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As a major agricultural country, China has always regarded the export of agricultural products as an important issue in foreign trade. In the face of the current volatile international situation, how to ensure the smooth export of China's agricultural products and realize the reasonable and efficient allocation of resources in the region requires us to take active measures to create a favorable environment, but also to seize new opportunities in the international changes to win the first opportunity for development.

The Regional Comprehensive Economic Partnership Agreement (RCEP) came into force on January 1, 2022, meaning that the FTA with the largest global economic volume is officially in operation. China, as a country in the region, has made great efforts to promote the launch and entry into force of RCEP, and trade in agricultural products is a key area covered by RCEP. Based on the above background, studying the effect of agricultural trade between China and RCEP member countries is of great practical significance for promoting the smooth flow of China's agricultural trade, diversifying the import and export channels of agricultural products, and realizing the high-quality development of agricultural exports.

As the largest free trade agreement in the world today, the economic and trade impact of RCEP has attracted extensive attention from scholars at home and abroad. Using the numerical simulation analysis of the general equilibrium gravity model, Jue Wang et al. (2023)[9] found that the RCEP agreement positively affects the national welfare and regional trade structure of each country through the trade cost channel and the technology diffusion channel.RCEP not only acts on the cost and technology channels of the industry, but also assists the integration of the industrial chain and the innovation chain through the differentiated positive and negative list rules (Xu, Ming. 2023)[10], it can be seen that the signing of RCEP has brought different degrees of positive effects on the economic and trade fields of member countries, promoting the sustainable growth of national economies.

Agricultural trade as an important part of RCEP cooperation, a large number of scholars on cooperation in the field of agriculture to conduct trade efficiency, trade potential and influence factors research. Shi Chao and Hu Liequ (2022) [11]analyze the impact of agricultural trade competitiveness, the share of agricultural employment and other factors on the efficiency of China's agricultural trade with other RCEP member countries. Most of the results show that RCEP cooperation will bring new growth momentum for China's agricultural export trade and promote the development of agricultural trade of the countries in the region (Du Xiaoyan, 2021)[12]. Some authors analyze the cooperation between the two countries through their agricultural products, and Zhang Xi (2024)[2] uses a stochastic frontier gravity model to analyze the efficiency and potential of agricultural trade between China and South Korea, and measures the different impacts of different factors, such as the liner shipping connectivity index, on the efficiency of agricultural trade between China and South Korea.

In terms of research methodology, the gravity model is an important tool for analyzing trade potential. The gravitational model originates from Newton's law of gravity, which states that the gravitational force between two objects is proportional to their respective masses and inversely proportional to the distance. The first to introduce the gravitational model into the field of international trade were Tinbergen (1962) and Poyhonen (1963). Since then, many scholars based on the simple gravity model, population, language, resource endowment and other elements into the gravity model and expand it, so that the explanatory power of the gravity model has been increasing. The gravity model has been widely used in the study of agricultural trade and potential. Pan Weiguang, Yang Qi, and Hsiang- TaiCheng (2013)[13] used the gravity model to study the flow of agricultural exports from China to South Korea and the potential of agricultural exports to South Korea. Sun Qihang et al. (2024) [3]used the extended trade gravity model to empirically analyze the influencing factors of China's agricultural exports to RCEP member countries, and derived the effects of influencing factors such as the GDP of China and importing countries. Feng Zixuan (2023)[6] empirically analyzes the influencing factors of agricultural trade for import and export flows using the extended gravity model to derive the types of agricultural trade potential between China and RCEP countries.

To sum up, RCEP has brought some significant impacts on the economy and trade of member countries, and deepened China's agricultural trade cooperation with RCEP partner countries, promoting China's agricultural products to further expand the international market and optimize the market layout.

Gravitational model was firstly produced in the field of physics, and then introduced into the research paradigm of economics by Tinbergen, Poyhonen and Linnemann and other scholars. After decades of development and improvement, the gravity model has become one of the most important research methods for studying international trade issues. This model quantifies the trade volume of two countries, which is of great significance in quantitatively analyzing the changes in international trade volume.

The basic form of the trade gravity model is as follows:

$$\ln F_{ij} = \alpha \ln Y_i Y_j + \gamma \ln D_{ij} + \varepsilon_{ij}$$

Where Fij represents the actual trade volume of country i to country j, YiYj is the product of GDP of China and the economic scale of the trading partner, Dij is the trade distance between the two countries, usually expressed by the distance between the political or economic centers

of the two countries, and the distance between the capitals of the two countries is selected as the explanatory variable in this chapter.

