OPEN ACCESS Freely available online

IJBSI International Journal of Business Studies and Innovation

ISSN 2737-5331
Volume 4, Issue 1
https://www.iikii.com.sg/journal/IJBSI
International Journal of Business Studies and Innovation

Article

Impact of Digital Trade Development on China's Export: A Case of RCEP

Wenting Xiao

Tan Kah Kee College, Xiamen University, Xiamen 363105, China; vivi1357982@163.com

Received: Feb 10, 2024; **Revised:** Feb 25, 2024; **Accepted:** Mar 15, 2024; **Published:** Mar 30, 2024

Abstract: A system to evaluate the level of digital trade development was developed using the entropy method to measure the level of digital trade development in Regional Comprehensive Economic Partnership (RECP) member countries from 2013 to 2022. Referring to relevant literature, we also applied the stochastic frontier gravity model and the trade inefficiency model to evaluate export efficiency. Export efficiency was an important factor affecting trade between China and RCEP member countries considering the significant heterogeneity of the countries. Export efficiency was affected by the level of digital trade development significantly, with investment and the level of transportation infrastructure. China needs to seize the opportunities of digital trade by strengthening cooperation with RCEP member countries in digital trade to grasp competitive advantages and optimize the commodity structure. It is essential to utilize the opportunity to enhance export efficiency with the member countries of RCEP.

Keywords: Digital Trade, Trade Efficiency, Entropy Method, Stochastic Frontier Gravity Model

1. Introduction

In recent years, China has actively accepted international economic and trade rules and improved the digital trade governance system to promote the reform and innovation of digital trade. China also has optimized and upgraded traditional and digital trade systems. In 2022, the size of China's digital trade reached a record high of USD 372.71 billion, an increase of 3.4% compared to 2021 including the total value of trade of digitally deliverable services. The total trade value of cross-border e-commerce also achieved significant growth, reaching USD 0.29 trillion, an increase of 9.8% compared to the previous year. Digital trade has become a new growth engine for China's trade, providing new momentum to promote opening up, enhance the status of the international division of labor, and move towards the middle and high end of the global value chain.

Digital technology is rapidly updated and iterative globally, and artificial intelligence (AI), blockchain, and digital technology promote the efficiency and transparency of trade processes, reducing the time and cost of trade. The World Trade Organization (WTO) predicts that by 2030, digital trade will show the growth rate of global trade by 1−2% every year, and digital transformation will develop the global economy. According to eMarketer, a global market research organization, about 2.56 billion people shopped online in 2022, and e-commerce retail sales exceeded USD 5 trillion. In 2022, global exports of information and communication technology (ICT) services reached USD 968.6 billion, showing an annual increase of 6.1%. Currently, more than 120 regional and bilateral trade agreements contain digital trade rules. Rules on issues are coordinated to promote paperless trade and protect the privacy of e-commerce users with the global governance system accelerating the reformation. As global digital trade is developing rapidly, digital trade has developed global trade considerably.

In 2020, 15 countries, including 10 ASEAN countries, China, Japan, South Korea, Australia and New Zealand, signed the Regional Comprehensive Economic Partnership (RCEP). The agreement covers the world's most populous and largest free trade area. RCEP aims to promote regional economic development through a comprehensive series of policy measures and remove trade tariffs. The promotion of e-commerce and special attention to the development of small and medium-sized enterprises and technical cooperation jointly promote the development of digital trade and economic prosperity in the region. Since the implementation of RCEP, China has adhered to the principle of mutual benefit and synergy and achieved remarkable results in trade between RCEP member countries. According to the 2023 Asia-Pacific Trade and Investment Report released by the United Nations (UN) Economic and Social Commission for Asia and the Pacific, digital trade in the Asia-Pacific region has grown rapidly in recent years. The level of regional digital trade development is uneven. From 2015 to 2022, the growth rate of the digital deliverable in the Asia-Pacific region was 9%, outpacing the global average of 6.8%. However, in 2022, six countries accounted for 85% of the digitally deliverable exports in the Asia-Pacific region with least developed countries accounting for less than 1%. If the level of digital trade in RCEP countries is increased, it benefits the economic development of these countries and helps China to trade with them. Thus, it is necessary to study the impact of the development of digital trade in RCEP member countries on the efficiency of China's exports. China's formulation of reasonable and targeted policies under the framework of RCEP digital trade rules is also demanded to create a better trade environment and improve the efficiency of China's exports. Therefore, the impact of the development level of digital trade in RCEP member countries on the efficiency of China's exports was investigated in this study.

