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Measurement of the Impacts of the Technical Barriers to Trade on Vegetable Export of China: An Empirical Study Based on the Gravity Model

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Abstract

With the residue limits of pesticides in vegetables as the indication, the present paper employs the gravity model to measure the impacts of the technical barriers to trade on vegetable export of China. The analysis shows that the residue limits of the pesticides in vegetables set by Japan, US and EU have apparent negative impacts on the vegetable export of China. The vegetable export of China decreases by 4.16% with the rise in the strictness of residue limits by 10%. On the other hand, to raise the strictness in residue limits of pesticides in vegetables in China has some positive impacts on the vegetable export of China. The reversed transmission of the affirmative list policy of Japan, despite its apparent short-term repressive impacts on the vegetable export of China, has positive impacts on the vegetable export of China as a whole to the US, European and Japanese markets.

Key words: The technical barriers to trade; The gravity model; The vegetable export

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INTRODUCTION

With the development of economic globalization, and on the condition of WTO's strictly limiting tariffs and quotas, anti-dumping, countervailing and other traditional non-tariff measures, to protect human and animal and plant health and environmental resources, technical barriers to trade (TBT)[1], because of its characteristics such as strong pertinence, good concealment, flexibility, are increasingly become the main policy tools and means in the world especially in the developed countries to make the trade protection, which has a far-reaching influence on international trade. In recent years, affected by various factors, China's export of agricultural products has become one of the most serious industries being limited by technical barriers to trade. TBT has caused great negative effect to China's agricultural product export and domestic agricultural production.

China is the world's main vegetable production and export country. In recent years its rapid export growth has become the second major categories of products. The main markets of China's vegetable export are Japan, the United States, Europe and other developed countries and regions, which set higher levels of technical barriers to trade, so vegetable products also encounter more serious technical barriers to trade. According to the examples and data, in recent years, China's vegetable products are

[1] TBT in this paper stands for Technical Barriers to Trade

hindered by technical barriers to trade, pesticide residues, microbial pollution and poor quality being the main reasons. And excessive pesticide residue account for 25% [2], which is our main concern. This article, taking American, European vegetable pesticide residue limits as a metric, is to measure TBT's effect on China's vegetable export.

1. SELECTION OF THE GRAVITY MODEL

1.1 The Development of the Gravity Model

The form of the gravity model is simple and its requirements for data are relatively simple. For nearly half a century, in the studies of international trade, the gravity model has been widely applied. In TBT's measure technology it is relatively the most objective, the most instructive, and the main direction to develop its potential.

Tinbbergen (1962) and Payhonen (1963), first applying the gravity model to study international trade, found that the trade flow between the two economies is to follow the law of attraction, that is: the scale of bilateral trade flow is proportional to their respective total economy and is inversely proportional to the distance between them, which can be expressed in the mathematical form type (1):

$$M_{ij} = a_0 \times (G_i^{a_1} \times G_j^{a_2}) / D_{ij}^{a_3} \quad (1)$$

In order to facilitate the regression and to make it linearized and to reduce the variance, the model is converted into the logarithmic form type (2):

$$\begin{aligned} \ln\ M_{ij} &= \ln a_0 + a_1\ \ln G_i + a_2\ \ln G_j \\ &+ a_3\ \ln D_{ij} + U_{ij} \end{aligned} \quad (2)$$

M_{ij} -- The trade flow between the exporting country i and the importing country j in a certain period

G_i -- The economic scale of the exporting country

G_j -- The economic scale of the importing country

G_{ij} -- The geographic distance between the two countries

a_o, a_1, a_2, a_3 are constants, their values being relative to the form of the economic activities. U_{ij} is a random error term, setting it obeying the normal distribution.

After that, scholars have kept the gravity model extended. Linnemann (1966) introduced the population variables into the model. Bergstrand (1989) introduced per capita income and exchange rate and other variables to the model. And Mccanltunn (1995), under the control of trade size and distance, through the data from the United States and Canada, conducted a research on border effects. At present, the perspectives of the research are expanding. Scholars are gradually introducing trade agreement, trade restrictions, the common currency, foreign direct investment and other indicators into the model, trying to explain the changes in trade flows by the combination of different economic variables.

Extended gravity model can be expressed as type (3):

$$M_{ij} = a_0 G_1^{a_1} G_j^{a_2} D_{ij}^{a_3} X_{ij}^{a_4} \quad (3)$$

The logarithmic form can be expressed as type (4):

$$\begin{aligned} \ln\ M_{ij} &= \ln a_0 + a_1\ \ln G_i + a_2\ \ln G_j \\ &+ a_3\ \ln D_{ij} + a_4\ \ln X_{ij} + U_{ij} \end{aligned} \quad (4)$$

Where X_{ij} explains the other factors affecting the trade flows between the two countries, such as, a common currency and the existence of TBT's set. The specific choice of parameters changes along with the study purposes.

