Trade Potential of China's Agricultural Products Export to RCEP Countries
Based on Expanded Trade Gravity Model

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ABSTRACT
Agricultural trade has always been an important component of foreign trade for China and RCEP countries. The formal implementation and effectiveness of RCEP undoubtedly bring huge development opportunities for China's agricultural export trade. This article compiles agricultural trade data between China and 14 other RCEP member countries from 2012 to 2022, by utilizing the extended trade gravity model, the influencing factors and the trade potential of China's agricultural products export to RCEP countries are studied and estimated. The findings indicate that, the GDP of China and its trade partners, as well as the population sizes of these trade partners, exhibit a significant positive impact on China's agricultural products export. The fluctuating exchange rate of U.S. dollar against RMB, has a considerable adverse effect on China's agricultural products export. China's agricultural products export to the majority of RCEP countries demonstrates considerable potential for growth and expansion.

Keywords: *RCEP, Trade potential, Agricultural products, Expanded trade gravity model.*

1. INTRODUCTION

After 8 years of negotiation, the Regional Comprehensive Economic Partnership (RCEP) officially came into effect on January 1, 2022, marking the birth of the world's largest free trade area composed of China, Japan, South Korea, Australia, and 10 ASEAN countries. After a series of international events such as US-China trade frictions and "anti-globalization", RCEP has undoubtedly become the best choice for China to seek third-party economic and trade cooperation partners [1]. The high level of openness, zero tariffs, and various preferential conditions within the free trade zone have brought tremendous development opportunities for China's export trade [2].

Free trade in agriculture is a key driving force for promoting the economies of RCEP member countries and plays a crucial role in their goods trade [3]. As a major member of RCEP, China needs to assess various factors affecting its agricultural exports, explore ways to enhance its export potential, and gain an advantage in the RCEP member countries' markets. The research on these issues will help promote the development of agricultural export trade between China and other RCEP countries, expand China's export scale, and enhance the competitiveness of Chinese agricultural products in the global market [4].

2. INFLUENCING FACTORS OF CHINA'S AGRICULTURAL EXPORT TRADE TO RCEP COUNTRIES

2.1 Model Construction and Data Analysis

2.1.1 Model Construction

This article chooses to use the trade gravity model to study the potential of agricultural products export trade. Tinberge and Poyhonen proposed that the trade volume (T) between two countries is directly proportional to their economic size (GDP) and inversely proportional to the geographical distance between them. The basic equation of the model can be expressed as follows:

$$T_{ijt} = \frac{A*(GDP_{it}*GDP_{jt})}{DIS_{ij}} \quad (1)$$

In Equation (1), T_{ijt} denotes the trade volume between country i and country j in period t, A denotes the coefficient, GDP_{it} and GDP_{jt} denote the size of the economies of country i and country j respectively in period t ,and DIS_{ij} denotes the geographical distance between country i and country j. Transform equation (1) and the trade gravity model is expressed in logarithmic form as follows:

$$lnT_{ijt} = \alpha + \beta_1 lnGDP_{it} + \beta_2 lnGDP_{jt} + \beta_3 LnDIS_{ij} + \mu \quad (2)$$

In equation (2), α is the constant term, β is the coefficient, and μ is the random error term.

On the basis of the original trade gravity model, combined with the characteristics and actual situation of agricultural trade in RCEP countries, new explanatory variables in the model were selected, such as the agricultural land area of the importing country ($LAND$), the population size of the RCEP importing country (POP), the exchange rate of the Chinese yuan ($RATE$), and the price index of agricultural commodities ($PRICE$), etc. So,

$$lnT_{ijt} = \alpha + \beta_1 lnGDP_{it} + \beta_2 lnGDP_{jt} + \beta_3 lnDIS_{ij} + \beta_4 lnLAND_{jt} + \beta_5 lnPOP_{jt} + \beta_6 lnRATE_{it} + \beta_6 lnPRICE_{it} + \mu \quad (3)$$

Equation (3) represents the expanded trade gravity model. Among the newly introduced explanatory variables, $LAND_{jt}$ stands for the area of agricultural land in country j in period t, POP_{jt} stands for the total population of country j in period t, $RATE_{it}$ signifies the exchange rate of country i's currency relative to the U.S. dollar, and $PRICE_{it}$ indicates the agricultural commodity price index of country i in period t.