Considering the diversity and complexity of the factors affecting international trade, on the basis of the traditional trade gravity equation, other factors affecting bilateral trade flows are gradually added to the equation, thus obtaining a more generally applicable extended gravity model with stronger explanatory power for phenomena in the economic field. Based on the traditional trade gravity model, this paper further measures the impact of population size, exchange rate, real average tariffs on primary products, government efficiency, and sea transportation of government expenditures on the trade flows of agricultural products, and the specific model is constructed as follows:

$$\begin{aligned} \ln F_{ij} = {} & \beta_1 \ln GDP_i GDP_j + \beta_2 \ln POP_i + \beta_3 POP_j + \beta_4 \ln D_{ij} + \beta_5 EXR + \beta_6 LSC \\ & + \beta_7 PVF + \beta_8 TAF + \beta_9 GEF + \beta_{10} Border + \beta_{11} Lang + \varepsilon \end{aligned}$$

Equation is the trade gravity model used in this paper. where i denotes China, j denotes RCEP member countries, and the explanatory variable Fij denotes China's agricultural exports to RCEP member countries between 2005 and 2022.GDPi and GDPj represent the respective total amounts of China and the trading countries in that year, respectively; Dij denotes the distance of the trading countries; POPi and POPj are their respective populations; in the increased explanatory variables, the EXR denotes the exchange rate of the RMB; LSC is the maritime connectivity index, which measures the extent of countries' use of maritime transportation; TAF is the real average tariff on primary products, although most countries have low tariffs at the moment, there are still many countries that impose tariff barriers on imports, especially on agricultural products; PVF stands for government efficiency; and GEF is the government expenditures, which respond to the capacity of the authorities to formulate and implement policies and the amount of investment in infrastructure construction, respectively. capacity of the authorities in policy formulation and implementation as well as the size of their investment in infrastructure construction; Border and Lang reflect whether China shares a common border and language with the RCEP partner countries, respectively.

Descriptive statistics

Variable	Sample size	Mean	Sd	Min	Max
lnFij	252	20.08	2.027	13.92	23.19
lnGDPiGDPj	252	55.70	2.087	50.19	59.91
lnPOPi	252	21.03	0.0270	20.99	21.07
lnPOPj	252	17.03	1.652	12.81	19.43
lnDij	252	8.176	0.582	6.862	9.309
EXR	252	1.921	0.0780	1.815	2.103
LSC	234	957.4	748.2	60.42	2384
PVF	252	12.79	25.52	22.34	12.52
TAF	252	7.734	6.508	-0.0200	31.29
GEF	252	0.533	1.065	-1.684	2.470
Border	252	0.214	0.411	0	1
Lang	252	0.143	0.351	0	1

The research object of this chapter is the 14 RCEP countries except China, and the panel data of 18 years from 2005-2022 are selected, and some missing values are reasonably treated by interpolation and other methods. The main data of agricultural trade volume are from UNCOMTRADE database, the GDP and population volume of the remaining RCEP member countries are taken from the World Bank WDI database, the GDP and population volume of China are from China Bureau of Statistics (CBS), the distance is from the GEPII database, the TAF is from the WDI database, and the LSC data are taken from UNCTAD database, the GEP and PVE data are taken from the UNCEP database, and the LSC data are taken from the UNCAD database. GEP and PVE data are taken from the World Bank WGI database.

Stata16.0 software was used to regress the data on fixed-effects regression and random-effects regression, and Hausman's test was performed to decide exactly which regression to use. Due to the large number of variables selected, the variables were tested for multicollinearity and smoothness before regressing the data. For the multicollinearity test, the variance inflation factor diagnostic results showed (Table 2).The mean value of VIF was 6.17, which is less than 10, indicating that there is no significant covariance among the variables, so there is no need to worry about the presence of serious multicollinearity problems.

Results of variance inflation factor test

Variable	VIF	1/VIF
$\ln GDP_i GDP_j$	8.370	0.120
$\ln POP_i$	2.040	0.490
$\ln POP_j$	3.700	0.270
$\ln D_{ij}$	6.080	0.165
EXR	1.470	0.680
LSC	22.22	0.0450
TAF	3.040	0.329
PVF	2.230	0.448
GEF	7.280	0.137
Border	1.780	0.562
Lang	9.690	0.103
Mean VIF	6.170	

After Hausman test, the p-value of the model is 0.195, which is greater than 0.05, and the original hypothesis cannot be rejected at 5% significance level, and it is considered that the random effect model should be used for the regression analysis instead of the fixed effect model. Based on the above analysis, this paper uses the random effect model to regress the panel data.