2.2 Applications of the Gravity Model in the Standard Measure of Trade Flow

Monenius (1999) used this model to analyze the trade effect of spontaneous standard, the panel data covering the data of 471 industrial products from 1980 to 1995 in 12 European countries. He found that the sharing standard can eliminate the potential cost differences and has a great effect on the volume of trade. If the number of bilateral mutual criteria increases 1%, the corresponding trade volume increases about 0.32%. He also found that a country's unilateral standard reduces the imports of non manufacturing sectors such as agricultural products, but promotes the trade of the manufacturing sector. This method was also applied in Gebrehiwet's study (2007) (on the export effect of the aflatoxin standards of America, Europe and other developed countries on fruits, vegetables and nuts food for Asia Pacific and African countries) and Chen's research (2008) (on the effect of oxytetracycline maximum residue limits in fish feed and chlorpyrifos maximum residue limit in insecticide on China's fish products and fresh fruit exports). They all come to the same conclusion: the maximum residual standard can restrict the export of developing countries, and the more restrict the standard, the more obvious the restriction effect.

In recent years, Chinese scholars have begun to use the gravity model to explain the effects of technical regulations and standards, technical barriers to trade. SHI Zhaoxing (2005) deduced the gravitational equation of trade flow from the new classic and the new trade theory, and made a macro analysis on the Chinese agricultural product export flow. SUN Dongsheng (2005), by use of the gravity model, analyzed the impact of Japanese limits of chlorpyrifos residues on China's vegetables export to Japan. PAN Fengjie, *et al.* (2010) analyzed and verified

[2] Data comes from the official website of agricultural products trade special network of the Ministry of Commerce (http//wms.mofcom.gov.cn/subject/ncp/index.shtml) and the relative data in the official website of the technical trade measures site of the General Administration of Quality Supervision, Inspection and Quarantine of the PRC (www.tbt-sps.gov.cn).

the influencing factors of the gravity model for China's vegetable export. In addition, XU Haiqing (2008), DONG Yinguo (2011), ZHONG Zijian (2010), ZHAI Yinli (2011) and other researchers used the gravity model to make a quantitative analysis on the influence of technical barriers to trade on China's export of agricultural products. According to the content of the research, and considering the availability of the data, this paper applies the gravity model method to the research.

2. THE CONTRUCTION OF THE MODEL AND THE DATA SOURCES

2.1 The Construction of the Model

To measure the effects of TBT on China's vegetable export, we have constructed gravity model 1 to measure the impact of vegetable pesticide residue limits standard on trade, and plan to make an empirical analysis by using the panel data from China's vegetable export to Japan, the United States and the European Union during the sixteen years from1995 to 2010.

The form of Model 1 is specified as type (5):

$$\ln M_{ijt} = \ln a_0 + a_1 \ln G_{it} + a_2 \ln G_{jt} + a_3 \ln D_{ij} + a_4 \ln S_{ij} + a_5 \ln S_{it} + U_{ij} \quad (5)$$

Where, M_{ijt} is the vegetable trade volume of China's export to country j during the t period. About the meaning of the explanatory variables, the theoretical prediction effect of the dependent variables (the expected symbols) and their descriptions are shown as in Table 1.

Table 1
The Meaning of the Explanatory Variables, the Expected Symbols and Their Descriptions

Explanatory variables	Meaning	Expected symbol	Description
G_{it}	Exporting country's per capita GNP	+	Comprehensive reflection of the exporting country's economic development level and population status, and the potential supply ability of the country.
G_{jt}	Importing country's per capita GNP	+	Comprehensive reflection of the importing country's economic development level, population status, and the potential demand ability of the country.
D_{ij}	The absolute distance between the capitals of the importing and exporting countries	-	The geographical distance influences the transportation costs, and also indirectly influences the trade costs because of the differences in the country's trade policy, customs and habits, and consumer's preferences.
S_{it}	The number of vegetable pesticide residue limits standard implemented in the exporting country	+	The higher standards of the export country can enhance product quality, enhance the sharing standard level, and promote trade.
S_{jt}	The number of vegetable pesticide residue limits standard implemented in the importing country	-	The higher standards of the importing country will increase commodity production and export costs, also create obstacles to trade.

