An Influence Factor Analysis of International Trade Flow using a Gravity Model

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***Abstract* - With the continuous development of economic globalization, trade between countries is more and more frequent in the world, which make the study of factors affecting that trade flows between countries to be essential. The traditional international economic and trade theory explains in detail the causes of trade and how to promote the development of international economy, but it does not address the determinants of trade flows. A trade gravity model based on the law of universal gravitation (Newton) is used in this paper to study the trade in the region. This paper selects the cross-section data of 13 major countries in the world in 2013 to develop a gravity model about international trade flow. The model test results show that the main trade is affected by: i) factors of scale of economies in the world, ii) geographical location, and iii) system arrangement.**

Keyword - Trade gravity model; the international trade flows; analysis of influence factors

I. INTRODUCTION

The basic idea of Trade Gravity Mode is the law of universal gravitation (Newton), which is show that Size of gravity is proportional to its mass, and is inversely proportional to the square of the distance between two objects. Tinbergen (1962) and Payphone (1963) Guided by the gravity[1], who come up with trade gravity mode in the first time in the early 1960 s. trade gravity mode is:

$$T_{ij} = KY_iY_j \Big/ D_{ji} \tag{1}$$

in raw form, where K is constant, T_{ij} is the bilateral trade volume between the two countries, Y_i and Y_j are the scales of two economies of countries in the region, GDP is the value of the variable usually; D_{ij} is the distance between the two countries, which generally refers to the distance of the two countries economic centre or between the main port. Trade gravity model is converted into linear form in the empirical test. The trade gravity model put forward after since the early 1960s, many scholars of the model carried on the thorough research, this makes the trade gravity model constantly enrich and develop based on the original for. Solid theoretical foundation is lack [2], but trade theory of the classical and new classical hasn't always been the inability to make empirical analysis of bilateral trade theory. Model undoubtedly provides a dynamic analysis tool for economists, which quantify the bilateral trade between the two countries, opens up a new space of research in the field that econometric analysis for the international trade theory. That makes the empirical study of international trade enter a new world. Domestic scholars on the research of the trade gravity model mainly focus on three angles: first is the study of the flow of trade and export potential China (mainland) with main trading partners; second is to study the degree of economic and trade integration China (mainland) with major regional trade organizations (such as asana, APEC); third Is the study the effect of mutual trade that China's different economic regions (for example, Hong Kong, Taiwan). This paper Build a world gravity model of bilateral trade flow, on the basis of previous analysis, to analyze the main factors affecting the bilateral trade flows, and put forward the corresponding policy and recommendations.

II. THE BASIC DATA SOURCE AND INSTRUCTIONS

A. Variable Declaration

The gravity model was first put forward by Newton who calculating gravity between celestial bodies, which is used for study the relation that number of travel population and gross population between the two cities by social scientists. When it is used as an empirical analysis tool that the flow of trade between the two countries, there has two variables in the most classic gravity model, which is the trader economies of scale and the distance between the trading nations. Economic scale of trading nation economy is generally expressed in nominal gross domestic product (GDP), which Reflects import demand or export supply capacity in a country or region . In most cases, the economic scale is greater in the trading nation, the ability of import or export of which has potential, where the bilateral trade flows is greater. The distance reflects the transport costs among trading countries, which is an important factor to hinder trade [3]. Theoretically, the distance between the two countries is farther, that the trade flows is smaller, when other things being equal. In the actual, the factor that is affecting trade flows between

the two countries is more than these. China's top ten trading nations, Such as India, Japan, etc, which has The characteristic that total population is more or the large population is density From the current situation of China's agricultural products trade; Canada and the United States not only show the economy mode, but also has a vast territory, large agricultural land area. Therefore, population and agricultural land area should also consider variable into the model in trading nation. The agriculture is the basic industry of a country, Produce sufficient supplies is the basis for the development of other industries. Agricultural products is relatively inelastic goods, the population has a great influence on the consumption level of agricultural product in trading nation, affects import and export flow of a country's agricultural products. Agricultural production depend on the land for, a country's agricultural land quantity determines agricultural production quantity in the country. As a result, agricultural land area first affect the country's agricultural output [4], and then affect the country's agricultural products trade with the demand of agricultural products in trading nation. In addition, a country's currency exchanges rate impact on import and export. In general, the exchange rate rise is to promote export, and restrict imports, and whereas the opposite.

