of foreign exchange and the actual tariff rate respectively, as well as added the GDP and population to the equation of foreign trade dependence degree. Finally, he got the theoretical value of the Dollars Index and the foreign trade dependence degree on the basis of

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the regression results, and made a comparison with the actual value.

Index method

The index method can be divided into the single index method and the comprehensive index method. The single index method, with the representative of Dollars (1992), thinks that under the conditions of free trade, commodity prices of all countries should be convergent, if any differences, it is role of trade protection, so the deviation of commodity price can reflect the trade distortions of a country. Sachs and Warner (1995), the main representatives of the comprehensive index method, adopt the "binary system" method to set the trade openness value as 0 or 1. If a country meets any conditions of the SW judging conditions, the value is 0, otherwise 1. The advantage of the method combines several factors affecting the trade openness, but the judging standard is subjective to some extent. In addition, this index can only be compared between countries with or without trade openness, and cannot reflect the variation trend of a country's trade openness.

However, whether it is a single index or comprehensive index, there is the problem of the poor availability of data, and there is no way to gather up the trade flow and trade policies.

Limitations of traditional calculating methods

In empirical studies, the foreign trade dependence method is most commonly used by the scholars. Several calculating methods of trade openness proposed by the scholars are listed in Table 1, in which, there are three methods most commonly used, namely, M/GDP, X/GDP and (X+M)/GDP. In most studies, the foreign trade openness degree is calculated by (X+M)/GDP. This method is relatively intuitive, reflecting the contribution of a country's foreign trade to its economic growth. With an easy access, the calculation is simple. However, the foreign trade dependence degree only focuses on the relationship between the foreign trade and the country's economic growth, resulting in the illusion of a large country having a smaller dependence on the foreign trade, thus underestimating the trade openness of the country. If it is used as a main variable for an empirical analysis, then the distortion of results may be caused. In 2006, Squalli and Wilson calculated and ranked the foreign trade dependence degree of commodities of 117 countries or regions around the world in 2004, and they found that Japan, the United States, Argentina, India, and Brazil were among the least open countries; and Germany, Russia, Britain, China were rated as the relatively-not-open countries. This is clearly not consistent with the reality.

Establishment and results analysis of calculation methods of new trade openness

Original calculation methods

Squalli believes in the subsequent studies that foreign trade dependence degree captures his information of the trade openness, but ignores the position of a country's foreign trade in the world trade. And this is precisely another important factor affecting the trade openness. The larger the proportion of a country's foreign trade in the world trade indicates the more active a country is in the international market, besides, the more contribution of the country to the world trade, it shows more openness. So they re-define the trade openness, and rebuild the calculation index for the trade openness by using the proportion of the country's foreign trade dependence degree and the

Table 1. Calculation methods of traditional trade openness

Methods	Definitions
M_i/GDP_i	Degree of dependence on import, the ratio of imports and GDP
X_i/GDP_i	Degree of dependence on export, the ratio of exports and GDP
$(X + M)_i/GDP_i$	Degree of dependence on foreign trade, the ratio of import-export volume and GDP
$1 - [(X + M)_i/2GDP_i] \times 100$	Adjusted degree of dependence on foreign trade, which is proposed by Frankel (2000) for dealing with abnormal value
$M/GDP_i - (1 - GDP_i / \sum_{i=1}^{k} GDP_i)$	Corrections carried out by Li et al. (2004) for the method of Frankel
$(X + M)_i/rGDP_i$	Actual degree of dependence on foreign trade, and the denominator is the GDP adjusted by purchasing power parity, which is proposed by Alcala and Ciccone (2004)

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trade volume in the world total trade volume. The calculation formula is as follows:

$$CTI_i = (1+Dr)\times TI_i = \frac{n(X+M)_i^2}{GDP_i \sum_{j=1}^{n}(X+M)_j} \quad (1)$$

where CTT_i represents the trade openness, and TI_i = (X+M)/GDP, n means the number of countries.

