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The Impact of RCEP National Digital Economy Development Level on China's Home Appliance Exports

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Abstract

This study explores the impact of digital economy development in RCEP member countries on China's home appliance exports. Based on the panel data from 2011 to 2022 and the principal component analysis method, the index system of the development level of the digital economy is constructed. Through the regression analysis of the solid effect model, it is found that the improvement of the development level of the digital economy in RCEP countries has significantly promoted China's home appliance exports. Further analysis shows that the development of digital economy in high-income and upper-middle-income countries has a more significant role in promoting China's home appliance exports. It provides empirical support for understanding the impact of digital economy development on trade under the RCEP framework.

Keywords

Digital Economy; Home Appliance Export; RCEP.

1. Introduction

On November 15, 2020, the Regional Comprehensive Economic Partnership (RCEP) was officially signed by 15 countries including ASEAN, China, Japan, South Korea, Australia and New Zealan [1]. The signing of this agreement not only marks the major progress of regional economic integration, but also indicates the in-depth cooperation and coordinated development of the signatory countries in the field of digital economy. Digital transformation is profoundly changing the world, including the continuous upgrading of economic and social structure and industrial structure, and the characteristics of a digital community of common destiny are increasingly obvious [2]. China's home appliance industry, as a key component of the manufacturing industry, has steadily increased its share in the international market in recent years with its significant advantages of high quality and high performance-price ratio. In view of the different development levels of the digital economy of RCEP member states, China's export of home appliances to them also presents differentiated characteristics [3].

According to the classification standard of export commodities of the United Nations Commodity Trade Commission, this study focuses on the trade volume of China's key "white goods" exported to RCEP countries from 2011 to 2022, namely, air conditioners, refrigerators and washing machines.

As shown in Fig.1, in the 13 years from 2010 to 2022, China's total export trade to RCEP countries has achieved volatile growth, from $4.036 billion in 2010 to $8.036 billion in 2022, an increase of 2.07 times. Specifically, during the period from 2010 to 2015, the total export trade showed a trend of first increasing and then decreasing. This fluctuation may reflect the cyclical changes in the global economy and the instability of international market demand. Since 2016, the total export trade has started to rise steadily, possibly thanks to the improving global economic environment, the development of the digital economy, and the improvement of the competitiveness of China's export products.

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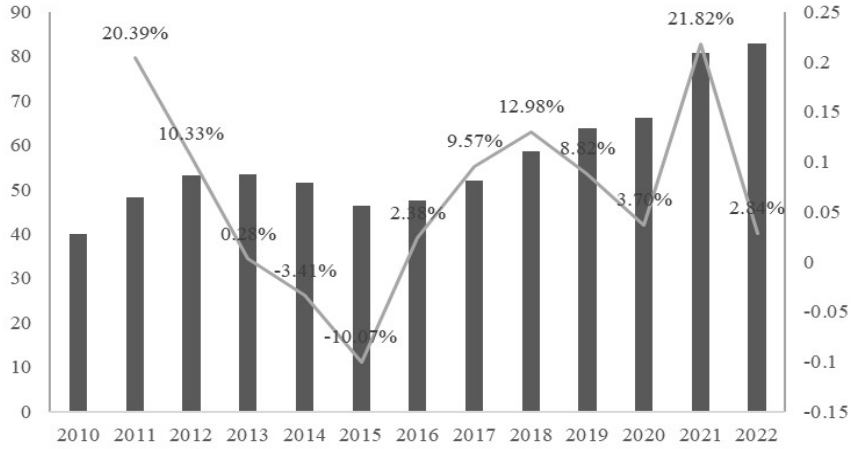

Fig. 1 China's total home appliance exports to RCEP countries (unit: USD 100 million)

2. Digital Economy Development Level Indicators

2.1. Index Measurement

By referring to previous research methods, Zhang Bochao and Shen Kaiyan [4,5]; Qi Junyan, Ren Yida [6,7] and others studied and constructed the RCEP national digital economy development level indicator system. According to the characteristics of digital economy, this paper uses STATA software and adopts principal component analysis to evaluate the digital economy development level of RCEP member states. The evaluation system includes three first-level indicators of digital infrastructure, application level and innovation environment, and ten second-level indicators, which fully reflect the development of the digital economy. The specific indicators and data sources are shown in Table 1:

Table 1. Digital Economy Development Evaluation Index System

Primary Index	Secondary Index	Name	Index Attribute	Source
Digital Infrastructure	Rate of electricity	A1	Forward Indicator	World Bank
	Fixed broadband penetration	A2		
	Mobile cellular subscription rates	A3		
	Number of secure Internet servers	A4		
Digital Application Level	Proportion of ICT products exported	B1		
	Proportion of ICT service exports	B2		
Digital Innovation Environment	Intellectual property royalties (received)	C1		
	Higher education enrollment rate	C2		
	Number of patent applications	C3		
	Number of scientific and technological journal articles	C4		

Firstly, KMO test and Bartlett test are applied to the standardized data set to verify whether it is suitable for principal component analysis. The results showed that the KMO value was 0.605, higher than the critical value 0.6, and the significance level of the P value was 0.000, lower than 0.05. These statistical indicators confirm that the data meet the preconditions of principal component analysis.

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Table 2. KMO And Bartlett Tests

KMO Value	0.605	
Bartlett Sphericity Test	Approximate Chi-square	1282.344
	Degree Of Freedom	45
	Significance	0.000

According to the standard of eigenvalue ≥1 of principal component analysis, principal components were extracted from the above 10 secondary indexes, and finally four principal components were determined. The cumulative variance contribution of these four principal components is 76.76%, indicating that they can reflect most of the information of the original data.

Table 3. Principal Component Extraction

Component	Eigenvalue	Proportion	Cumulative
Comp1	3.24373	0.3244	0.3244
Comp2	2.0535	0.2053	0.5297
Comp3	1.37578	0.1376	0.6673
Comp4	1.00287	0.1003	0.7676

Subsequently, the uniqueness test is carried out, and if the uniqueness value of the corresponding variable of a principal component exceeds 0.6, it is considered abnormal and the principal component must be removed and extracted again. According to Table 2.4, the uniqueness of all 10 variables is lower than 0.6, so it is not necessary to exclude them.

Table 4. Uniqueness Test Value

Variable	1	2	3	4	Uniqueness
A1	0.663	-0.267	0.241	-0.324	0.327
A2	0.864	-0.227	-0.273	0.0806	0.121
A3	0.423	-0.480	0.373	-0.418	0.276
A4	0.353	-0.381	0.128	0.669	0.267
B1	0.415	0.144	0.780	-0.0545	0.196
B2	0.210	0.555	0.475	0.442	0.227
C1	0.525	-0.0924	-0.404	0.000460	0.553
C2	0.737	-0.394	-0.177	0.209	0.226
C3	0.594	0.735	-0.178	-0.127	0.0599
C4	0.605	0.723	-0.168	-0.105	0.0719

The maximum variance method is used to calculate the standardized feature vector to form the principal component matrix. The coefficient corresponding to the principal component of the secondary index is multiplied by the sum of its variance contribution rate, and then divided by the cumulative variance contribution rate to obtain the final coefficient of each secondary index, and the indicator model of the development level of digital economy is constructed. The formula is as follows:

$$DEL = (f1^{*}\ 0.3244 + f2^{*}\ 0.2053 + f3^{*}0.1376 + f4^{*}\ 0.1003)/\ 0.7676$$

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2.2. Measurement Result

The corresponding secondary index data are substituted into the model to obtain the calculation results of the digital economy development level of RCEP countries from 2010 to 2022 [8]. And find the total average of 13 years, and rank the average score as follows.

As can be seen from the ranking results, the top five countries in the level of digital economy development are: China, the Philippines, Singapore, South Korea and Malaysia, while Myanmar, Brunei and Cambodia are at the bottom. China has been in the lead for 13 years. Generally speaking, developed countries and countries with high per capita income have a relatively high level of development and have formed a good trend of exporting digital products. However, due to inadequate information infrastructure, developing countries are relatively backward in the development of the digital economy, and often need more international cooperation and technical assistance to support the development of their own digital economy.