Table 1 the Variable、meaning and Expected symbols of China about agricultural products with foreign trade in gravity model : This paper will Introduce model trading countries GDP、cultivated land area[5]、 Population and the exchange rate into the trade gravity， the size of trade flow are relate with the GDP of trading countries, cultivated land area and population, negatively correlated with the distance between trading countries.

This paper take variable, meaning and symbol into the gravity model, that shown as the table below from the above analysis (table 1):

TABLE 1 THE VARIABLE、MEANING AND EXPECTED SYMBOLS OF CHINA ABOUT AGRICULTURAL PRODUCTS WITH

variabl	meaning	symbol
T	total amount of products trade that China and other trading countries	
GDPi	trading nation's GDP	+
GDPj	China‘s GDP	+
D	distance that Beijing and the capital economic center of trading nation	-
Li	trading nation's per capita arable land	+
Lj	China's per capita arable land	+
POPi	Trading nation's population	+
POPj	China's population	+
InR	RMB exchange rate against the dollar	+or-

B. Source of Data and Instructions

B1. Sampling Range

The time range of sample data that is selected by this paper is from 2004 to 2011, which is the annual trade data of agricultural products. Scope of the sample countries is located in the top 30 countries, which agricultural products trade with China, Specific include The United States, Brazil, Japan, Malaysia, Australia, Argentina, South Korea, Thailand, Indonesia, India, Canada, the Russian federation, Vietnam, New Zealand, France, Germany, the Netherlands, Spain, the Philippines, the United Kingdom [6], Peru, Uruguay, Chile, Singapore, Italy, Mexico, Denmark, Belgium, South Africa, Uzbekistan. We Chose 30 largest trading nation and regions which trade with the Chinese agricultural products, because the volume of trade occupy a large proportion that with China's agricultural products in these countries and regions. For example, according to China's agricultural products trade statistics in 2011, we calculated the total trade volume of China's agricultural products with the first 30 largest trading countries and regions is 81.84% of China's the total trade volume of agricultural products. Therefore, these countries are typical.

B2. Data Sources

This paper use the data all can get in the website or information, data sources as follow:(1) China's agricultural products trade data in 2006-2013 years is calculating China's annual import and export of agricultural products trade data that is provided by the international trade website from the department of China's commerce ministry; (2) distance data of China and trading nation or region get from web site ttp://www.geodistance.com/. (3) China and trading nation or region's GDP, population and cultivated land area and other related data get from family bank database. (4) RMB exchange rate against the dollar from China statistical yearbook (5) Finally trade data and GDP data is For the empirical in the data[7], which According to the annual inflation of the GDP deflator and consumer prices to deflate data that is for the base period in 2004.

B3. Model Set

This paper introduces virtual variables including trade arrangements, and other explanatory variables, extend the trade gravity model. In addition, the linear model is set up, which is in order to meet the needs of the linear estimation, and eliminate the influence of different variance. Equation 1 can be transformed into change for linear form, as follows:

$$In(X_{ij}) = A + \alpha In_{Yi} + \beta In_{Yj} + \gamma In_{Dij} + \xi_{ij} \quad (1\text{-A})$$

where α、β、γ are the coefficients and ξ is the interference.