This paper uses this formula with revising it by adding the import and export openness of agricultural products. The import trade openness of agricultural products embodies the degree of the foreign openness of the country or region, namely, the degree of allowing the foreign agricultural products entering the domestic market. The export trade openness of agricultural products reflects the capacity of agricultural products in the country or region to earn the foreign exchange through exports and the trade barriers encountered in the international agricultural product market. Furthermore, the contribution of import and export trade of agricultural products affects the expansion of the trade scale of agricultural products. As a result, when calculating the trade openness of agricultural products, the import and export trade compose agricultural products. The corrected calculation formula is as follows:

$$AG_{open,t} = \frac{X_{i,t}}{X_{i,t}+M_{i,t}} AGX_{open,t} + \frac{M_{i,t}}{X_{i,t}+M_{i,t}} AGM_{open,t} \quad (2)$$

$$AGX_{open,t} = \frac{nX_{i,t}^{\ 2}}{AGGDP_{i,t}\sum_{j=1}^{n} X_{j,t}} \quad (3)$$

$$AGM_{open,t} = \frac{nM_{i,t}^{\ 2}}{AGGDP_{i,t}\sum_{j=1}^{n} M_{j,t}} \quad (4)$$

where $AG_{open,t}$ represents the trade openness of agricultural products; $AGX_{open,t}$ means the export trade openness; $AGM_{open,t}$ indicates the import trade openness; $X_{i,t}$, $M_{i,t}$ means the import and export volume of agricultural products of country i in the period of t; and $AGGDP_{i,t}$ represents the agricultural added value of country i, and n means the number of countries.

Characteristics of the new calculation methods

More objectivity

The degree of the agricultural products' trade opening to the outside world of a country or region is mainly reflected in two aspects: First, the foreign trade dependence of agricultural products. The larger indicator indicates more independence of the agricultural economy of the country or region on the international markets. The second is the proportion of trade volume of agricultural products in the world's agricultural trade. The larger indicator indicates the more activity of the country or region in the international agricultural product market, and the larger impact on the expansion of the world trade scale of agricultural products. The calculation formula of the new trade openness of agricultural products includes the content of these two aspects, so that it can reflect the real situation of the agricultural trade openness of the country or region more accurately and truly.

Multidimensional nature

The indicator system of the new agricultural trade openness includes the export and import trade openness of agricultural products, and it can intuitively reflect the contribution of the import and export trade openness of agricultural products to the trade openness of agricultural products. The new calculation formula takes the proportion of the import and export trade of agricultural products in period t as the weight. If the import volume of agricultural products equals the export volume of agricultural products, then the weight of import is equal to that of export of agricultural products; if the import volume of agricultural products does not equal the export volume of agricultural products, then the export weight increases during the favourable balance, and the import weight increases during the unfavourable balance. Such changes can reflect the relationship between the trade imbalance of agricultural products and the trade openness of agricultural products. In addition, the new calculation formula not only includes the relative agricultural economic indicators of a country or region, but it also contains the corresponding world's total economic indicator. This not only reflects the impact of the absolute scale of the economic exchange of the country or region with the outside world on the agricultural economy of the country or region, but it also embodies the position and role of the country or region in the world's trade in agricultural products.

Data sources and description

This paper selects 56 countries and regions such as the United States, Japan and Britain as the samples. The total trade volume of agricultural products in these 56 countries or regions accounts for an average

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of 91.6% of the world's total volume of agricultural products, and it can represent the world's trade volume of agricultural products. Up to finalizing this paper, the relevant data is only updated to 2012, so the data interval is 1981–2012. The range of agricultural products is the WTO data and the data of aquatic products. The agricultural trade data are derived from the WTO, and the data of aquatic products comes from the UN data. The added value of Chinese agriculture is replaced with the added value of the first industry, and then translated to the U.S. dollars with the exchange rate of the same year. The original data is derived from the 2013 Chinese Statistical Yearbook.

Analysis of the calculation results of new methods

Comparative analysis of the calculation results of the new and old methods

Before 2000, the average proportion of the trade volume of Chinese agricultural products in that of the world's agricultural products was only about 2%, making a small contribution to the world's agricultural trade. So, before 2000, the numerical value of calculation on the basis of two methods was small. But after joining the WTO, China's agricultural trade has shown the trend of rapid growth. According to the analysis on the calculation results of the new methods, the trade openness of agricultural products presented a rapid upward trend after 2000, and increased to 83.26% in 2012, far higher than 16.08%, which was calculated on the basis of the foreign trade dependence degree. It directly reflects the scale of China's agricultural trade as well as its status changes in the world's agricultural trade, and further proves that the proportion of the Chinese agricultural trade in the world's agricultural trade is an important factor affecting the trade openness of agricultural products in China (Table 2).

China's import and export trade openness of agricultural products calculated on the basis of the new methods

After calculating the overall trade openness of China's agricultural products, we calculate the import and export trade openness, respectively. It has been found that after joining the WTO, the export trade openness of China's agricultural products only increased a little, but the export trade openness presented a trend of rapid growth. In 2012, the import and export trade openness of China's agricultural products were 5.62% and 110.86%, respectively, indicating that the enhancement of the trade openness of China's agricultural products was mainly contributed by the import trade openness of China's agricultural products (Figure 2).