2.1.2 Data Sources

This paper aims to study the trade potential of China's agricultural products export to RCEP countries, and therefore selects 14 RCEP members other than China as the research objects. To ensure data quality and comprehensiveness, the data interval from 2012 to 2021 has been selected.

China's agricultural trade data with RCEP member countries are based on the "Monthly Report on China's Agricultural Import and Export" released by the Chinese Ministry of Commerce. Key data such as Gross Domestic Product (GDP), Agricultural Land Area, and Population are all sourced from the World Bank database. The exchange rate data of RMB against USD is sourced from the WEO database The agricultural product price index is based on data from the Food and Agriculture Organization of the United Nations (FAO), and the agricultural product price index is based on 2015 as the base year The straight-line distance between the capitals is calculated using Google Earth.

2.1.3 Descriptive Statistics

Descriptive statistical analysis was conducted on panel data of 14 RCEP member countries except for China, and the results are shown in “Table 1”.

Table 1. Descriptive statistics of variables

Variable	Obs	Mean	Std. dev.	Min	Max
$lnGDP_{it}$	140	16.38613	.2050684	16.07987	16.70383
$lnGDP_{jt}$	140	12.41518	1.741578	9.229457	15.64058
$lnDIS_{ij}$	140	8.175243	.5794667	6.863051	9.285848
$lnLAND_{jt}$	140	10.50409	3.230118	1.88707	15.16637
$lnPOP_{jt}$	140	7.849741	1.642484	3.686376	10.21189
$lnRATE_{it}$	140	1.873014	.0420453	1.815281	1.931304
$lnPRICE_{it}$	140	4.636668	.0576732	4.56918	4.745037
lnT_{ijt}	140	11.2078	1.972669	7.045602	13.99633

From the descriptive statistical results of the model variables, it can be seen that the variables related to RCEP member countries such as $lnGDP_{jt}$, $lnLAND_{jt}$, $lnPOP_{jt}$, and lnT_{ijt}, etc., have shown significant standard deviations. This indicates that there are significant differences and fluctuations among RCEP member countries in terms of population size, economic scale, agricultural scale, and agricultural product import volume.

2.2 Model Testing and Regression Analysis

2.2.1 Stationarity Test

Before conducting regression analysis, it is necessary to test the stationarity of variables. Due to the selection of long panel data, and the geographical distance between the two countries will not change over time, to ensure the robustness of the regression results, LLC test was conducted on six variables other than DIS_{ij}, and the test results are detailed in "Table 2".

Table 2. Results of LLC test

Variable	Statistic	P-value
$lnGDP_{it}$	5.1944	0.0000
$lnGDP_{it}$	-3.7190	0.0001
$lnLAND_{it}$	-4.8859	0.0000
$lnPOP_{it}$	2.1427	0.0161
$lnRATE_{it}$	-0.9801	0.1635
$lnPRICE_{it}$	-2.7120	0.0033

The results showed that the P-value of the variable of population size was greater than 0.05, which did not pass the stationarity test. Therefore, cointegration between variables needs to be considered.

2.2.2 Cointegration Test

Based on the results of the stationarity test, the cointegration test on explanatory variables other than the geographical distance between the two countries was conducted using the Westerlund and Pedroni test (See "Table 3").

Table 3. Pedroni test and Westerlund test results

Type of test	Test Statistic	Statistic	P-value
Pedroni test	Modified Phillips–Perron t	6.1290	0.0000
	Phillips–Perron t	-18.1575	0.0000
	Augmented Dickey–Fuller t	-13.0944	0.0000
Westerlun test	Variance ratio	2.2780	0.0114

According to the test results in "Table 3", the P-values of all variables are below 0.05, significantly rejecting the null hypothesis and indicating a stable long-term cointegration relationship between variables. This provides a solid foundation for subsequent regression analysis.