J. Tinbergen introduced two virtual variables that the common boundary and preferential arrangement In the gravity model. The results show that distance between the trading nations significant influence effect of trade expansion, extended form of gravity model is:

$$X_{ij} = \alpha_1 GDP_i^{\beta_1} GDP_j^{\beta_1} D_{ij}^{\beta 2} AD_{ij}^{\beta 3} PR_{ij}^{\beta 3} \mu_1 \quad (2)$$

X_{ij}^{1} is the bilateral trade flows, GDP is Gross domestic product of trading nation or region, AD and PR is the virtual variable, α_1 is the constant term, μ_1 is stochastic error term, Other is parameters that is estimated.

P. Poyhamen replaced GDP with national income per head, replace distance with transport costs, and extend The gravity model ,who think that a country's exports is proportional to the national income per head, which is inversely proportional to the cost of transportation. H. Linneman believe that technology difference and economic scale is the determinant of comparative advantage, and The potential exports of a country is related to gross national product (GNP) and openness in bilateral trade country', other barriers to trade ,such as Tariffs, transport costs, quotas is negative related to The bilateral trade flows.

III. THE EMPIRICAL RESULT ANALYSIS

A. Panel Data Unit Root Test

First, we use simple gravity model to empirical analysis China and samples of trade flow about the agricultural products, then to empirical analysis China's agricultural products trade flows which is based on the development of gravity model [8]. By the development of the gravity model, we build gravity model of China's agricultural products trade flow which is as follows.

1. Classical gravity model:

$$InT = \alpha_0 + \alpha_1 InGDP_i + \alpha_2 InGDP_j + \alpha_3 InD + \mu_{ij} \quad (3)$$

2. The trade gravity model that join cultivated land area:

$$InT = \alpha_0 + \alpha_1 InGDP_i + \alpha_2 InGDP_j + \alpha_3 InD + \alpha_4 InL_j + \alpha_5 InL_i + \mu_{ij} \quad (4)$$

3. Trade gravity model that Join the cultivated land area and population variables:

$$InT = \alpha_0 + \alpha_1 InGDP_i + \alpha_2 InGDP_j + \alpha_3 InD + \alpha_4 InL_j + \alpha_5 InL_i + \alpha_6 InPOP_j + \alpha_7 InPOP_i + \mu_{ij} \quad (5)$$

4. Gravity mode that Join the cultivated land area, population and exchange rate variable l:

$$InT = \alpha_0 + \alpha_1 InGDP_i + \alpha_2 InGDP_j + \alpha_3 InD + \alpha_4 InL_j + \alpha_5 InL_i + \alpha_6 InPOP_j + \alpha_7 InPOP_i + \alpha_8 InR + \mu_{ij} \quad (6)$$

α_0 is the constant term, μ_{ij} is stochastic error term, α_1 to α_8 is estimate a variable coefficient, Other variable meanings are shown in table1

This paper adopt in view of the assumption of homogenous panel LLC inspection and face plate to different quality of fake Fisher-ADF test, Fisher-PP test unit root test instrument for each variable to make the result has stronger robustness and persuasive, This paper take LLC inspection that Homogenous panel hypothesis, Fisher-ADF test that Heterogeneous panel hypothesis and Fisher - PP inspection, those Unit root test on each variable, which Make the result has stronger robustness and persuasive, Test results as shown in table 2.

TABLE 2

variable	LLC	Fisher-ADF	Fisher-PP
LnT	-1.91624**(0.0277)	46.6131(0.8970)	61.0096(0.4394)
InGDPi	-4.37078***(0.0000)	56.6489(0.5989)	65.1243 (0.3031)
InGDPj	-3.82712*** (0.0001)	13.3126 (1.0000)	26.1891 (1.0000)
InLi	-2.81607*** (0.0025)	77.3393** (0.0310)	183.889*** (0.0000)
InLj	-75.1383*** (0.0000)	571.008***(0.0000)	642.742***(0.0000)
InPOPi	-17.4816*** (0.0000)	111.966*** (0.0000)	128.373*** (0.0000)
POPj	0.41246 (0.6600)	14.1158 (1.0000)	14.1158 (1.0000)
InR	0.27227 (0.6073)	6.06538 (1.0000)	2.18368 (1.0000)
ΔLnT	-12.9676***(0.0000)	133.223***(0.0000)	191.186***(0.0000)
ΔInGDPi	-9.06813*** (0.0000)	96.5153*** (0.0020)	135.011*** (0.0000)
ΔInGDPj	-6.46052*** (0.0000)	52.6234 (0.7394)	48.8938 (0.2149)
ΔInLi	-12.6976*** (0.0000)	161.933*** (0.0000)	201.037*** (0.0000)
ΔInLj	-12.3257*** (0.0000)	74.3231 (0.1010)	211.751*** (0.0000)
ΔInPOPi	6.85998*** (0.0000)	102.607*** (0.0003)	126.021*** (0.0000)
ΔPOPj	-11.4073*** (0.0000)	125.023*** (0.0000)	124.615*** (0.0000)
InR	-10.5468*** (0.0000)	86.6129** (0.0139)	120.938*** (0.0000)

