

Impact of BRICS Trade Facilitation on China's Exports Using Cross-Border E-Commerce

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Abstract With the rapid growth of the global digital economy, cross-border e-commerce, as an emerging form of trade, has gradually become a powerful engine to promote the development of global trade. BRICS is an important force in the global economy, and the progress of the BRICS countries' trade facilitation level has an important impact on the global trade environment. This paper conducts an in-depth study of the dynamic changes in BRICS trade facilitation from 2013 to 2022, and uses an extended gravity model to analyze the specific impact of this change on China's exports using cross-border e-commerce. The results show that although the BRICS countries have made some progress in trade facilitation, the overall level still needs to be improved, and there are obvious differences among member countries. However, the improvement of trade facilitation among BRICS countries has undoubtedly brought significant positive effects to China's exports using cross-border e-commerce.

Key words Trade facilitation, BRICS, Cross-border e-commerce, Export trade

1 Introduction

With the advancement of the wave of digital economy, the influence of cross-border e-commerce in the field of international trade has become increasingly significant, and it has gradually become an important force to promote the growth of global trade. Especially in the context of COVID-19 pandemic's severe impact on the global real economy, cross-border e-commerce has demonstrated strong development resilience and potential with its unique business model. According to data released by the Ministry of Commerce, the scale of China's cross-border e-commerce export transactions reached 12.3 trillion yuan in 2022, a year-on-year increase of 26.8% compared to 9.7 trillion yuan in 2020. At the same time, the scale of cross-border e-commerce users is also growing rapidly. In 2022, the number of cross-border e-commerce users in China reached 168 million, a year-on-year increase of 8.38%. This figure not only reflects the prosperity of the cross-border e-commerce market, but also indicates its broad development space in the future. Cross-border e-commerce not only effectively reduces the cost of information transmission between enterprises, but also injects new vitality into cross-border trade and becomes a new engine to promote the development of global trade^[1]. However, the vigorous development of cross-border e-commerce is not accidental. It relies on the continuous innovation and progress of Internet technology, and it is inseparable from the unimpeded international trade channels and the stability of the international market environment. Against the background of slowing global

economic growth, BRICS countries, as an important force in the global economic structure, still maintain strong economic vitality and growth momentum. In the past "golden decade", the contribution rate of the BRICS countries to the world economy was once close to 70%, and the contribution rate of the G7 countries in the same period was only 10%, which fully demonstrates the huge economic potential of the BRICS countries and trade prospects.

For China, cross-border e-commerce is currently in a golden age of development. How to strengthen trade cooperation with BRICS countries and promote the process of trade facilitation is undoubtedly an important strategic direction for the development of cross-border e-commerce in China. Through in-depth cooperation with BRICS countries, we can jointly explore new trade models, broaden market channels, achieve mutual benefit and win-win results, and inject new impetus into the long-term development of cross-border e-commerce.

2 Review of relevant literature

At present, there are abundant papers on the measurement and impact of trade facilitation in academic circles at home and abroad. These studies often use gravitational models and their derivatives to explore in depth the specific impact of trade facilitation on static and dynamic indexes of trade. In the study of measuring trade facilitation, the common method is to construct a trade facilitation index system suitable for the research object, and assign scientific and reasonable values to each index. Wilson *et al.*^[2] constructed an index evaluation system based on WTO rules, which includes 4 first-level indexes and 8 second-level indexes. Since then, domestic and foreign scholars have continuously optimized this index system to reflect the trade facilitation level in different regions. Shepherd and Wilson^[3] evaluated the degree of trade facilitation in some Asian countries using a series of indexes such as seaport foundation, airport foundation, customs clearance

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efficiency, and trade system. Fan Qiufang *et al.*^[4] constructed an index system for measuring the trade facilitation level from four aspects: port efficiency, customs environment, regulatory environment, and financial e-commerce, and quantitatively analyzed the trade facilitation level of economies along the "Belt and Road". Chaili^[5] established a trade facilitation evaluation system for economies along the "Belt and Road" by using 5 first-level indexes and 16 second-level indexes including infrastructure, e-commerce, rules and regulations, customs environment, and financial services. Liu Wen^[6] used 4 first-level indexes and 12 second-level indexes including infrastructure construction, rules and regulations, customs environment, and e-commerce to evaluate the trade facilitation level of economies along the "Belt and Road".