Regression results analysis

Variable	OLS	FE	RE
$lnGDP_iGDP_j$	0.165*** (0.0398)	0.167** (3.04)	0.195*** (3.72)
$lnPOP_i$	8.996*** (1.422)	7.485*** (3.87)	9.008*** (6.15)
$lnPOP_j$	0.755*** (0.0311)	1.935** (3.17)	0.640*** (6.10)
lnD_{ij}	-0.823*** (0.111)	-1.082 (-1.33)	-0.513 (-1.83)
EXR	-0.969** (0.419)	-0.872** (-2.68)	-0.774* (-2.42)
LSC	0.000164 (0.000170)	0.001*** (4.66)	0.001*** (4.94)
PVF	-1.75e-13 (1.54e-13)	-0.000 (-1.88)	-0.000 (-1.66)
TAF	-0.0233*** (0.00711)	-0.022** (-2.92)	-0.022** (-3.35)
GEF	0.772*** (0.0701)	0.162 (1.37)	0.261* (2.50)
Border	0.563*** (0.0998)	0.000 (.)	0.050 (0.11)
Lang	0.174 (0.233)	0.000 (.)	-0.258 (-0.52)
constants	-183.0*** (29.33)	-169.582*** (-4.87)	-185.925*** (-6.44)
observation	234	234	234
Hausman_Test	Prob>chi2 = 0.195		
Final choice of regression	RE		

Based on the data in Table 3, the following expanded trade gravity equation is obtained:

$$\ln F = -185.925 + 0.195\ln GDP_i GDP_j + 9.008\ln POP_i + 0.640\ln POP_j - 0.774EXR + 0.001LSC - 0.022TAF + 0.261GEF$$

From the regression results, the following conclusions are drawn:

First, the coefficient of the GDP multiplier(lnGDPiGDPj) between China and the RCEP partner countries is 0.195, which is significantly positive at the 0.1% level, indicating that lnGDPiGDPj has a significant positive impact on lnF, the GDP multiplier of the two countries has a significant positive impact on the export of China's agricultural products to the RCEP member countries.

Secondly, after increasing the population size factor of the importing and exporting countries, the impact of both factors on the export trade flow is positive, and significantly positive at the 0.1% level. When the population size of the importing country is larger, the demand for agricultural products will increase significantly, which further promotes China's agricultural products exports to the corresponding partner countries.

Third, the distance cost factor does not pass the significance test, meaning that distance cost is not the main factor affecting China's agricultural exports to RCEP member countries. However, the distance factor shows a negative impact on trade flows, trade flows decrease as distance increases.

Fourth, the coefficient of RMB exchange rate (EXR) is -0.774, which is significantly negative at 1% level, indicating that lnEXR has a significant negative impact on lnF, RMB exchange rate has a significant negative impact on China's export of agricultural products to RCEP countries. The quantity of agricultural products exported to RCEP partner countries decreases with the increase of exchange rate, and the amount of agricultural products imported from China decreases by 0.774% for every 1% increase of RMB exchange rate.

Fifth, the coefficient of the liner shipping connectivity index(LSC) is 0.001, which is significantly positive at the level of 0.1%, indicating that there is a positive correlation between the shipping liner index and the quantity of agricultural products exported. Agricultural products belong to bulk commodities, and the mode of transportation is mostly dominated by sea and railroad transportation, and some of the partner countries of the RCEP can only import agricultural products by sea due to their geographical location.

Sixth, government efficiency(PVF) and government expenditure(GEF) only one through the significance test, and in the 0.1% level is significantly positive, government expenditure increase is conducive to increase the level of income of the people of the importing country to rise, and then stimulate the people for the purchase of agricultural products demand, optimize the structure of imports of agricultural products.

Seventh, the coefficient of the real average tariff of primary products(TAF) is -0.022, which is significantly positive at the 1% level. Although most countries have low tariffs, the implementation of tariff barriers for agricultural products will significantly reduce the number of imports, and the RCEP agreement contains low or even zero-rate provisions for agricultural products, which can effectively promote China's agricultural exports.

Eighth, common borders and language do not pass the significance test, indicating that they are not the main factors affecting trade flows.