The first section of this article introduces the research background, significance, and the research framework of the present research. The second section defines key concepts, briefs literature review results, and suggests the research questions by comparing the perspectives and results of different studies. The third section discusses the current situation of exports between China and RCEP member countries from the perspective of market scales and structures. The fourth section presents the measurement and analysis methods of the development level of digital trade in RCEP member countries through the establishment of an index evaluation system using the entropy method. The fifth section describes an empirical analysis of the impact of the development level of digital trade on the efficiency of exports and the efficiency of China's trade with RCEP member countries. The stochastic frontier gravity model and the trade efficiency model are also explained. The sixth section concludes the study results and suggests strategies for improving the development level of digital trade with RCEP member countries.

2. Background Knowledge and Literature Review

2.1. Development Level of Digital Trade

2.1.1. Definition of Digital Trade

The connotation of digital trade has been researched widely. Weber (2010) defined digital trade as products or services that are transmitted and delivered digitally on the Internet. In 2013, the U.S. International Trade Commission (USITC) included digital content, social media, search engines, and other products and services in digital trade (Zhang, 2024). The definition of digital trade then was limited to digital products and services. In 2014, the USITC expanded the scope of digital trade to cross-border data flows and physical products sold on the Internet (Xu *et al*., 2024). Li *et al*. (2021) integrated the definition of the concept of digital trade level in international organizations and included trade digitization in digital trade, which includes digital trade in goods, digital services, and cross-border data trade in digital ordering and digital payment as the main realization methods. The WTO, International Monetary Fund (IMF), and Organisation for Economic Co-operation and Development (OECD) defined digital trade as all trade ordered or paid for digitally in the Handbook on the Measurement of Digital Trade in digital ordering trade, digital delivery trade, and digital intermediary platform for trade (Xu *et al*., 2024).

2.1.2. Indicator of Development Level of Digital Trade

There are two methods to measure the development level of digital trade: the single index method and the comprehensive index system method. The single indicator method starts from the definition of digital trade. A single indicator is selected regarding the total amount of actual trade of digital delivery of services to measure the development level of local digital trade. Lin (2024) selected the national export volume of digital delivery services as an indicator to measure the development level of digital trade. Chen (2020) used the total value of digital trade to measure the level of digital trade according to the definition of digital trade by USITC.

The development level of digital trade is measured by constructing an index evaluation system. Hou and Jie (2023) constructed an index system from five aspects: digital infrastructure, digital industry level, digital trade development environment, digital innovation ability, and trade potential. They used the entropy method to measure the digital trade development level of RCEP countries. Feng and Duan (2022) selected six first-level indicators, including digital innovation, digital skills, digital trade scale, digital infrastructure, digital trust risk, and digital trade barriers, and used the entropy method to evaluate the development level of digital trade in 49 countries. Wang *et al*. (2023) measured the development level of digital trade in 30 provinces (autonomous regions and municipalities) in China by constructing an index system of digital trade in seven dimensions: digital network infrastructure, logistics environment, industrial digital trade, digital industrialization trade, trade potential, digital skill endowment, and digital technology innovation. Guan *et al.* (2023) determined 15 second-level indicators from the four dimensions of digital infrastructure, industrial digital trade, digital industrialized trade, and trade potential and used the entropy weight method to refine the second-level indicators and calculate the development level in 71 countries. Zhang and Zhang (2024) measured the development level of digital trade in five dimensions: digital trade infrastructure, digital technology, industrial digital trade, digital industrialization trade, and import and section. They used the entropy method to measure the development level of digital trade in 30 provinces in China.