In cross-border e-commerce transactions, trade facilitation links such as payment and logistics are particularly important. Currently, research focuses on the impact of trade facilitation on cross-border e-commerce. Wang Rui *et al.*^[7] used the data of cross-border e-commerce comprehensive test areas in 35 cities in China to empirically analyze the impact of trade facilitation on cross-border e-commerce trade in Chinese cities. Wang Junjuan^[8] conducted an in-depth discussion on the trade facilitation effect of the cross-border e-commerce industry between China and the 16 Central and Eastern European countries on the basis of calculating the trade facilitation level between China and the 16 countries along the "Belt and Road". Zhang Jing^[9] used the index data of cross-border e-commerce in China and the economies along the "Belt and Road" to study the impact of trade facilitation on cross-border e-commerce in various countries from the perspective of trade costs using the GMM method. From the perspective of the spatial impact of trade facilitation and cross-border e-commerce, Zhu Wei^[10] used provincial panel data to empirically analyze the significant spatial aggregation characteristics between trade facilitation and cross-border e-commerce development.

In recent years, many papers have also empirically studied the impact of trade facilitation on China's product exports. Zhu Jing and Bi Ying^[11] constructed an empirical model, taking the economies along the "Silk Road" as the research target, and deeply explored the effect of the improvement of trade facilitation on China's agricultural product exports from both horizontal and vertical dimensions. Wu Zhaodan *et al.*^[12] used the extended gravity model to empirically analyze the impact of trade facilitation in countries along the "Belt and Road" on China's foreign trade. Ge Chunbao and Yu Jinping^[13] also used the extended gravity model to conduct in-depth research on the impact of trade facilitation on China's exports. These studies not only enrich our understanding of the impact of trade facilitation, but also provide an important reference for policy formulation and practice.

3 Measurement and analysis of trade facilitation level of BRICS countries

3.1 Selection and description of indexes This paper measures the trade facilitation level from 4 first-level indexes (infra-

structure, customs environment, institutional environment, e-commerce and financial services), and 18 second-level indexes. The data are mainly from the *IMD Global Competitiveness Report*. Due to the lack of data in some years, the linear trend analysis method is adopted to make up for it.

Infrastructure (Inf). The construction of a country's infrastructure is directly related to its product circulation rate and production costs. If a country's infrastructure is becoming more and more perfect, then the country's foreign trade level will increase significantly accordingly. Generally, road infrastructure affects transportation speed, and information technology infrastructure provides trading platforms. Therefore, this paper sets a score range of 1 to 7 points for the infrastructure index, and the higher the index score, the better the infrastructure level.

Customs environment (Cus). This index is mainly used to measure the efficiency of a country's import and export customs clearance and the transparency of the customs control system. In cross-border e-commerce trade, a good customs environment will simplify trade procedures, improve efficiency and avoid unnecessary losses. Except for the tariff barrier's score range (0 – 100 points), the other indexes' score range is 1 – 7 points, where 1 represents the highest degree of restriction, and 7 represents no restriction.

Institutional environment (Ins). A good institutional environment is conducive to economic development and foreign trade growth. Institutional environment indexes are usually used to measure whether a country's policies are transparent and whether the system is standardized. Except for the government's corruption perceptions index, which ranges from 0 to 100 points, the rest of the indexes range from 1 to 7 points.