2.2.3 Regression Model Construction

This article uses Stata18.0 software to perform fixed effects regression and random effects regression on the data through Hausman test to determine the appropriate regression model.

The Hausman test results are shown in "Table 4".

Table 4. Hausman test results

Hausman test statistic	Prob > chi2
5.38	0.3712

The probability value for the chi-squared statistic is 0.3712, therefore, the researchers accept the null hypothesis and believe that the regression analysis should use a random effects model instead of a fixed effects model. This is related to the fact that the geographical distance between the two countries does not change over time, and the

variable $lnDIS_{ij}$ has collinearity, making it more suitable to choose a random effects model.

The model regression results are shown in "Table 5".

Table 5. Model regression results

Explanatory variable	Fixed-effects regression (math.)	Random-effects regression (math.)
$lnGDP_{it}$	0.5022304***(3.08)	0.6948879***(5.87)
$lnGDP_{it}$	0.5417965***(3.71)	0.6504715***(6.31)
$lnDIS_{ij}$	0	-0.1329564(-0.34)
$lnLAND_{it}$	0.7753552*(1.71)	-0.1122386(-1.34)
$lnPOP_{it}$	2.572453**(2.93)	0.6703482**(3.46)
$lnRATE_{it}$	-1.373775**(-2.23)	-1.035745*(-1.68)
$lnPRICE_{it}$	0.2151015(0.67)	0.145592(0.45)
_cons	-30.51005***(-4.42)	-9.985681**(-2.65)
R^2	0.5658	0.9149
Prob > chi2	0.0000	

a Note: ***, **, * represent levels of 1%, 5%, and 10% respectively

From "Table 5", it can be seen that the R ²of the random effects model is as high as 0.9149, significantly higher than that of the fixed effects model. The random effects model performs better in terms of goodness of fit, fully demonstrating its high explanatory power for data.

According to the data in Table 6, after removing the insignificant explanatory variables (DIS_{ij} , $LAND_{jt}$, $PRICE_{it}$) from the regression equation and remaining the significant explanatory variables, the final expanded trade gravity equation is obtained.

$$lnT_{ijt} = -9.986 + 0.695lnGDP_{it} + 0.65lnGDP_{jt} + 0.67lnPOP_{jt} - 1.04lnRATE_{it} \quad (4)$$

2.2.4 Influencing Factors Analysis

From the regression results, it can be seen that the explanatory variables are consistent with the predictive symbols, and the following conclusions can be drawn:

- The coefficient of the logarithm of China's gross domestic product ($lnGDP_{it}$) is 0.695, which is significantly positive at the 1% level. The growth of China's GDP has a significant positive effect on the export of agricultural products to RCEP trading partners. Specifically, with a 1% increase in China's GDP, the trade export of agricultural products to RCEP countries is expected to increase by 0.695%.
- The coefficient of the logarithm of Gross Domestic Product of RCEP Trading Partner Countries ($lnGDP_{jt}$) is 0.65, which is significantly positive at the 1% level, indicating that the GDP of RCEP trading partner countries has a significant positive impact on China's agricultural product exports. For every 1% increase in GDP of RCEP trading partner countries, China's agricultural exports to them will increase by 0.65%.
- The coefficient of the logarithm of the population size of RCEP trading partner countries ($lnPOP_{jt}$) is 0.67, which is significantly positive at the level of 5%, indicating that the population size of RCEP trading partner countries has a significant positive impact on China's agricultural exports. For every 1% increase in the population size of RCEP trading partner countries, China's agricultural exports to them will increase by 0.67%.
- The coefficient of the logarithm of the exchange rate between the US dollar and the Chinese yuan ($lnRATE_{it}$) is -1.04. At a significant level of 10%, the coefficient is negative, indicating that an increase in the exchange rate (i.e., the appreciation of the US dollar) has a significant negative effect on China's agricultural exports to RCEP countries. Specifically, for every 1% increase in the exchange rate between the US dollar and the Chinese yuan, China's agricultural exports to RCEP countries will decrease by 1.04%.