2.2. Trade Efficiency

2.2.1. Definition of Trade Efficiency

Trade efficiency has been studied extensively in international trade, and its understanding stems from "technical efficiency" in the production function. Farrel (1957) introduced the concept of technological efficiency into the study of the production frontier to measure the relationship between the actual output and the theoretically maximum output under certain technical conditions. The volume of trade is affected by factors such as geographical distance between trading countries, total economic volume, and total population so it is similar to the production function. Owing to the improvement of efficiency analysis methods and production frontier analysis methods, Armstrong (2007) introduced the Stochastic Frontier Analysis Method to measure trade efficiency and trade potential. Recently, scholars have defined the concept of trade efficiency from the perspective of measurement methods. Chen and Meng (2023) used the Stochastic Frontier Gravity Model and found that trade efficiency is similar to the production function. The volume of trade can be regarded as a function of economic, geographical, institutional, and other variables in countries, while trade efficiency is defined as technological efficiency. He *et al*. (2021) defined trade efficiency as the ratio of actual trade value to trade potential and measured the gap between the actual and ideal status of trade. The trade efficiency is usually between 0 and 1, and the higher the trade efficiency value, the closer the actual trade value is to the trade potential. Zhang and Zhang (2017) defined trade efficiency in international trade as the ratio of the actual trade volume to the theoretical "trade potential" so the key to measuring trade efficiency is trade potential. Fan (2020) stated that trade efficiency is related to the distance between the actual trade volume and the optimal trade level.

2.2.2. Impact of Development Level of Digital Trade on Trade Efficiency

There are few studies on the development level of digital trade on trade efficiency. The impact of the development level of digital trade on the export of specific products has been mainly focused. However, it is generally believed that improving the development level of digital trade increases trade efficiency and the export of products. Scholars have discussed the impact of digital trade on trade efficiency but the impact of the development level of digital trade on trade efficiency has not been explored extensively. Chen (2024) compared the digital trade rules of different regional organizations and concluded that digital trade changes the inherent traditional trade, improves trade efficiency, and reduces trade costs. Zhou and Yi (2023) analyzed the role of digital technology in the division of labor in the global value chain and concluded that digital trade improves traditional trade efficiency, optimizes the trade structure of intermediate goods, and values trade in goods more. Digital trade improves trade efficiency and the sustainability of trade and promotes green trade (Zhang, 2024). Ma (2023) compared the digital trade rules of RCEP and the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) and concluded that the digital trade rules simplify the trade process, reduce trade costs, and improve trade efficiency.

Different models including the Stochastic Frontier Gravity Model, Benchmark Regression Model, and Mediating Effect Model are used while the Stochastic Frontier Gravity Model is the most widely used. Based on the data from 45 countries from 2010 to 2021 and using the stochastic frontier method, Ming and Zhu (2023) found that improving the development level of digital trade of importing countries of agricultural products significantly influenced the export efficiency of China's agricultural products. Mo and Chen (2023) found that the level of digital software and hardware in importing countries in RCEP positively impacted the export efficiency of China's digital service trade. They also used the Stochastic Frontier Gravity Model. Li and Liu (2023) used the data of digital service trade from 17 countries in the Asia-Pacific region and the Stochastic Frontier Gravity Model and found that the improved digital infrastructure environment of importing and exporting countries improved the efficiency of bilateral digital trade. Hou and Jie (2023) measured the development level of digital trade in RCEP member countries using the Stochastic Frontier Gravity Model. They found that the development level of digital trade in partner countries reduced trade costs between countries and improved the export efficiency of China's cross-border e-commerce products. Zhang (2024) found that the improvement of the development level of digital trade of enterprises improved trade efficiency and reduced the trade cost of export using a Benchmark Regression Model and an Intermediary Effect Model.