E-commerce and financial services (Fin). With the progress and maturity of Internet information technology, the e-commerce industry has achieved great development. Under this index, five secondary indexes are obtained by subdividing: financial service convenience, financial service cost, information technology popularity, high-tech transformation, and regional economic freedom index. The first four indexes range from 1 to 7 points, the higher the score, the more perfect the financial and e-commerce environment. The last index ranges from 0 to 100 points, and the higher the score, the higher the degree of freedom.

3.2 Data processing and measurement When examining the relevant indexes to define the trade facilitation level, due to the complexity and differences of index samples and data, it is impossible to directly measure the data. Therefore, in this paper, the maximum method is used to normalize the data:

$$Y_i = X_i / X_{\max} \quad (1)$$

where Y_i denotes the normalized value of X_i , and X_{\max} denotes the maximum value among various indexes.

In order to prevent the problem of heteroscedasticity, this paper obtains the corresponding weight of each index with the help of principal component analysis. This paper refines the original data

with the help of SPSS.20 software, and uses the above methods to assign weight to each index.

KMO and Bartlett tests are performed before principal component analysis. The test result of KMO is 0.526, the test statistic of the latter is 262, and the corresponding probability is 0.000, so the index is suitable for principal component analysis. The analy-

sis results show that the sum of variances of the core explainable indexes accounts for more than 80% , and its generality and representativeness are very strong. Therefore, the core explainable indexes should be mainly investigated and used as the basis for weight measurement. The coefficient scores of the final index weight are shown in Table 1.

Table 1 Measurement system and index weight of trade facilitation level

First-level indexes (Weight)	Second-level indexes	Score	Weight	Weight code
Infrastructure (<i>Inf</i>) (0.272)	Public infrastructure (A1)	1 – 7 points	0.083	W_{11}
	Railway infrastructure (A2)	1 – 7 points	0.058	W_{12}
	Port infrastructure (A3)	1 – 7 points	0.074	W_{13}
	Air transport infrastructure (A4)	1 – 7 points	0.056	W_{14}
Customs environment (<i>Cus</i>) (0.248)	Tariff barriers (B1)	0 – 100 points	0.008	W_{21}
	Non-tariff barriers (B2)	1 – 7 points	0.081	W_{22}
	Clearance process complexity (B3)	1 – 7 points	0.087	W_{23}
	Non-trade expenditure (B4)	1 – 7 points	0.071	W_{24}
Institutional environment (<i>Ins</i>) (0.339)	Government corruption perceptions index (C1)	0 – 100 points	0.041	W_{31}
	Policy transparency (C2)	1 – 7 points	0.083	W_{32}
	Government regulatory burden (C3)	1 – 7 points	0.081	W_{33}
	Litigation processing efficiency (C4)	1 – 7 points	0.077	W_{34}
	Judicial independence (C5)	1 – 7 points	0.058	W_{35}
E-commerce and financial services (<i>Fin</i>) (0.141)	Financial service convenience (D1)	1 – 7 points	0.021	W_{41}
	Financial service cost (D2)	1 – 7 points	0.055	W_{42}
	Regional economic freedom index (D3)	0 – 100 points	0.022	W_{43}
	Information technology popularity (D4)	0 – 100 points	0.017	W_{44}
	High-tech transformation (D5)	1 – 7 points	0.027	W_{45}

Data source: *Global Competitiveness Report*, Corruption Perceptions Index, Logistics Performance Index, *etc.*

3.3 Measurement results and analysis Before measuring the trade facilitation level, it is necessary to make a weighted summation of the weight value W_{ij} ($i = 1, 2 \cdots 4, j = 1, 2 \cdots 5$) of the second-level indexes and the normalized index value X_{ij} ($i = 1, 2 \cdots 4, j = 1, 2 \cdots 5$) corresponding to the second-level indexes, so as to obtain the evaluation index *TFI* formula, namely:

$$TFI = W_{11}X_{11} + W_{21}X_{12} + W_{31}X_{13} + W_{41}X_{14} + W_{21}X_{21} + W_{22}X_{22} + W_{23}X_{23} + W_{24}X_{24} + W_{31}X_{31} + W_{32}X_{32} + W_{33}X_{33} + W_{34}X_{34} + W_{35}X_{35} + W_{41}X_{41} + W_{42}X_{42} + W_{43}X_{43} + W_{44}X_{44} + W_{45}X_{45} \quad (2)$$

where *TFI* (Trade Facilitation Index) is the trade facilitation level value of each BRICS country, X_{ij} represents the 18 second-level indexes after normalization, and W_{ij} represents the weight of each index after calculation.