The country worth focusing on is the Philippines. In the measurement system constructed by other scholars, the score of the development level of the digital economy of the Philippines is roughly above the medium level, while in this paper, it is in the second position after China. Comprehensive previous studies have found that the Philippines has a high proportion of ICT products and services exports, so it has a high score in the level of digital application, which makes up for the shortcomings of the other two first-level indicators in the calculation. The reason may be that its labor force is relatively low, and it has become a digital product outsourcing service base for countries such as Japan and South Korea, which have driven the development of its own digital economy to a certain extent.

Table 5. Digital Economy Development Level Index Measurement Results

Nation	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Avg. Score
CHN	1.51	1.61	1.73	1.86	1.98	2.22	2.42	2.52	2.68	2.76	3.02	3.04	3.14	3.05
PHL	1.22	1.27	1.35	1.31	1.38	1.4	1.67	1.52	1.51	1.61	1.82	1.8	1.71	1.96
SGP	1.12	1.09	1.13	1.16	1.16	1.23	1.4	1.53	1.58	1.71	1.9	2.08	2.16	1.93
KOR	1.07	1.05	1.04	1.1	1.14	1.21	1.23	1.32	1.42	1.45	1.59	1.75	1.64	1.7
MYS	1.1	1.05	1.08	1.07	1.06	1.14	1.13	1.15	1.17	1.18	1.53	1.56	1.34	1.56
JPN	1	0.99	1	1	0.99	0.99	1.01	1.04	1.05	1.12	1.26	1.27	1.3	1.4
AUS	0.85	0.85	0.86	0.88	0.9	0.89	0.91	0.94	0.99	1.02	1.06	1.16	1.11	1.24
NZL	0.77	0.79	0.8	0.8	0.8	0.81	0.83	0.85	0.87	0.91	1.05	1.2	1.13	1.16
VNM	0.46	0.51	0.59	0.67	0.68	0.75	0.78	0.82	0.83	0.85	0.92	0.94	0.95	0.98
IDN	0.75	0.74	0.66	0.61	0.62	0.61	0.6	0.6	0.63	0.65	0.85	1.02	0.94	0.93
LAO	0.52	0.53	0.54	0.54	0.63	0.64	0.62	0.59	0.56	0.56	0.9	1.87	0.64	0.91
THA	0.72	0.68	0.67	0.66	0.67	0.67	0.66	0.66	0.66	0.65	0.72	0.72	0.71	0.89
MMR	0.8	0.67	0.53	0.39	0.5	0.66	0.51	0.41	0.33	0.36	0.41	0.46	0.51	0.65
BRN	0.38	0.39	0.39	0.4	0.41	0.42	0.42	0.43	0.43	0.47	0.6	0.67	0.64	0.61
KHM	0.35	0.29	0.27	0.29	0.3	0.35	0.36	0.4	0.36	0.38	0.54	0.9	0.61	0.54

3. Research Design

3.1. Model Setting

This paper takes the traditional trade gravity model as the basic model. Based on previous studies and data availability, this paper takes the digital economy development level index (DEL) as the core explanatory variable. Meanwhile, the following control variables are added to the expanded gravity model: Gross domestic product (DGDP) per capita and GDP growth rate (GDR) to reflect the scale of national economy; Trade cost (TC) reflects the maritime cost of trade

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between two countries; The degree of openness of host country reflects the degree of trade barriers. The final model is as follows:

$$\ln ATE_{ijt} = \beta_0 + \beta_1 \ln DEL_{jt} + \beta_2 \ln DGDP_{jt} + \beta_3 \ln GDR_{jt} + \beta_4 \ln TC_{ijt} + \beta_5 \ln OPEN_{jt} + \varepsilon_{ijt}$$