Table 2. Comparison (%) of $AG_{open,t}$ of China's foreign trade dependence degree method and new methods during 1981–2012

Year	Foreign trade dependence degree method	New method	Year	Foreign trade dependence degree method	New method
1981	7.14	9.93	1997	9.46	15.21
1982	6.39	8.84	1998	8.26	12.48
1983	4.97	5.60	1999	8.63	13.70
1984	4.86	5.11	2000	10.85	21.44
1985	6.31	8.11	2001	10.59	21.57
1986	7.50	9.75	2002	11.14	23.82
1987	8.29	10.65	2003	13.75	33.02
1988	9.00	12.47	2004	14.60	40.76
1989	8.66	11.95	2005	15.22	43.12
1990	8.59	10.40	2006	15.76	46.29
1991	9.58	12.06	2007	15.64	48.32
1992	9.92	13.07	2008	15.51	53.45
1993	8.69	12.67	2009	13.09	45.93
1994	12.48	19.94	2010	15.62	67.46
1995	11.43	17.74	2011	16.87	80.28
1996	9.67	14.71	2012	16.08	83.26

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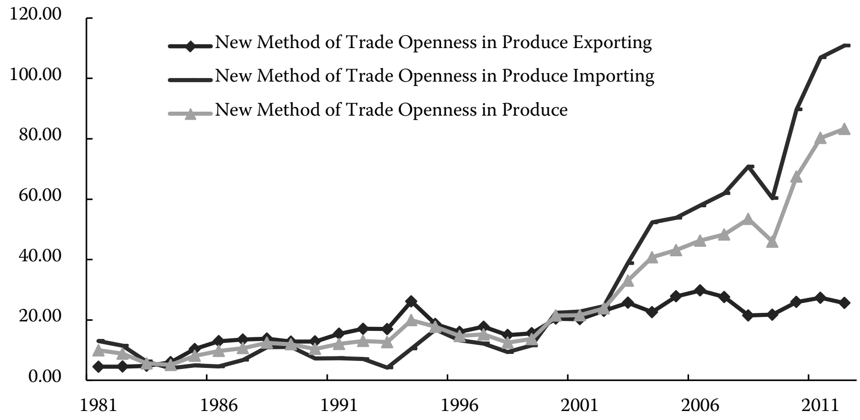

Figure 2. Import and export trade openness of China's agricultural products calculated on the basis of new methods (%)

EMPIRICAL ANALYSIS OF AGRICULTURAL TRADE OPENNESS ON RURAL FOOD PRICE

The selection of variables and model setup

Model setup

With the panel data analysis method, this paper makes an empirical analysis for the relationship between the agricultural trade opening and China's rural food price. In the process of collecting data, it has been found that the partial data of Beijing, Tianjin, Shanghai, Tibet, Chongqing and Hainan is lost, so this paper selects 25 cities in the Chinese Mainland except for Beijing, Tianjin, Shanghai , Tibet, Chongqing and Hainan, and takes the data of 1995–2011 for the analysis, so the basic model is constituted as follows:

$$\ln p_i = \alpha_0 + \beta_1 \ln pc_{it} + \beta_2 \ln open_t + \beta_3 \ln rgdp_{it} + \\ + \beta_4 \ln m2_t + \beta_5 \ln dis_{it} + \mu_{it} \quad (5)$$

where P_i means the food price, pc represents the price index of agricultural production information, open refers to the agricultural trade openness calculated on the basis of new methods, grip stands for the per capita GDP, m^2 means the supply of currency, and dis refers to the agricultural damage area.

Since there may be two-way causality relationship between the explanatory variables and the explained variables, we refer to the method of Zhi and Xiabo (2010) about the indogeneity problems, that is, the item of all explanatory variables one period lagging rather than the item of the current period is taken as the regression variables, so that the endogeneity problems caused by the two-way causality relationship in the model can be effectively reduced. The regression equation then becomes:

$$\ln p_i = \alpha_0 + \beta_1 \ln pc_{it-1} + \beta_2 \ln open_{t-1} + \beta_3 \ln rgdp_{it-1} + \\ + \beta_4 \ln m2_{t-1} + \beta_5 \ln dis_{it-1} + \mu_{it} \quad (6)$$

Data sources

In this paper, the rural food price uses the consumer price index of the rural residents' food, and mainly selects six categories of food, including grain, oil, meat, eggs, aquatic products and vegetables, which is represented by P_i, among which, i = 0, 1,..., 6 and respectively stands for the total index of food price, as well as the price index of grain, oil, meat, eggs, aquatic products and vegetables.