According to formula (2), the final *TFI* values of the trade facilitation levels of China, Russia, Brazil, India and South Africa from 2013 to 2022 can be obtained.

As shown in Table 2, on the whole, the trade facilitation level among BRICS countries showed a fluctuating upward trend from 2013 to 2022, but there was a large gap in the trade facilitation level among countries. Specifically, Brazil had the lowest trade facilitation level, with a *TFI* value above 0.6, a slight decline from 2013 to 2018, and a slight increase since 2019, showing a "U-shaped" trend. The trade facilitation level in Russia contin-

ued to improve. In 2014, the *TFI* value exceeded 0.7, and in 2021, the *TFI* value further exceeded 0.8, showing great development potential. The *TFI* value of India's trade facilitation level was basically above 0.8, showing a fluctuating growth trend as a whole, except for individual years. China's had the highest trade facilitation level, leading other countries among the BRICS countries. From 2013 to 2018, the *TFI* value of China's trade facilitation level was above 0.8. In 2019, the *TFI* value exceeded 0.9, and in 2022, the *TFI* value reached 0.934. Before 2016, South Africa's trade facilitation level was always in the first place, and the *TFI* value was basically above 0.9. The *TFI* value has declined in volatility since 2017.

4 The impact mechanism of BRICS trade facilitation on China's exports using cross-border e-commerce

4.1 Impact on scale of export transactions Using the iResearch method, this paper can calculate China's exports using cross-border e-commerce and volume of import and export transactions between China and other BRICS countries by China's import and export transaction volume with other BRICS countries, China's total import and export trade volume and China's import and export transaction volume through cross-border e-commerce, as shown in Table 3.

Table 2 *TFI* value of BRICS trade facilitation level from 2013 to 2022

Year	China	Russia	Brazil	India	South Africa	Average
2013	0.848	0.669	0.663	0.800	0.910	0.778
2014	0.853	0.701	0.643	0.776	0.901	0.775
2015	0.846	0.701	0.622	0.813	0.925	0.781
2016	0.861	0.711	0.605	0.870	0.912	0.792
2017	0.885	0.739	0.608	0.869	0.833	0.787
2018	0.875	0.760	0.607	0.882	0.799	0.784
2019	0.916	0.771	0.618	0.864	0.822	0.798
2020	0.907	0.774	0.623	0.867	0.784	0.745
2021	0.928	0.834	0.634	0.872	0.813	0.756
2022	0.934	0.842	0.652	0.873	0.832	0.787

Table 3 China's import and export transactions through cross-border e-commerce with other BRICS countries and the world 100 million US dollars

Country	India		Russia		South Africa		Brazil		Global	
	Import	Export	Import	Export	Import	Export	Import	Export	Import	Export
2013	118.59	177.96	119.28	203.39	36.88	138.36	86.08	562.61	654.84	3 929.04
2014	187.40	203.02	117.44	432.38	49.65	131.69	619.11	120.07	916.78	5 195.07
2015	327.62	191.80	187.28	566.29	83.92	147.46	164.61	704.85	1 309.68	6 548.41
2016	458.41	234.93	287.85	734.68	102.78	178.30	176.53	921.11	1 746.24	8 003.61
2017	687.76	347.38	458.57	1 083.32	145.47	239.10	260.78	1 321.86	2 561.15	9 167.77
2018	2 094.22	67.98	1 482.48	230.63	486.21	35.61	986.33	264.07	10 331.93	2 764.88
2019	2 654.05	181.04	1 500.74	424.23	632.36	101.56	1 369.15	664.45	11 685.26	3 841.73
2020	502.12	180.81	597.00	543.30	532.30	178.09	1 254.00	453.67	798.95	1 569.85
2021	509.11	187.41	612.96	487.76	546.41	164.42	1 216.33	475.65	756.89	2 018.38
2022	513.14	196.54	623.23	524.23	575.11	138.86	1 345.00	468.63	784.92	2 172.57