Where, i indicates China, j indicates the importing country or region, and t indicates the year. ATEijt said China's exports of white goods to Country j during the period of t (millions of dollars), DELjt said the level of digital economic development during the period of t, DGDPjt said the per capita GDP of country j during the period of t (ten thousand dollars), GDPRjt said the GDP growth rate of country j during the period of t, TCijt represents the transportation cost between China and the importing country in period t (the product of the distance between China and the capital of Country i and the average annual crude oil price in period t, $10,000), and OPENjt represents the degree of foreign trade openness of country j in period t. The variables are described as follows:

Table 6. Variable Description And Data Source

Variable Type	Name	Variable Meaning	Anticipatory Symbol	Data Source
Explained Variable	lnATE	Number of China's export volume of home appliances to the host country		UN Comtrade Database
Core Explanatory Variable	lnDEL	Logarithm of the development level of the host country's digital economy	+	Calculated Above
Control Variable	lnDGDP	Logarithm of GDP per capita of host country	+	WDI Database
Control Variable	lnGDR	Logarithm of annual GDP growth rate of host country	+	WDI Database
Control Variable	lnTC	Logarithm of transportation cost between China and host country	-	CEPII Database
Control Variable	lnOPEN	Logarithm of the host country's trade openness	+	WDI Database

3.2. Empirical Analysis

3.2.1. Descriptive Statistics

In this paper, panel data of 14 RCEP member countries (excluding China as an exporting country) from 2010 to 2022 are selected, and each missing value is supplemented by interpolation method. The description of each variable is the result after taking logarithms. Descriptive statistics and correlation analysis are carried out as shown in Table 7 and Table 8:

Table 7. Descriptive Statistics

Variable	N	Mean	Min	Max	SD
lnATE	182	4.808	1.112	8.229	1.615
lnDEL	182	-0.202	-1.325	0.770	0.462
lnDGDP	182	-0.068	-2.548	2.180	1.442
lnGDR	182	1.394	0.001	2.676	0.538
lnTC	182	1.951	0.072	3.497	0.672
lnOPEN	182	4.400	2.384	5.938	0.659

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Table 8. Correlation Coefficient Matrix

	lnATE	lnDEL	lnDGDP	lnGDR	lnTC	lnOPEN
lnATE	1					
lnDEL	0.611***	1				
lnDGDP	0.366***	0.475***	1			
lnGDR	-0.263***	-0.146**	-0.653***	1		
lnTC	-0.215***	-0.131*	0.206***	-0.0110	1	
lnOPEN	-0.261***	0.0420	0.0520	0.187**	-0.0680	1

Variance inflation factor test was performed on the data to avoid multicollinearity between variables. The test results are shown in Table 9, and the VIF value of each variable is less than 3, so regression analysis can be performed.

Table 9. Variance Inflation Factor Test

Variable	VIF	1/VIF
lnDGDP	2.980	0.336
lnGDR	2.210	0.452
lnDEL	1.550	0.646
lnTC	1.230	0.813
lnOPEN	1.130	0.885
Mean	VIF	1.820

3.2.2. Regression Results and Analysis

First, the F-test is used to determine whether the mixed model or the fixed-effect model should be used. The test results show that the P value is 0.0000, so the null hypothesis is rejected and the fixed effect model is chosen. Then the Hausmann test, which has a P-value of 0.0000, rejects the random effects model and finally uses the fixed effects trade gravity model.

By adopting the step-to-step regression method, model (1) to model (5) is the regression result of gradually adding explanatory variables and control variables, and the model can explain 58.7% of the total fluctuation, as shown in Table 3.5. According to the regression results, the DEL correlation coefficients of the development level of digital economy are all positive, and are significant at the 1% test level. When only the core variable of digital economy development level is added, the regression coefficient can reach 1.210, which has a significant promoting effect on China's home appliance exports. Although the regression coefficient began to decline after the addition of other control variables, and finally reached 0.414, the development of the digital economy was still significant at the 1% level. For every 1% increase in RCEP national digital economy development, China's home appliance exports to the country will increase by 0.414%.