- The coefficient of the logarithm of the geographical distance between China and RCEP trading partners ($lnDIS_{ij}$) did not pass the significance test, indicating that geographical distance is not the dominant factor in China's agricultural export trade scale to RCEP countries. There may be two reasons for this: firstly, the continuous improvement of cross-border infrastructure and the increasing frequency of liner shipping between China and RCEP countries; secondly, due to the differences in agricultural trade structure between China and RCEP member countries, the geographical distance no longer significantly hinders China's agricultural export to RCEP countries.
- The coefficient of the logarithm of agricultural land area in RCEP trading partner countries ($lnLAND_{jt}$) did not pass the significance test, indicating that the agricultural land area of trading partner countries is not the main factor affecting China's agricultural export trade scale to RCEP countries. This may be due to the fact that the increase in agricultural land area in most countries today comes from non-agricultural land conversion, which means converting land originally used for other purposes into crops or other agricultural products. The amount of this conversion is usually low and does not affect the scale of agricultural trade between the two parties.
- The coefficient of the logarithm of China's agricultural product price index did not pass the significance test, indicating that the impact of China's agricultural product price index on China's agricultural export trade scale to RCEP countries is limited. This may be related to the agricultural product structure of RCEP countries. Some agricultural products that cannot be produced domestically and rely heavily on imports will not be affected by price fluctuations, nor will they lead to a decrease in trade volume. Therefore, it cannot have a significant impact on the scale of agricultural trade between the two sides.

3. CALCULATION OF CHINA'S AGRICULTURAL EXPORT TRADE POTENTIAL INDEX TO RCEP COUNTRIES

Based on the trade potential calculation method used by Sun Lin (2008), this article calculates the trade potential index by dividing the actual export value of agricultural products from China to RCEP member countries by the theoretical export value [5].

The trade potential can be divided into three categories: when the trade potential index is less than or equal to 0.8, it belongs to a huge potential type, indicating that the bilateral trade potential has not been fully released and has significant development space; when the trade potential index is between 0.8 and 1.2, it indicates a potential development type, which means that there is vast potential for bilateral trade and it is expected to further expand; when the trade potential index is greater than or equal to 1.2, it represents a potential reshaping type, which means the trade potential has been fully developed. To further increase the trade volume, it is necessary to actively explore new trade opportunities.

The results of China's trade potential index and its types of agricultural exports to RCEP member countries are shown in “Table 6”

Table 6. Trade potential index and type of China's agricultural exports to RCEP countries

	Indonesia	Japan	South Korea	Australia	New Zealand	Malaysia	Philippine	Thailand	Singapore	Brunei	Cambodia	Myanmar	Vietnam	Laos
2012	1.23	0.89	0.92	0.83	0.85	0.96	0.86	0.90	0.95	0.87	0.79	0.79	0.92	0.69
2013	1.25	0.89	0.91	0.83	0.84	0.96	0.87	0.91	0.96	0.86	0.82	0.82	0.92	0.69
2014	1.24	0.88	0.91	0.83	0.85	0.96	0.86	0.92	0.97	0.86	0.81	0.86	0.93	0.66
2015	1.24	0.88	0.91	0.83	0.86	0.96	0.87	0.94	0.97	0.88	0.80	0.85	0.94	0.70
2016	1.24	0.88	0.91	0.84	0.86	0.96	0.88	0.93	0.96	0.91	0.77	0.86	0.95	0.68
2017	1.24	0.88	0.90	0.83	0.85	0.95	0.88	0.92	0.94	0.91	0.76	0.87	0.05	0.67
2018	1.23	0.88	0.90	0.83	0.86	0.94	0.87	0.91	0.94	0.92	0.79	0.87	0.95	0.74
2019	1.24	0.87	0.90	0.83	0.86	0.95	0.87	0.92	0.94	0.90	0.82	0.88	0.95	0.72
2020	1.23	0.86	0.89	0.82	0.84	0.96	0.87	0.92	0.95	0.91	0.84	0.85	0.94	0.68