Trade Potential Value and Trade Potential Type of China's Agricultural Exports to RCEP Member Countries

Nations	Trade Potential	Type Of Trade Potential
Korea	0.75	Export Trade Potential To Be Developed
Australia	0.70	
New Zealand	0.68	
Japan	0.66	
Philippines	0.70	
Indonesia	0.72	
Laos	0.77	
Myanmar	0.91	Export Trade Potential Growth
Brunei	1.13	
Singapore	1.06	
Thailand	1.08	
Malaysia	1.20	Mature Export Trade Potential
Vietnam	1.23	
Cambodia	1.41	

According to the previous construction of China and RCEP countries agricultural export gravity model, brought into the statistical data to start the trade potential index measurement, through the estimated ideal state of potential exports and a country's actual level of imports to compare, can be derived from the trade potential measurement index. When the value of trade potential is greater than 1.20, the trade potential is mature; when the value of trade potential is greater than 0.80 and less than 1.20, it belongs to the growth type of trade potential; when the trade

potential is less than 0.80, it belongs to the type of trade potential to be developed. This index calculation method is used to measure the trade potential of the 14 RCEP countries in the field of agricultural imports in 2022, and the specific results are shown in Table 4:

From the above results, it can be seen that in China's agricultural export trade with RCEP countries in 2022, most of the countries are in the type of trade potential to be developed (7), and only a small number of countries are in the type of trade potential to be mature (4) and trade potential to be grown (3).

Based on the current situation and relevant data of China's agricultural export trade to RCEP member countries from 2005 to 2022, this paper empirically analyzes the influencing factors of China's agricultural export trade to RCEP member countries by using the extended trade gravity model, and measures the trade potential of agricultural exports based on the model results, and draws the following conclusions:

First, China's agricultural export volume to RCEP member countries from 2005 to 2022 shows a rising trend in successive years; the export market is gradually diversified, among which, China's agricultural export trade volume to Japan is the largest, The structure of the agricultural export category is unbalanced, and the majority of China's export trade with the RCEP countries is concentrated in category 0 agricultural products, with a high trade concentration. Brunei has the lowest proportion, while the proportion of ASEAN countries has gradually increased in recent years. The 0th category of agricultural items has a significant trade concentration, and China's export commerce with RCEP countries is mostly concentrated in this category due to the imbalanced structure of agricultural export categories.

Second, the four factors of GDP, population, liner shipping index, and government expenditures of China and importing countries have a significant positive effect on expanding China's agricultural exports to RCEP member countries; the two factors of RMB exchange rate and real average tariffs of primary products have a significant negative effect on China's agricultural exports to RCEP member countries; and the three factors of government efficiency. The three factors of government efficiency, common border and language are not significant in this study.

Third, China's agricultural exports to Australia, Japan, the Philippines, New Zealand, Indonesia, South Korea, and Laos are in the category of undeveloped export potential, while those to Singapore, Thailand, Brunei, and Myanmar are in the category of growing export potential, and those to Vietnam, Malaysia, and Cambodia are in the category of mature export potential. Overall, China's agricultural exports to RCEP member countries have a broad space for development:

1) Depending on the needs of each nation, increase the volume of agricultural trade between China and the other RCEP members.

The potential and effectiveness of trade in agricultural products with China are also very diverse due to the disparities in the other RCEP members' levels of agricultural growth and openness. Consequently, in order to further raise the level of trade, we must use diverse approaches for each country. In particular, we must thoroughly investigate novel approaches to trade with nations that have strong trade potential and high trade efficiency. Our attention should be directed at raising the caliber of agricultural products for nations with low trade efficiency and great trade potential.

2) Encourage the building of marine transportation infrastructure in every nation to lessen the detrimental effects of geographic isolation.

A cooperative fund between China and the member nations can be established to offer financial assistance for the development of infrastructure related to maritime transportation. In order

to maximize trade potential, the expansion of maritime transportation infrastructure should also concentrate on the comparatively underdeveloped regions of the economy. Countries should also enhance the carrying capacity and preservation of agricultural products during the transportation process, as well as increase the number of ships that arrive and depart from their borders, in order to lessen the detrimental effects of geographic distance and maritime transportation.

3) Strengthening communication and cooperation among governments and enhancing government service functions

In order to promote the in-depth development of agricultural trade, our government should strengthen economic and political exchanges with the governments of RCEP member countries, such as agricultural product exhibitions and sales fairs. In addition, China and the RCEP member countries should jointly establish a trade information platform for agricultural products to provide a high-quality platform for enterprises to trade agricultural products. Through the government's unique service function, it should also provide decision-making basis for enterprises trading in agricultural products, to lay a solid foundation for the smooth implementation of trade.

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