The coefficient of per capita income level DGDP in the gradual regression has remained relatively stable, the significance level is 1%, indicating that per capita income level has played a significant positive role in promoting the export of home appliances in China. For every 1% increase in the per capita income level of RCEP countries, China's home appliance exports to the country will increase by 1.733%. The per capita income level represents the consumption level and consumption potential of the host country to some extent. Exports of relatively expensive products, such as home appliances, are mainly to countries with relatively high per capita incomes.

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Table 10. Reference Model Regression

		lnATE	lnATE	lnATE	lnATE	lnATE
lnDEL		1,210*** (0,151)	0,559*** (0,132)	0,455*** (0,134)	0,374*** (0,132)	0,414*** (0,132)
lnDGDP			1,732*** (0,163)	1,721*** (0,160)	1,739*** (0,155)	1,733*** (0,153)
lnGDR				-0,212*** (0,071)	-0,170** (0,070)	-0,188*** (0,070)
lnTC					-0,239*** (0,069)	-0,248*** (0,069)
lnOPEN						0,191* (0,098)
_cons		5,052*** (0,043)	5,038*** (0,033)	5,311*** (0,098)	5,704*** (0,148)	4,916*** (0,430)
N		182	182	182	182	182
r2		0,278	0,570	0,591	0,619	0,628
r2_a		0,218	0,531	0,552	0,580	0,587
F test		0	0	0	0	0

* p<0.1, ** p<0.05, *** p<0.01 The value of t is in parentheses

The GDR coefficient of GDP annual growth rate is negative, the possible reason is that the main exporters of home appliances in China are developed countries, and their GDP growth rate is slowing down, or even individual annual GDP growth rate is lower than 0. Some developing countries have maintained high GDP growth despite low per capita income. The turnover period of household appliances is short, which belongs to the current transaction, often depends on the per capita income of the period, and is not sensitive to the GDP growth rate with lagging effect.

The TC coefficient of transaction cost is negative, indicating that geographical distance, crude oil price and other factors significantly inhibit the export of home appliances. For every 1% increase in RCEP national transaction costs, China's home appliance exports to the country will decline by 0.248%. In recent years, the price of crude oil has fluctuated sharply, and the cost of shipping has increased accordingly. In the future, countries will strengthen their international port construction and improve the efficiency of loading and unloading.

The host country's trade openness promotes home appliance exports at a significant level of 10%. The higher the degree of trade openness of a country, the higher the facilitation of its trade, so the more conducive to China's export of home appliances to the country.

3.3. Regression Model Test

3.3.1. Robustness Test

In this paper, digital infrastructure (DEL_A), digital application level (DEL_B) and digital innovation environment (DEL_C), which are the first level indexes in the evaluation system of digital economy development, are taken as substitute variables. The model was included for empirical test to verify the robustness of the previous empirical results.

The results show that after replacing the explained variables, there is no significant impact on the regression results, and the core explanatory variable digital economy development index coefficient is still significantly positive at the level of 1%, and the value fluctuation is small. The coefficients and significance of the other control variables are not significantly different, indicating that the results obtained above have a certain degree of robustness.

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Table 11. Robustness Test Regression Results

	lnATE	lnATE	lnATE
lnDEL_A	0,158*** (0,022)		
LnDEL_B		0,165*** (0,435)	
LnDEL_C			0,188*** (0,032)
lnDGDP	1,507*** (0,138)	1,898*** (0,139)	1,752*** (0,133)
lnGDR	-0,152** (0,063)	-0,232*** (0,069)	-0,166** (0,065)
lnTC	-0,120* (0,065)	-0,240*** (0,069)	-0,230*** (0,064)
lnOPEN	0,035 (0,088)	0,106 (0,098)	0,092 (0,091)
_cons	4,095*** (0,407)	4,870*** (0,435)	2,046*** (0,668)
N	182	182	182
r2	0,700	0,626	0,673
r2_a	0,667	0,585	0,637
F test	0	0	0

* p<0.1, ** p<0.05, *** p<0.01 The value of t is in parentheses

3.3.2. Endogeneity Test

To avoid the problem of reverse causality, endogeneity test was performed. The core explanatory variables are treated with lag and substituted into the model respectively. According to the statistical test results, no matter the core explanatory variable DEL lags for one period or two periods, it is significantly positive at the level of 1%, which is consistent with the previous regression results, verifying that there is no significant endogeneity problem between variables.