	Indonesia	Japan	South Korea	Australia	New Zealand	Malaysia	Philippine	Thailand	Singapore	Brunei	Cambodia	Myanmar	Vietnam	Laos
2021	1.25	0.86	0.89	0.82	0.84	0.96	0.87	0.92	0.95	0.91	0.87	0.89	0.93	0.72
Average	1.24	0.88	0.91	0.83	0.85	0.96	0.87	0.92	0.95	0.90	0.81	0.85	0.94	0.70
Type	Potential re-shaping	Potential development												High-potential

The data in “Table 6” shows the following results:

- The trade potential index of China's agricultural exports to most RCEP countries is between 0.8 and 1.2, which belongs to the potential development type. China still has considerable potential and development space for agricultural exports to RCEP countries.
- The average trade potential index of China's agricultural exports to Laos is only 0.7, which is lower than 0.8, indicating a huge potential type. This suggests that there is still enormous potential for exploration between China and Laos. Therefore, it is necessary to actively seize the opportunity of the RCEP agreement coming into effect, strive to enter and explore the Laotian agricultural products market, and promote to expand the agricultural products trade scale.
- The average trade potential index of China's agricultural exports to Indonesia is 1.24, which is greater than 1.2 and belongs to potential reshaping type. This indicates that China's agricultural trade with Indonesia has become very frequent, and the agricultural market is close to saturation. It is necessary to actively explore new trade factors to increase the scale of China's agricultural exports to Indonesia.

4. CONCLUSION

This article is based on data from 2012 to 2021 and uses an extended trade gravity model to study the influencing factors of China's agricultural exports to RCEP member countries. Based on the analysis results of the regression model, the trade potential index of China’s agricultural products export to RCEP countries was calculated, and the potential types were classified. The following conclusions were drawn:

Firstly, the "Monthly Report on China’s Agricultural Import and Export" shows that from 2012 to 2021, China's agricultural exports to RCEP member countries have shown an overall growth trend. During this period, the share of agricultural trade between China and RCEP members has been increasing, and the types of exported agricultural products have become increasingly diverse and abundant. Now, RCEP member countries have become important markets in China's agricultural exports.

Secondly, the research results show that the GDP growth of China and RCEP member countries and the population expansion of RCEP member countries have significant positive effects on China's agricultural exports to RCEP partner countries. On the contrary, the rise in the exchange rate of the US dollar against the Chinese yuan poses a negative factor for China’s agricultural products export. In addition, the geographical distance between China and RCEP member countries, the agricultural land area of RCEP member countries, and China's agricultural product price index did not show significant effects in this study.

Finally, the trade potential index of agricultural exports between China and most RCEP countries range from 0.8 to 1.2, indicating a potential development type. This suggests that there is still some potential and development space for agricultural trade between China and most RCEP countries. The potential type of China's agricultural exports to Laos belongs to huge potential type, so there is enormous development space between China and Laos. The potential type of China's agricultural exports to Indonesia belongs to potential reshaping type. On the basis of maintaining the existing agricultural product trade, it is necessary to actively try other trade factors and expand the scale of agricultural products trade between the two sides. Overall, the opportunities for China’s agricultural exports to RCEP countries are still considerable.

When formulating agricultural export policies for RCEP member countries, China should fully utilize the institutional advantages of RCEP and make strategic adjustments based on the trade potential and differences in agricultural product demand of different member countries. It should reasonably formulate scientific export strategies, vigorously develop the economy, stabilize the exchange rate, and steadily increase the scale of agricultural products export trade between China and RCEP member countries [6].

AUTHORS' CONTRIBUTIONS

Dan Liu wrote the manuscript, Jilu Liu was responsible for data calculation and analysis, Chun Wang contributed to revising and editing.

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