Note: the hypothesis of LLC test, Fisher - ADF test, Fisher - PP test has unit root; *, * *, * * *, respective significance test that 10%, 5% and 1%, the test results are corresponding P in brackets ; Δis one order difference .D is Distance variable Has particularity in the gravity model ,which distance that specific trading nation and China's is constant value, which does not change along with the change of the year, so we can not do the unit root test.

table 2 shows that the variable lnLj, InR is unable to refuse hypothesis that is panel unit root, under 10% significance level; All variables whose first order difference to refuse the original hypothesis under 1% significance level. Therefore, we comprehensive the three kind methods of panel unit root test, all variables aren't the stationary sequence.

B. Pedro panel co-integration test

Unit root test results get the conclusion of the whole order list that is each variable in Model, which meet the requirements of the panel co integration test. This paper takes method of co-integration test that Base on the residual Perdroni and Kao test. This paper empirical analysis the influencing factors of China's agricultural products trade flow that Base on the gravity model on for, which take classical gravity model and extend gravity model for empirical analysis then establish the following four models (3), (4), (5), (6).

TABLE 3 PANEL CO-INTEGRATION TEST RESULTS

variable	LLC	Fisher-ADF	Fisher-PP
LnT	-1.91624**(0.0277)	46.6131(0.8970)	61.0096(0.4394)
InGDPi	-4.37078***(0.0000)	56.6489(0.5989)	65.1243 (0.3031)
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ΔInPOPi	6.85998*** (0.0000)	102.607*** (0.0003)	126.021*** (0.0000)
ΔPOPj	-11.4073*** (0.0000)	125.023*** (0.0000)	124.615*** (0.0000)
InR	-10.5468*** (0.0000)	86.6129** (0.0139)	120.938*** (0.0000)

Note: *, * *, * * *, respectively through the significance of test that is 10%, 5%, 1%.

D is Distance variable and it has particularity in the gravity model, which distance that specific trading nation and China's is constant value, which does not change along with the change of the year, the change of arable land is small in each year, which is the approximate constant.

table 3 show that the result of Panel - v inspection, the Panel - Rho, Group - Rho inspection was not significant, others results of the rest are pass the significance test of

1% (co-integration relationship between variables of the original hypothesis is refused under the 1% significant level). Model 1 \model 2, and 3, can be regarded as panel co-integration model of influencing factors that China's agricultural products foreign trade, which shows that trade volume of the model of Each model and variables in the model keep the dynamic equilibrium relationship .

C. Panel Data Regression Results

We take formula (3), (4), (5), (6) get Panel data regression results. we take the data that is China's foreign trade of agricultural products l from 2004 to 2011 into the model, which is Based on unit root test results, panel co-integration test results and the above three models. We with the least square method in measuring EVIEWS6.0 software simulation of the regression results, which is as shown in table 4.