All the time, Japan is the biggest market of China's vegetable export, but also the most stringent country setting technical barriers to trade for China's vegetables, especially the affirmative list policy carried out since 2006 has made China's vegetable export to Japan in a more severe situation. Some studies have revealed that the affirmative list policy has caused in a short period of time great negative impact on China's vegetable export to Japan, but the research on this policy's influences on the overall situation of China's vegetable export in a relatively long period is short. In order to reflect the whole effects of the affirmative list policy on China's vegetable export, we add dummy variables to it on the basis on of Model 1, so we have Model 2 shown as type (6):

$$\ln M_{ijt} = \ln a_0 + a_1 \ln G_{it} + a_2 \ln G_{jt} + a_3 \ln D_{ij} + a_4 \ln S_{ij} + a_5 \ln S_{it} + a_6 R + U_{ij} \quad (6)$$

In which R is the dummy variables of the affirmative list, its value being 1 since 2006, and its estimated coefficient beingncertainty, and the rest of the explanatory variables being shown as before.

2.2 The Data Sources

In Model 2, M_{ijt} is the vegetable trade of China's exports to country j in t period. The data come from the "China Foreign Economic Statistical Yearbook", in which each year all data from Chapter 7, 8 and 20 are accounted according to the customs imports and exports classification. Per capita GNP in China, Japan, the United States and the European Union are from the official website of the Statistical Bureau of People's Republic of China www.stats.sor.cn/tjsj/qtsj/gisi and "The World Economy Yearbook 2010-2011". Considering the availability of data, German's data stand for the data of EU as the German economy is the largest and most

influential economy in the EU. The geographical distances from China to Japan, the United States and the European Union are obtained through the "distance calculator" of www.hjqing.com, among which the distance to the EU is the distance to Germany.

Japan sets the standards of vegetable pesticide residue limits according to the pesticide use of each kind of vegetables. The standards had 1,743 items in the vegetable products before 2003. In 2003, the number reached 3728 items. From 2006, the number of agricultural residues rose sharply from more than 9,000 to more than 50,000 items. The standards for vegetables increased 2 times reaching to 7,456 items according to conservative estimates. For leaf type, bulbs, fruit vegetables and tomatoes, broccoli and other single vegetables, the United States laid down 677 items in pesticide residue limits standards. In 2007 the vegetables pesticide residue standard reached 802 items. The standards of pesticide residues in EU vegetables were made on the classification of vegetables. The six great vegetables such as roots, fruits and vegetables, leafy vegetables were given 375 standards before 2003. Beginning in 2003, the number rose to 583 standards (REN, XU, & ZHANG, 2007). Before 2001, integrating vegetable pesticide residue limits standards of the Ministry of agriculture, the Ministry of Health and the State Bureau of Technical Supervision and Inspection, China had 53 national standards. From 2002, China implemented pollution-free agricultural products standards, among which pollution-free vegetables contained 325 pesticide residue limits standards. In October, 2005, the new national standards in "Maximum Residue Limits for Pesticides in Food" began to implement, 478 criteria were formulated according to the 136 kinds of pesticides (ZHOU, & ZHONG, 2006). Statistical descriptions of the key variables in the model are shown as in Table 2:

Table 2
Statistical Descriptions of the Variables

	M exports amount	GNP_c China's per capita GNP	GNP_j the importing country's per capita GNP	D_i distance	S_C China's standards	S_j the importing country's standards
The average value	10.43	1430.63	34549.79	11192.10	200.69	1591.75
The median	9.86	1050.00	34730.00	10591.00	53.00	677.00
The maximum value	23.54	3590.00	48190.00	19924.00	478.00	7456.00
The minimum value	1.27	530.00	22980.00	2478.00	53.00	375.00
The standard deviation	7.12	905.50	6669.91	7317.38	176.64	1978.28

4. THE EMPIRICAL RESULTS AND DISCUSSIONS

4.1 The Empirical Results

The research data come from the cross-sectional data and the panel data consisting of time series. The time span is 16 years, each year having 3 data of the amount of China's vegetable export to Japan, America, EU, with a total of 48 data. According to the characteristics of the data, the model makes a quantitative analysis, using the panel's generalized two multiplications and using the software E-views 5.0. The regression results are shown as in Table 3:

Table 3
The Regression Results Analysis

Variable	Expected symbol	Coefficient	T value	Coefficient	T value
		Model 1		Model 2	
Ln (GNP_C) China	+	0.626257***	7.935515	0.624001***	7.787282
Ln (GNP_i) importing country	+	0.779561***	8.636311	0.789304***	8.242161
Ln(D)	-	-0.950827***	-23.22654	-0.955371***	-22.04901
ln(S_C) Chin's standards	+	0.182956***	5.831171	0.181480***	5.656973
Ln(S_j) importing country's standards	-	-0.416406***	-8.331557	-0.422129***	-7.930366
R				0.033742	0.329233
F		1391.458		1080.864	
P		0.0000		0.0000	
R^2		0.992		0.991	
D.W.		1.06		1.06	
N		48		48	

Note: ***, **, * indicates respectively at the significant level of 1%, 5%, 10%.