The data is mainly from the "China's Agriculture Yearbook", the "China Rural Statistical Yearbook" and the "China Statistical Yearbook" with the year 1995 as the base year. Among them, the per capita GDP of each region is got by deflating the per capita GDP with the fixed-base index number of consumer price of provinces in order to remove the impact of price factors. The money supply (M2) is obtained by deflation the with fixed-base index number of the consumer price of residents all over the country.

Stationarity of variables and the co-integration test

As the time duration of this paper is 17 years, the stationarity of all variables and their co-integration relations should be tested before the estimation of the model.

Panel unit root test

Empirical studies have shown that when testing the unit root of panel data with various methods, as long as one method fails to pass the test, it is indicated that there is a unit root in the original sequence, which belongs to the non-stationary sequence. The results show that the logarithmic-series of other variables are all single integer sequences except that the original sequence of lndis is stationary.

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Table 3. Panel co-integration test

	Model (1) Food	Model (2) Grain	Model (3) Oil	Model (4) Meat	Model (5) Eggs	Model (6) Aquatic products	Model (7) Vegetables
Kao Test	–5.477 (0.0000)	–7.9587 (0.0000)	–2.9845 (0.0014)	–4.3574 (0.0000)	–3.2428 (0.0000)	–3.7972 (0.0001)	–2.406 (0.0081)
Pedroni-group rho	8.4358 (0.0000)	7.0009 (0.0000)	7.9124 (0.0000)	7.5283 (0.0000)	4.7546 (0.0000)	7.5309 (0.0000)	6.2321 (0.0000)
Pedroni-group ADF	7.6140 (0.0000)	–7.7072 (0.0000)	–15.4327 (0.0000)	–5.9250 (0.0000)	–14.3803 (0.0000)	–6.8296 (0.0000)	–9.6261 (0.0000)

The values in brackets are p-values, the null hypothesis H0: there is no co-integration relationship

Panel co-integration test

This paper adopts the Pedroni and Kao co-integration test method. Table 3 shows that all equations passé the Kao and Pedroni co-integration test, and the p values of these two statistics are far less than 0.05, namely, both rejecting the null hypothesis, which represents that there is a co-integration relationship among various variables in each equation, so that the original equation can be regressed directly.

Estimated results and analysis

Overall estimated results of food price

The regression results of the combined index of food price indicate that with the one lagged period of the China's agricultural trade openness increased by each 1%, the combined index of current price will increase by about 0.1%. Especially since 2006, China's rural food price index presented consistency with the change trend and fluctuation margins of the international food price index and the differences between them get smaller and smaller. During 2006–2011, the international food price showed the trend of drastic fluctuations and rapid rising. Meanwhile, the trade openness of China's agricultural products also continued to expand, increasing to 80.28% in 2011 from 46.29% in 2006. Thus, it can indicate that the fluctuation in the international food price may exert an influence on the rural food price through the trade openness of China's agricultural products. In addition, the regression results also show that the combined index of China's total rural food price is mainly affected by the agricultural production price and the per capita GDP. With the agricultural production price increased by each 1% in one later period, the price of the China's rural food in the current period will rise by 0.7689%; with the per capita GDP increased by each 1% in one lagged period, the China's rural food consumption price in the current period will rise by 0.1332%.

Table 4. Estimated results of the model

	Model (1) Food	Model (2) Grain	Model (3) Oil	Model (4) Meat	Model (5) Eggs	Model (6) Aquatic products	Model (7) Vegetables
L1.Lnpc	0.7689* (0.0425)	0.1917* (0.0569)	0.8523* (0.0715)	0.3682* (0.0839)	0.8855* (0.0605)	0.2962* (0.0598)	0.3232* (0.061)
L1.Lnopen	0.0987* (0.0094)	0.0364*** (0.0211)	0.1742* (0.0169)	0.0774** (0.0359)	0.3077* (0.0177)	0.0495** (0.0224)	–0.2146* (0.0231)
L1.Lnrgdp	0.1332* (0.0466)	0.0266 (0.0644)	0.1142 (0.08560	0.368* (0.0894)	0.1341 (0.090)	0.0749 (0.0673)	0.1271*** (0.0685)
L1.Lnm2	–0.0748* (0.0262)	0.4034* (0.0501)	–0.1847* (0.0472)	0.0079 (0.0684)	–0.347* (0.0618)	0.1558* (0.0521)	0.5257* (0.0529)
L1.Lndis1	0.0072 (0.0072)	0.0104 (0.0063)	0.0366* (0.011)	0.0217** (0.0111)	–0.0121 (0.0128)	0.0116*** (0.0067)	–0.0228* (0.0069)
Constant	0.447* (0.1254)	–1.7095* (0.0905)	0.8571* (0.225)	–0.8219* (0.2012)	2.4296* (0.2026)	0.38* (0.0985)	–3.1967* (0.103)
R^2	0.9078	0.7327	0.6632	0.7373	0.7147	0.5776	0.7670
Qty of Observed Value	400	375	400	375	400	375	375