Data source: NetEase and iiMedia.com's China Cross-border E-commerce Market Data.

It is worth noting that with the unanimous adoption of the *Trade Facilitation Agreement* at the WTO Bali Ministerial Conference in 2013, the scale of import and export transactions between China and other BRICS countries by cross-border e-commerce has been increasing year by year, and the economic and trade exchanges between countries are relatively intensive. Therefore, the enhancement of the trade facilitation level of the BRICS countries will directly contribute to the opening of China's foreign trade pattern and the expansion of the scale of foreign trade.

4.2 Impact on export procedures and costs The improvement of the trade facilitation level will help simplify export procedures and reduce export costs. In recent years, BRICS countries have continuously strengthened mutual cooperation and reached certain consensus on simplifying customs clearance procedures, strengthening customs supervision, and improving customs efficiency. The Chinese government actively promotes the process of domestic opening up, and proposes various preferential policies in terms of taxation and infrastructure construction, creating a relatively stable economic environment for attracting foreign capital. The BRICS countries have continuously strengthened the transformation and upgrading of the customs system. While simplifying import and export procedures, they have also reduced the time cost and transaction cost of cross-border e-commerce, enabling China's cross-border e-commerce to have more capital to improve its products and services, thereby enhancing its attractiveness in the international market. However, too loose trade environment will also increase a country's trade risk, increase transaction costs, affect

transaction quality, and bring harm to a country's import and export trade.

5 Empirical analysis of the impact of BRICS trade facilitation on China's exports using cross-border e-commerce

5.1 Model setting Based on the gravity model^[14–15] proposed by Tinbergen and Poyhonen, this paper introduces factors such as trade flow, trade facilitation level, and tax rate to construct an extended trade gravity model:

$$\ln Exp_{ijt} = \alpha + \beta_1 \ln TFI_{jt} + \beta_2 \ln GDP_{jt} + \beta_3 \ln T_{jt} + \beta_4 \ln P_{jt} + \beta_5 \ln D_{ijt} + \varepsilon_{ijt} \quad (3)$$

where i and j denote BRICS countries, and t denotes year, EXP is the export volume of BRICS country i to country j by cross-border e-commerce, the core variable TFI represents the trade facilitation level of the BRICS countries (usually, the higher the trade facilitation level, the greater the impact on cross-border e-commerce transactions), GDP is used to represent the economic level of a country, T represents the tariff level, P represents the population, and D represents the geospatial distance between countries, α represents a constant term, β_1 , β_2 , β_3 , β_4 , β_5 , represent coefficients of elasticity, and ε is a random disturbance term.

5.2 Sample selection and data sources

5.2.1 Sample selection. This paper selects the panel data of BRICS countries from 2013 to 2022 as the research sample, and the variables in the extended gravity model are shown in Table 4.