4.2 The Related Discussions

From the regression results, the symbol of each interpretation variable and the expected symbol is basically the same, and most of them reach a significantly higher level. The whole of the equation and every coefficient are tested by F. The determination coefficient of the equation R^2 reaching 0.99, that is, the goodness of fit in the model is very good.

The specific analysis of the regression results is shown as the following:

(1) The importing country's vegetable pesticide residue limits standards have obvious inhibitory effect on China's vegetable export. In Model 1, at the significant level of 1%, the regression coefficient of the importing country's standard is -0.416, meaning that the number of the importing country's standards increases every 10%, China's vegetable export will reduce by 4.16%; and if you take into account the impact of affirmative list policy, the regression coefficient will be -0.422. Thus the increase of the importing country's whole number of pesticide residue limits standard will have a greater inhibitory effect on China's exporting vegetables, and this is consistent with the real situation.

(2) China's vegetable pesticide residue limits standards have a certain role in promoting its vegetable export. In Model 1 and Model 2, at the significant level of 1%, the regression coefficients of China's vegetable pesticide residue limits standard are respectively 0.183 and 0.181, both being positive, indicating that improving China's vegetable pesticide residue limits standards and strengthening the measures to control the pesticide residues in vegetables can improve China's vegetable quality, and that passing the secure and reliable information of China's product quality to the importing countries' consumers is beneficial to China's vegetable products entering into Japan, US and Europe.

(3) The per capita GNP of both importing and exporting countries has an obvious promoting effect on China's vegetable export. In Model 1, at the significant level of 1%, the regression coefficient of importing country's per capita GNP is 0.780, meaning that the importing country's per capita GNP rise every 10%, that is, the importing country's domestic demand increases every 10%, China's vegetable exports will increase by 7.80%; and the regression coefficient of China's per capita GNP is 0.626, meaning that China's GNP per capita rise every 10%, China's vegetable exports will increase 6.26%. Considering the affirmative list policy, the per capita GNP of the both importing and exporting countries still have significant promotion in China's vegetable exports. In short, in a period of economic prosperity, the development of bilateral trade between the two sides will be better, and the economic downturn is not conducive to the development of trade.

(4) The geographical distance of both sides has a negative effect on China's vegetable export. In Model 1 and Model 2, the coefficients geographical distance are -0.951 and -0.955, showing that shortening the geographic distance of both sides can reduce the trade cost and promote bilateral trade.

(5) On the whole, the affirmative list policy has a positive effect on China's vegetable exports, its regression coefficient being 0.034. The reason may lie in: 1) while the affirmative list policy has a significant short-term inhibition effect on China's vegetable exports to Japan, China's export enterprises increase the development of American and European markets, reducing dependence on the Japanese market. From the actual situation, compared with 2006, China's vegetable exports to Japan in the years of 2007, 2008, 2009 had a negative growth rate, while exports to Europe and the United States had bigger growth. 2) In the long term, the affirmative list policy may force the vegetable production and export enterprises in China to strengthen management, reduce pesticide residues, so as to improve the international competitiveness of exporting agricultural products and promote the export. From the results of the models, the variable of the regression coefficient in the affirmative list policy has not achieved 10%, its long-term effect deserves our further study.

CONCLUSIONS AND POLICY RECOMMENDATIONS

The results ofdata analysis show that: the vegetable pesticide residue limits standards of Japan, America and Europe have a more significant negative impact on China's exports of vegetables. The more the number of the standards, the larger its negative impact; while promoting China's vegetable pesticide residue limits standards has a certain role in China's vegetable export; the Japanese affirmative list policy has a significant short-term inhibition effect on China's vegetable exports to Japan, but its forcing mechanism can prompt China's export enterprises to increase the development efforts of European and American markets, and by strengthening management, reducing pesticide residues, so as to improve the international competitiveness of exporting agricultural products, and to promote the export.

According to the above conclusions, this paper holds that to deal with technical barriers to trade, China's vegetable export must focus on the control of pesticide residues.

(1) Pay close attention to the changes in the technology standards of the importing and exporting countries, perfect tracking and evaluating the mechanisms, release timely the relevant information; comply to the scientific standards timely and actively, and defense the unreasonable demands positively and actively.

(2) Strengthen the construction of the technical regulations and standard systems of vegetable products,

improving the adoption rate of international standards and promote the internationalization of China's standards.

(3) Optimize the environment of agricultural production, strengthen the management of agricultural inputs, and establish the agricultural product quality safety traceability system "from field to table" to enhance the level of product quality and safety.

(4) Implement the export market diversification strategy, consolidate the original Japanese, European, American and other traditional markets, at the same time, develop the efforts in ASEAN, the Middle East, Central Asia, Russia and other peripheral markets, and actively establish a stable trade channels with these markets, not only having the advantages of distance, but also moderately alleviating the risk of too concentrated export markets.

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