The numerical value in brackets is the robust SE, *, ** and *** stands for being significant in the level of 1%, 5% and 10%, respectively

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The regression results of major categories of food

This paper will make a detailed analysis for the regression results of major categories of food in the following content.

Price effect model of grain

The estimated coefficient of the agricultural trade openness (L1.Lnopen) is 0.0364, indicating that with the agricultural trade openness increased by each 1% in one lagged period, the consumption price of the domestic rural grain in the current period will rise by 0.0364%. The grain mainly includes rice, soybeans, corn and wheat. At present, except for rice, the corn, wheat and soybeans are all presenting the trade deficit. Because the China's soybean production costs are higher than the import price of soybeans, coupled with China's status of a net importer of soybeans, the import of a large number of soybeans is conducive to reducing the domestic consumption price of soybeans. Although since the beginning of 2010, China has changed to a corn net importer from a corn net exporter, the average trade terms of corn is only 0.75, indicating that the average import price of corn is higher than the average export price of corn in China. On one hand, the export of corn leads to the rising of consumption price of similar kinds of corns; and on the other hand, the price of exported corn is higher than the price of domestic common corns. Thus, the import and export trade of corn pushes up the rising of the domestic corn prices. It can be known from Table 5 that the average trade terms of China's corn is only 0.83, so that the international trade of corn can only promote rising of the domestic corn consumption prices. Although China is a net importer of wheat, the average trade terms of wheat are 0.88, that is, the import of wheat does not play a role in reducing the domestic wheat prices.

In summary, even if the import of a large number of soybeans can help to reduce the consumption price of the domestic soybeans, the international trade of rice, corn and wheat will result in the rise of the consumption prices of domestic similar products. The grain is still the main food for the consumption of Chinese rural residents, so the improvement of the agricultural trade openness will lead to the rise of the China's rural grain prices. Moreover, the regression results also indicate that the fluctuation in the agricultural production prices and monetary policies have larger impacts on China's rural grain prices, which is significantly positive.

Price effect model of meat, eggs and aquatic products

The estimated coefficient of the agricultural trade openness (L1.Lnopen) in one lagged period is 0.0774%, 0.3077% and 0.0495%, indicating that with the China's agricultural trade openness increased by each 1% in one lagged period, the consumption price of rural meat, eggs and aquatic products in the current period will rise by 0.0744%, 0.3077% and 0.0495%, respectively. It can be thus seen that the agricultural trade openness has the largest influence on the price of eggs, and it has the least impact on the price of aquatic products. First, corn and bean pulp are the main fodder for eggs, accounting for 60–65% and 20–25% of the fodder for eggs, respectively. It can be known from the foregoing that the trade open-

Table 5. Trade terms of Chinese food (P_x/P_x)

Year	Rice	Corn	Wheat	Soybean	Vegetables	Oil	Eggs	Meat	Aquatic products
2001	0.48	0.79	0.59	1.54	0.70	2.30	0.27	1.31	2.64
2002	0.57	0.39	0.60	1.27	0.97	2.04	0.25	1.23	2.47
2003	0.51	0.34	0.66	1.25	0.83	2.28	0.25	1.21	2.45
2004	0.79	0.40	0.63	1.26	0.80	2.30	0.00	1.28	2.65
2005	0.90	0.37	0.65	1.46	0.75	2.29	0.29	1.24	2.73
2006	0.84	0.73	0.78	1.45	0.93	1.96	0.14	1.27	2.40
2007	0.79	0.93	0.83	1.16	0.81	1.97	0.22	1.21	2.33
2008	0.81	1.15	1.05	1.30	0.90	1.74	0.12	1.23	2.57
2009	1.13	1.00	1.18	1.55	1.39	2.54	0.11	1.22	2.59
2010	1.00	1.12	0.66	1.58	2.71	2.56	0.21	1.09	2.42
2011	1.30	1.04	1.31	1.37	3.27	2.24	0.39	1.04	2.41
Average	0.83	0.75	0.81	1.38	1.28	2.20	0.21	1.21	2.52