Table 12. Endogeneity Test Regression Results

	lnATE (Lag 1)	lnATE (Lag 2)
lnDEL	0,683*** (0,128)	0,798*** (0,163)
lnDGDP	1,724*** (0,163)	1,756*** (0,181)
lnGDR	-0,169** (0,073)	-0,228*** (0,074)
lnTC	-0,303*** (0,063)	-0,228*** (0,064)
lnOPEN	0,262*** (0,098)	0,154 (0,096)
_cons	4,759*** (0,418)	5,244*** (0,403)
N	168	154
r2	0,652	0,622
r2_a	0,610	0,572
F test	0	0

* p<0.1, ** p<0.05, *** p<0.01 The value of t is in parentheses

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3.3.3. Heterogeneity Analysis

Due to the wide variation in levels of development among the RECP countries, the United Nations has chosen to group countries according to per capita income. The 14 member countries are divided into three groups: high-income countries, upper-middle-income countries and lower-middle-income countries. Regression analysis was conducted to explore whether there were significant differences among different income countries.

The regression results show that in both high-income countries and middle and high-income countries, the development level of digital economy has a significant promoting effect on China's home appliance exports, but it is not significant in low - and middle-income countries. The factor that significantly affects the export of home appliances to low - and middle-income countries is the per capita GDP, which may be due to the poor digital infrastructure in low - and middle-income countries, and the communication and shopping through the network have yet to be developed.

Table 13. Heterogeneity Test Regression Results

	lnATE (High)	lnATE(Upper-middle)	lnATE(Middle and low)
lnDEL	1,455*** (0,233)	2,204*** (0,457)	-0,038 (0,165)
lnDGDP	0,127 (0,320)	3,697*** (0,583)	2,209*** (0,206)
lnGDR	0,044 (0,077)	-0,226 (0,141)	-0,316** (0,138)
lnTC	0,118 (0,139)	-0,462* (0,251)	-0,102 (0,103)
lnOPEN	-0,580 (0,365)	1,666 (1,072)	0,140 (0,104)
_cons	7,306*** (1,719)	-0,328 (4,684)	7,747*** (0,535)
N	78	26	78
r2	0,539	0,876	0,775
r2_a	0,471	0,837	0,741
F test	0	0	0

* p<0.1, ** p<0.05, *** p<0.01 The value of t is in parentheses

4. Summary

From the results of the empirical analysis, it can be seen that the digital economy development level of the host country can significantly promote the export of home appliances in China. In view of the impact of the RCEP national digital economy development level on China's home appliance exports, this paper puts forward the following policy recommendations:

Firstly, Chinese home appliance companies should strengthen cooperation with RCEP member states in the field of digital economy to promote technological exchanges and market expansion. In view of the positive correlation between the development level of digital economy and the export of home appliances, Chinese enterprises can improve the digital access level of target markets by participating in the construction of regional digital infrastructure, such as broadband network and mobile communication system, and thus increase the market penetration rate of home appliances.

Secondly, the Chinese government and enterprises should jointly promote the development of e-commerce platforms, especially among RCEP member countries. By establishing and optimizing cross-border e-commerce platforms, transaction costs can be reduced, trade

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efficiency can be improved, and online sales of home appliances can be promoted, especially in countries with a high level of digital economy development.

Finally, China should actively participate in and promote trade facilitation measures under the RCEP framework, such as reducing tariff barriers and simplifying customs procedures, so as to reduce transaction costs and improve the competitiveness of home appliance exports. At the same time, Chinese enterprises should also pay attention to the policy dynamics of RCEP member countries, take advantage of policy advantages, optimize the export structure, and realize the diversification of export markets.

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