Table 4 Description of variables

Variable symbol	Variable name	Principle explanation	Unit	Expected symbol
Exp_{ijt}	Export volume using cross-border e-commerce	Explained variable, it is used to reflect the scale of cross-border e-commerce trade between China and other BRICS countries	US \$ 100 million	–
TFI_{jt}	Trade facilitation level	The higher the trade facilitation level, the more it can promote the development of cross-border e-commerce trade between the two countries	–	+
GDP_{jt}	Gross domestic product	It indicates the overall economic level of a country, generally, the larger the economic scale, the greater the potential trade demand between the two countries	US \$ 100 million	+
T_{jt}	Average import tariff	The higher the import tariff level, the less conducive to the development of trade, and the smaller the scale of trade	%	–
P_{jt}	Population	The population will promote consumption and thus increase the scale of trade, and will also change the domestic division of labor and thus hinder trade, so the expected sign is uncertain	100 million people	+ / –
D_{ijt}	Geographical distance	The farther the geographical distance between China and other BRICS centers, the higher the transportation cost, which is not conducive to the development of trade	km ²	–
F_{jt}	Infrastructure construction	The better the infrastructure, the higher the level of trade	...	+
C_{jt}	Customs environment	The better the customs environment is, the more favorable it is for import and export	...	+
R_{jt}	Institutional environment	The better the institutional environment, the higher the level of trade	...	+
E_{jt}	E-commerce and financial services	The better the development of e-commerce and financial services, the higher the level of trade development	...	+

Data source: *International Statistical Yearbook* and National Bureau of Statistics of China.

5.2.2 Descriptive statistics of variables. The panel data model is used to estimate the specific impact of the degree of trade facilitation of BRICS countries on China's cross-border e-commerce trade in the past ten years, and the descriptive statistical results of variables are obtained through the Stata17.0 software, as shown in Table 5.

Table 5 Statistical description of data

Variable	Mean	Standard deviation	Maximum	Minimum	Sample size
Exp_{ijt}	617.691 8	581.491 3	2 654.05	36.88	40
TFI_{jt}	0.769 85	0.101 113	0.925	0.605	40
GDP_{jt}	20 868.13	5 130.805	33 851	12 768	40
T_{jt}	10.673 9	2.501 478	16.862	8.43	40
P_{jt}	5.921 694	12.044 01	74.08	0.538 74	40
D_{ijt}	6 357.5	3 947.063	12 933	2 854	40
F_{jt}	4.21	0.336 006	4.8	2.9	40
C_{jt}	3.955	0.391 759	4.5	3.1	40
R_{jt}	4.055	0.462 574	4.6	3.0	40
E_{jt}	4.15	0.288 097	4.6	3.4	40

Data source: *International Statistical Yearbook*, National Bureau of Statistics of China and calculation results based on Stata17.0.

5.3 Model estimation and result analysis

5.3.1 Selection of basic model. In the selection of research object, this paper takes the BRICS countries as the object to construct panel data. In the selection of specific model, it is first assumed to be a random effect model. If the *P* value is less than 0.05, the null hypothesis should be rejected. Secondly, it is assumed to be a mixed-effect model. If the *P* value is equal to 0, the null hypothesis should be rejected. Therefore, the fixed effects model is chosen.

5.3.2 Overall effect analysis. Using Stata17.0 software, the

fixed effect model is used to regress the overall effect of the trade facilitation level of BRICS countries on China's exports using cross-border e-commerce. The regression results are shown in Table 6.

Overall, the model passes the significance test as a whole, and the regression results are consistent with expectations. The empirical results show that the core explanatory variable BRICS trade facilitation level is positively correlated with China's exports using cross-border e-commerce, and has passed the 1% significance test, which means that when domestic trade facilitation level increases by 1 unit, China's exports using cross-border e-commerce

will increase by 2.546 2 units. The sign of the GDP of the BRICS countries is positive at the significance level of 5% , that is, for every 1 unit increase in the GDP of the importing country, China's export volume by cross-border e-commerce will increase by 0.464 7 units. It shows that the higher the economic development level of the importing country, the stronger the potential purchasing power and the greater the trade demand. The population of the BRICS countries is positive at the significance level of 5% , that is, for every 1 unit increase in the population of the importing country, China's export volume by cross-border e-commerce will increase by 0.412 3 units. It shows that the effect of increasing domestic demand brought about by population growth exceeds the effect of deepening domestic division of labor, which has a positive effect on the total volume of cross-border e-commerce trade in China.