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ing of agricultural products can help to reduce the price of domestic soybeans, but it will increase the price of the domestic corn. Also, because corn is the main feed grain, the trade opening may lead to the rise of the feed prices of eggs, thereby increasing the consumption price of eggs. Second, China is the largest exporter of aquatic products with trade terms greater than 2. In this context, the improvement of the agricultural trade openness is likely to promote the rise in prices of rural aquatic products in China. However, the consumption of aquatic products of rural residents is still relatively small, so the rising value is relatively small. Third, the average trade terms of China's meat is greater than 1, coupled with the influence of corn prices, the enhancement of the agricultural trade openness in China may also result in the increase in the consumption price of rural meat in China. Meanwhile, the China's agricultural production price has the greatest impact on the rural meat, eggs and aquatic products in China, followed by the per capita GDP.

Price effect model of oil

The regression results show that with the agricultural trade openness increased by each 1% in one lagged period, the consumption price of the domestic rural oil will rise by 0.1742% in current period. The average trade terms of China's oil products are greater than 2 (for details see Table 5), that is, the average export price of oil products is about 2.2 times its average import price. But on the whole, the enhancement of the agricultural trade openness will raise the price of China's rural oil food.

Price effect model of vegetables

The estimated coefficient of the agricultural trade openness in one lagged period is –0.2146%, indicating that with the China's agricultural trade openness increased by each 1% in one lagged period, the consumption price of China's rural vegetables in the current period will reduce by 0.2146%. Vegetables are the labour-intensive agricultural products mainly for export in China. In 2011, the export and import volume of China's vegetables were 9.322 billion dollars and 0.356 billion dollars, respectively, and the net export volume reached 8.966 billion dollars. Although the average trade terms of China's vegetables are 1.28, the trade terms in most years are less than 1. All of these seem to contradict to the estimated results, which may be attributed to the fact that the yield of vegetables in China rural areas can basically meet the needs of their own population. Due to the agricultural trade openness, the production structure of the domestic crop farming has changed and tends to plant agricultural products with comparative advantages as well as to expand their production and exports. In 1995, there were only 9515 hectares of the planted area of vegetables in China, accounting for 6.25% of the total sown area of crops; in 2012, this value increased to 20 353 hectares, accounting for 12.45% of the total sown area of crops. Because of the increase in the supply of vegetables, the price of vegetables reduces. In addition, the regression results also show that the currency has the largest impact on the vegetable consumption price of rural residents, followed by the agricultural production price and the scale of the per capita GDP.

ANALYSIS OF THE IMPACT OF FOOD PRICE CHANGES ON THE FARMERS' FOOD CONSUMPTION

The impact of food price changes on the farmers' expenditure of food

Firstly, according to the research of this paper, we assume that C_i means the consumption expenditure on the ith food, P_i refers to the price of ith food, and Q_i represents the quantity of the i^{th} food consumed. So we can conclude $C_i = P_i \times Q$. Secondly, we select 6 kinds of major food items to calculate which are grain, oil, meat, eggs, aquatic products and vegetables, so the corner mark "*i*" above is limited to the range from 1 to 6. Finally, we can deduce the formula (7) below. When the consumption structure remains unchanged, the rate of consumption expenditures changes caused by the consumption price changes is equivalent to:

$$\frac{\Delta C_i}{C_i} = \frac{Q_i}{\sum_{i=1}^{6} Q_i} \times \frac{\Delta cpi_i}{cpi_i} \qquad (7)$$

As the aggregate consumption data of food is absent, and the major food consumed by farmers include grain, oil, meat, eggs, aquatic products and vegetables, this paper approximately replaces the food consumption quantity with the consumption of these types of food. According to the previous estimated results, we can calculate the change rate of the impact of enhancement of the agricultural trade openness on the food consumption expenditure of China's rural residents, and the calculation results are shown in Table 6.