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TABLE 4 REGRESSION RESULTS TRADE FLOW THAT CHINA'S AGRICULTURAL PRODUCTS FOREIGN IN GRAVITY MODEL

variable	model1	model2	model3	model4
LnC	-8.419722*** (-4.326957)	-6.502253*** (-4.597158)	-523.0674* (-1.761617)	-444.0581 (-0.807890)
InGDPi	0.325591*** (14.28956)	0.295886*** (14.21919)	0.276129*** (13.47973)	0.275996*** (13.42249)
InGDPj	0.882620*** (9.086693)	0.913956*** (6.737549)	-0.654244 (-0.690774)	-0.252874 (-0.098668)
lnD	-0.337477*** (-8.944739)	-0.458964*** (-13.88681)	-0.365957*** (-7.547296)	-0.365566*** (-7.53630)
InLi		0.133832*** (9.670150)	0.090438*** (4.276070)	0.090379*** (4.264382)
InLj		0.263123 (0.313031)	1.100205 (0.2055)	0.983546 (0.968941)
InPi			0.123932*** (3.638524)	0.124043*** (3.626794)
lnPj			46.45364* (1.734722)	38.77595 (0.740552)
lnR				0.511429 (0.166918)
	R-squared:0.643274 Adjusted	R-squared:0.770561 Adjusted	R-squared:0.747434 Adjusted	R-squared:0.746670 Adjusted
	R-squared:0.638740 F-statistic:	R-squared:0.765658 F-statistic:	R-squared:0.739814 F-statistic:	R-squared:0.737897 F-statistic:
	141.8575 ***	157.1758***	98.08176***	85.10674***

Note: the hypothesis of LLC test, Fisher- ADF test, Fisher - PP test has unit root; *, * *, * * *, respective significance test that 10%, 5% and 1%.

IV. CONCLUSIONS

A. Model results analysis

The model 1 is a classical form of trade gravity model, where The value of adjusted R2 is 0.638740.that Show the fitting of this equation is good; F is statistic value that is 141.8575,which refuse the null hypothesis that variable is 0 on the 1% significance level. The value of adjusted R2 is 0.638740 in The model 2,which Show the fitting of this equation is good; F is statistic value that is 141.8575,that Through the test 1% significance level. The value of adjusted R2 is 0.739814 in The model 3,which Show the fitting of this equation is good; F is statistic value that is 98.08176,that Through the test 1% significance level. The value of adjusted R2 is 0.737897 in The model 4,which Show the fitting of this equation is good; F is statistic value that is 85.10674,that Through the test 1% significance level.

B. Regression Results Analysis

First, Model 1 and model 2 show that the symbols of Variable coefficient are in line with expectations, trade flow of China's agricultural and the size of GDP in trading countries is directly proportional, the distance between them is inversely proportional , the amount of cultivated land Is proportional in trading nation. Model 2 show that Regression results of lnLj didn't pass the 10% level of significance test, this Shows that China's arable land area isn't significant impact on China's agricultural trade, isn't the main influence factors.

Second, Model 3 is add demographic variables on the basis of model 2, the regression results of concluded which show China's agricultural products trade flows is negatively related to the Chinese GDP scale, The result was not significant, which are related with the population of China and trading countries , and passed the significance test of 10% level , regression results of variable that is Distance and cultivated land area is in line with expectations.

China's agricultural trade flow and GDP in trading countries is positive correlation in the classical gravity model, regression results is significant there are different situations, because this variable of China's GDP explanation for China's agricultural products trade flow was weakened by the population variable. In general rule GDP scale is the function of the country's population, Demographic factors instead of GDP, which explains China agricultural trade flows

Finally, Model 4 add the exchange rate on the basis of model 3,where the regression results show that the population of China is no longer significantly influence factors of China's agricultural products trade flows the

exchange rate isn't significant influence on China's agricultural products trade flows, The regression results of other variables isn't substantive changes. Exchange rate affect both import and export, which Rise promote exports and curb imports, and Reduce the promote the import and export curbs, so The positive and negative influences of exchange rate will cancel each other out in trade volume. As a result, exchange rate isn't the significant factors that affect China's agricultural products trade.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflicts of interest.

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