Table 6 Regression results of the impact of BRICS trade facilitation on China's exports using cross-border e-commerce

Explanatory variable	Coefficient	<i>t</i> value	<i>P</i> value
$LnTFI_{jt}$	2.564 2 * * *	2.651 2	0.005 1
$LnGDP_{jt}$	0.464 7 * *	2.432 4	0.026 7
LnT_{jt}	-0.121 0	-0.781 1	0.364 1
LnP_{jt}	0.412 3 * *	1.821 3	0.045 3
R^2		0.765 3	
F		42.622 4	
$P(F)$		0.000 0	

5.3.3 Effect analysis of sub-indexes. Since different sub-indexes have different impacts on exports using cross-border e-commerce, it is necessary to pay attention to the effect of sub-indexes when examining the impact of trade facilitation on exports using cross-border e-commerce. This paper uses the four first-level indexes of trade facilitation level to replace the TFI in the overall effect model, and establishes the following four extended gravity models:

$$LnExp_{ijt} = \alpha + \beta_1 LnF_{jt} + \beta_2 LnGDP_{jt} + \beta_3 LnT_{jt} + \beta_4 LnP_{jt} + \beta_5 LnD_{ijt} + \varepsilon_{ijt} \quad (4)$$

$$LnExp_{ijt} = \alpha + \beta_1 LnC_{jt} + \beta_2 LnGDP_{jt} + \beta_3 LnT_{jt} + \beta_4 LnP_{jt} + \beta_5 LnD_{ijt} + \varepsilon_{ijt} \quad (5)$$

$$LnExp_{ijt} = \alpha + \beta_1 LnR_{jt} + \beta_2 LnGDP_{jt} + \beta_3 LnT_{jt} + \beta_4 LnP_{jt} + \beta_5 LnD_{ijt} + \varepsilon_{ijt} \quad (6)$$

$$LnExp_{ijt} = \alpha + \beta_1 LnE_{jt} + \beta_2 LnGDP_{jt} + \beta_3 LnT_{jt} + \beta_4 LnP_{jt} + \beta_5 LnD_{ijt} + \varepsilon_{ijt} \quad (7)$$

As shown in Table 7, the regression results of Model 1 show that the infrastructure of BRICS countries has a positive effect on China's exports using cross-border e-commerce, and has passed the 1% significance test. The regression results of Model 2 show that the customs environment of BRICS countries has a positive effect on China's exports using cross-border e-commerce, and has passed the 5% significance test. In Model 3, the regression coefficients of the BRICS institutional environment fail the significance test. The regression results of Model 4 show that BRICS e-commerce and financial services have a positive effect on China's exports using cross-border e-commerce, and have passed the 5% significance test.

Table 7 Regression results of sub-index effects

Explanatory variable	Coefficient	<i>t</i> value	<i>P</i> value
LnF_{jt}	2.016 1 * * *	2.721 2	0.005 4
LnC_{jt}	1.218 3 * *	1.048 4	0.028 7
LnR_{jt}	0.335 2	0.578 1	0.378 2
LnE_{jt}	0.856 2 * *	2.167 4	0.093 1

NOTE * * *, * *, * indicate that the regression coefficients pass the significance level test at 1% , 5% and 10% , respectively. The same below.

6 Conclusions and recommendations

6.1 Conclusions This paper measures the degree of trade facilitation of BRICS countries from 2013 to 2022, constructs an extended trade gravity model, and empirically analyzes the impact of the trade facilitation level of BRICS countries on China's exports using cross-border e-commerce.