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Table 6. Change rate of the household consumption expenditures (%)

	2001	2003	2006	2008	2010	2011
Grain	1.3414	0.2377	0.0560	0.1521	–0.3207	1.0372
Oil	0.1816	0.0362	0.0077	0.0217	–0.0507	0.1726
Meat	0.1999	0.0380	0.0118	0.0304	–0.0706	0.2431
Eggs	0.2257	0.0396	0.0107	0.0304	–0.0762	0.2474
Aquatic Products	0.0286	0.0060	0.0018	0.0056	–0.0121	0.0400
Vegetables	–3.5496	–0.6550	–0.1617	–0.4449	0.9835	–3.1438
Change rate of agricultural trade openness (%)	58.33	10.53	2.56	6.98	–15.09	48.89

This paper only reports the farmers' food consumption expenditures in 2001, 2003, 2008 and 2011, and the calculation process uses the consumption structure of 2000, 2002, 2005, 2007 and 2009 as the initial structure

It can be known from Table 6 that as the China's agricultural trade openness increased by 58.33% in 2000, the consumption expenditures of major categories of food consumed by China's rural residents increased in 2001, but the consumption expenditures of vegetables were reduced. Specifically, the consumption price of grain, oil, meat, eggs and aquatic products in rural areas rose by 2.12%, 10.16%, 4.51%, 17.95% and 2.89%, respectively, and the consumption price of vegetables reduced by 12.52%. Maintaining the consumption structure in 2000 unchanged, the rural residents' consumption expenditure for grain, oil, meat, eggs and aquatic products rose by 1.34%, 0.18%, 0.2%, 0.23% and 0.02%, respectively, but the consumption expenditures of vegetables were reduced by about 1.34%. Since in 2000, the rural residents' consumption of grain and vegetables accounts for 63.18% and 28.36%, respectively, in the total food consumption. So it is concluded that the enhancement of China's agricultural trade openness has the largest impact on the rural residents' consumption expenditure for grain and vegetables, followed by eggs, meat, oil and aquatic products.

Impact of food price changes on the quantity of the farmer's food consumption

Estimation of the price elasticity of demand for major food

To calculate the impact of the food price changes on the farmers' food consumption, the first is to estimate the price elasticity of demand for food. In general, the method for estimating the price elasticity of demand for food can be divided into two categories: the single-equation method, such as the Working-Leaser model; and the system equation estimation method, including the extensible linear expenditure system model (Zhang et al. 2004), and the almost ideal demand system model (QUAIDS) (Xu 2011), as well as the quadratic form of the almost ideal demand system model (QUAIDS) (Zhang et al. 2012). Due to the possible interactions between food prices, the system equation method is widely used in the empirical research. However, the estimation of the price index in the AIDS model is nonlinear, so the LA/AIDS (AIDS Liner Approximation) model is often used in the actual research for the empirical analysis. And some studies show that the LA/AIDS model has a better consistency with the AIDS model (Liu and Zhong 2009). In view of the availability of data and other issues, this paper will use the two-stage model (LA/AIDS) of Liu and Zhong to estimate the price elasticity of demand for the major food of rural residents on the basis of the panel data model of 25 cities (1995–2011) in China.

The LA/AIDS model is divided into two stages. The first stage is mainly used to calculate the income elasticity of demand for food; and the second stage is used to estimate the price elasticity of demand for food. The LA/AIDS model is utilized for the system regression of various foods, and the specific model is set as follows:

$$\omega_i = \alpha_{i0} + \beta_i \left[\ln(x) - \sum_j \bar{\omega}_j \ln(p_j) \right] + \sum_j \gamma_{ij} \ln(p_j) + \mu_i \quad (8)$$

where ω_i means the proportion of the consumption expenditure of food in the category i in the total expenditure of food, x refers to the total food consumption expenditure, $\bar{\omega}_j$ presents the average value of the proportion of various food, and p_j means the consumption price of food in the category i.

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Table 7. Impact of agricultural trade openness on the farmer's food consumption before and after joining the WTO (%)

	Grain	Oil	Meat	Eggs	Aquatic products	Vegetables	Change rate of agricultural trade openness
Self-price city	–0.09	–0.89	–0.66	–0.94	–1.1	–0.83	–
2001	–0.19	–9.04	–2.98	–16.87	–3.18	10.39	58.33
2003	–0.03	–1.63	–0.54	–3.05	–0.57	1.88	10.53
2006	–0.01	–0.40	–0.13	–0.74	–0.14	0.46	2.56
2008	–0.02	–1.08	–0.36	–2.02	–0.38	1.24	6.98
2010	0.05	2.34	0.77	4.36	0.82	–2.69	–15.09
2011	–0.16	–7.58	–2.50	–14.14	–2.66	8.71	48.89

The calculation formula of non-compensatory price elasticity of demand is:

$$e_{ij} = -\delta_{ij} + (\gamma_{ij}/\overline{\omega}_i) - (\beta_i/\overline{\omega}_i)\overline{\omega}_j \quad (9)$$

when $i = j$, $\delta_{ij} = 1$; when $i \neq j$, $\delta_{ij} = 0$

According to the research purpose of this paper, this paper focuses on the self-price elasticity of demand for food, and will not consider the cross-price elasticity, the results shown in Table 7. From Table 7, the rural residents' self-price elasticity of demand for food is the minimum. When the grain price rises by 1%, the demand of rural residents for grain is only reduced by 0.09%, that is, the consumption of rural residents for grain is almost free from the influence of the price fluctuations of grain. It is indicated that grain is still the necessity in the life of farmers, thus lacking in elasticity. The rural residents' self-price elasticity of demand for aquatic food is the maximum. When the price of aquatic products rises by 1%, the demand of rural residents for aquatic products will be reduced by 1.1%, that is, full elasticity. The rural residents' self-price elasticity of demand for oil, meant, eggs and vegetables is -0.89, -0.66, -0.94 and -0.83, respectively. When the price of oil, meat, eggs and vegetables rises by 1%, the rural residents' consumption for them is reduced by 0.89%, 0.66%, 0.94% and 0.83%, respectively.

Impact of food price changes on the farmer's food consumption

According to the previous estimation results, we can calculate the impact of enhancement of the agricultural trade openness on consumption of various types of food. On the whole, rural residents reduce their consumption of grain, oil, meat, eggs and aquatic products, and increase the consumption of vegetables (for details see Table 7).

Take 2001 as an example, in 2000, the agricultural trade openness of China improved by 58.33%, so that the consumption price of grain, oil, meat, eggs and aquatic products in rural areas rose by 2.12%,10.16%, 4.51%, 17.95% and 2.89%, respectively, and the consumption price of vegetables was reduced by 12.52% in 2001. Due to the trade openness, the consumption of grain, oil, meat, eggs and aquatic products was reduced by 0.19%, 9.04%, 2.98%, 16.87% and 3.18% respectively, and the consumption of vegetables increased by 10.39%, indicating that the enhancement of the agricultural trade openness has the largest impact on the consumption demand of rural residents for eggs, oil, vegetables, all more than 9%.

And it has less impact on the consumption of grain, meat and aquatic products, mainly because the rural residents' self-price elasticity of demand for grain is small (–0.09), and the demand is almost not affected by the price changes.

The lower impact on meat and aquatic products is because the coefficient of impact of the agricultural trade openness on their price is relatively small, 0.0774% and 0.0495%, respectively. Thus, when the agricultural trade openness increases by 58.33%, the consumption price of meat and aquatic products in China's rural areas just changes by 4.51% and 2.89%, far less than those of eggs (17.95%), oil (10.16%) and vegetables (12.52%).

CONCLUSIONS

Based on the analysis of the national data during 1981–2012, two main conclusions can be drawn in this paper as follows:

1. With the time point of joining the WTO as the boundary, the calculation results of two kinds of

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trade openness present significant differences. The calculation results of the traditional agricultural trade openness are seriously underestimated. For example in 2012, the differences in results of the new and old method reached 67%. The new method can more accurately reflect the true extent of opening up of the agricultural trade in China, and it can better embody the position and role of China in the world's trade of agricultural products, which is more reasonable.

2. The agricultural trade openness has a significantly positive impact on the total price level of the rural residents' food, and presents a positive correlation with the consumption price of other five categories of food except for its negative correlation with the price of vegetables. In addition, due to the increase in price, the rural residents' grain consumption expenditure increases significantly with the largest impact. The consumption of meat, eggs, oil and aquatic products is reduced, and the consumption of vegetables increases.

This conclusion shows that, first, the consumption welfare of China's rural residents is affected after joining the WTO and especially the food consumption of farmers in poor areas is affected negatively. The only way to improve the farmers' consumption welfare is to encourage farmers to adjust the structure of production and to improve the farmer's income levels with the target of maximizing the revenue according to the principle of comparative advantage; second, the price of agricultural products and the farmers' welfare problem must be considered in the global framework. Especially for the products like grain with the high openness and large trade volume, their price changes are greatly affected by the international market price of grain. It will be difficult to succeed in controlling the product prices by continuing to adjust the domestic supply, to limit prices and so forth. In the long run, it is necessary to formulate global strategies to solve the fluctuation in prices of the domestic agricultural products, so as to improve the supply capacity for international agricultural products and to reduce the fluctuations in the prices of international agricultural products.

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Contact address:

Difei Zhao, School of Economics and Management, Fuzhou University, Fuzhou, China
e-mail: zhaodifei123@126.com