The conclusions of the study are as follows: First, the trade facilitation level among BRICS countries showed a fluctuating upward trend from 2013 to 2022, but there was a large gap among countries. Brazil had the lowest degree of trade facilitation, showing a "U-shaped" trend. The degree of trade facilitation in Russia was constantly improving, and there was great potential for development. The overall trade facilitation level in India showed a fluctuating growth trend. China had the highest trade facilitation level, and it has become the country with the highest level of facilitation among BRICS countries. South Africa had the highest trade facilitation level among BRICS countries before 2016, and it has dropped in volatility since 2017. Second, the improvement of trade facilitation among BRICS countries has promoted the continuous growth of China's exports using cross-border e-commerce. The empirical results show that for every unit increase in the degree of trade facilitation of BRICS countries, China's export volume by cross-border e-commerce will increase by 2.546 2 units. In addition, the four sub-indexes of infrastructure, customs environment, e-commerce and financial service level have a significant positive impact on China's exports using cross-border e-commerce.

6.2 Recommendations

6.2.1 Strengthening the interconnection of trade infrastructure. Infrastructure construction is an important guarantee for the development of the domestic economy, and can better reduce the cost of cross-border e-commerce transportation, attract foreign investment, and create better conditions for international cooperation. In 2022, BRICS countries occupied nearly half of the world's investment in infrastructure, demonstrating their huge development potential. The use of the PPP model can further promote the development of infrastructure and the improvement of the quality of public services in BRICS countries, that is, enterprises and individuals can integrate into government funds, to quickly establish a capital chain, make up for the gap in infrastructure funds, and improve the quality of public services. Therefore, the BRICS countries should win more trust from the people in terms of infrastructure construction, and strengthen the cooperation between the government and private capital, which is conducive to social stability, economic development, and the progress of people's living standards.

6.2.2 Strengthening customs management and coordination. Customs procedures are an important channel for the supervision, review and statistics collection of goods or commodities imported and exported by the country. Inefficient customs procedures will reduce transportation efficiency, increase transportation time, and lose more labor costs and financial costs. Improving customs procedures can also greatly improve the trade facilitation level. First of all, it is necessary to simplify the customs clearance procedures for goods, adhere to the implementation of "single window", improve work efficiency, and reduce time costs. The second is to strengthen the supervision of the customs department, improve the transparency of customs management, and reduce unnecessary costs for traders. In addition, it is necessary to strengthen exchanges with the customs of cooperative countries, establish an information network, keep abreast of changes in the customs policies of various countries, and reduce and avoid corresponding disputes and cross-border detention costs.

6.2.3 Improving the institutional system. A sound institutional system is an important guarantee for the sustainable and rapid development of trade. In order to improve the integrity and scientificity of system establishment, BRICS countries should constantly improve their own laws and regulations, and governments need to formulate corresponding development policies to create a convenient trade environment. In addition to adjusting their own trading systems in accordance with the trade norms and habits of BRICS countries and strengthening the space for cooperation among countries, BRICS countries should also actively advocate the establishment of a "BRICS Trade Zone" to maximize the use of the internal market of the BRICS.

6.2.4 Developing electronic information technology. A good financial and e-commerce environment can not only promote the high-quality transformation of a country's economic development, but also improve the efficiency of cross-border e-commerce information collection in trade. BRICS countries should promote the transformation of the financial and e-commerce environment, strengthen the construction of information technology, bring electronic information technology in line with international standards, and help the construction of network information platforms among BRICS organizations, so as to promote more economic cooperation for each other in the future and achieve the goal of mutual benefit and win-win among BRICS countries.

6.2.5 Strengthening cross-border e-commerce trade cooperation and exchanges between China and other BRICS countries. The vigorous development of cross-border e-commerce has become a new growth point of China's foreign trade. Therefore, it is necessary to strengthen cross-border e-commerce exchanges with other BRICS countries, follow up with other BRICS countries' trade hotspots, and promote cross-border e-commerce between organizations. At the same time, it is also necessary to promote the products of other BRICS countries to enter the Chinese market, and continuously improve the quantity and quality of cooperation among BRICS countries. Finally, it is necessary to actively promote the policy

and economic cooperation between China and other BRICS countries, thereby promoting the import and export trade and economic development of China and its trading partners.

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