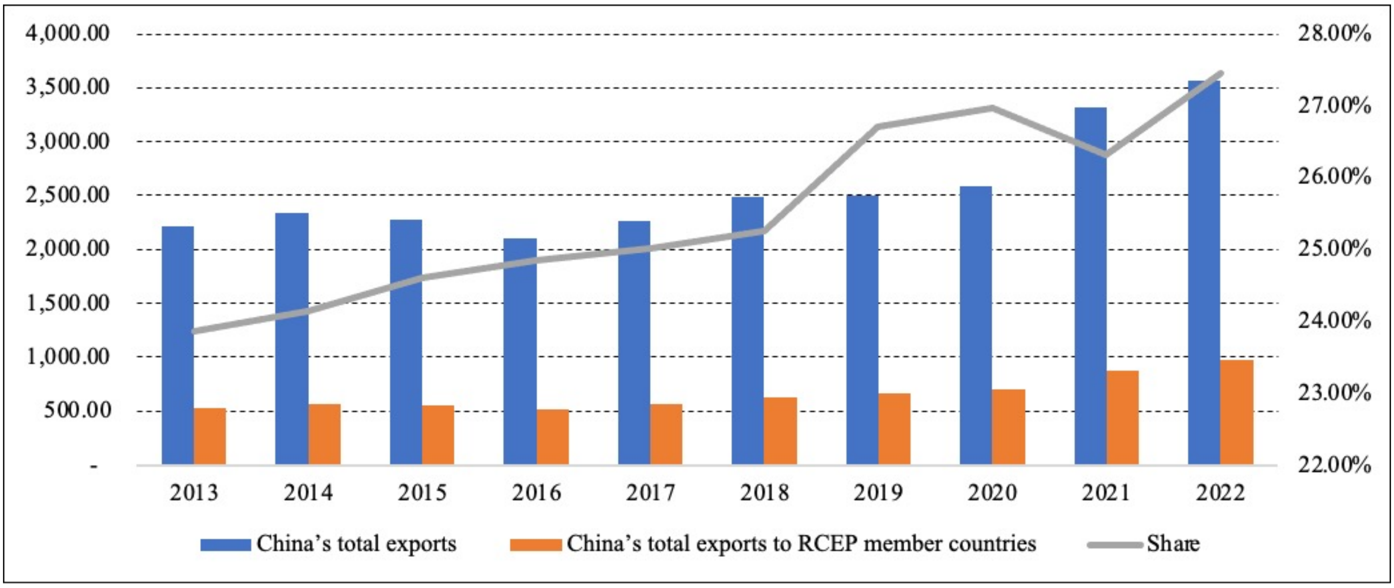
Such results revealed the intrinsic relationship between the development level and trade efficiency of digital trade. The development of digital trade reduces trade costs and promotes trade efficiency. The level of digital trade development in partner countries of RCEP promotes China's exports of products. The development level of digital trade also improves the trade efficiency of digital service trade. However, there are relatively few studies on the level of digital trade and export efficiency, and the research areas of digital trade are relatively wide, mainly concentrated in countries of the "Belt and Road" and provinces and cities in China. However, there is little result on the measurement of RCEP digital trade level.

Thus, this study aims to explore the impact of the development level of digital trade in partner countries on the efficiency of China's section regarding the general trend of digital trade development, especially in the post-epidemic era. The RCEP contains many modern digital trade rules, which provide opportunities for the development of digital trade among member countries. Thus, RCEP is taken as the research object to provide a reference for the development of digital trade in regional organizations. Based on the existing literature, the overall level of digital trade development, a difference in the level of digital trade development, the level of digital trade development, and its effect on the trade efficiency of China are explored in this study.

3. China's Trade with RCEP Member Countries

3.1. Scale of Trade

From 2013 to 2022, China's total exports and the proportion of its total exports to RCEP member countries showed an overall increase (Fig. 1). Since 2013, China's total exports have increased from USD 2,209 billion in 2013 to USD 3,560.5 billion in 2022. At the same time, China's total exports to RCEP member countries have also shown a steady growth from USD 527 billion in 2013 to USD 977.3 billion in 2022 by about 1.85 times. From 2013 to 2020, the proportion of China's total exports to RCEP member countries in China's total exports increased from 23.9 to 27%. During 2020−2021, the proportion declined but rebounded in 2022 from 26.3 to 27.4%. Thus, the contribution of RCEP members to the growth of China's trade increased. In addition, with RCEP since 2022, the policy for RCEP has been enforced which stimulated the regional economic and trade potential, and China's trade with RCEP member countries continued to increase.



(Source: Based on the China Statistical Yearbook (2013-2022)).

Fig. 1. China's total exports to RCEP member countries and their share from 2013 to 2022

3.2. Market Structure

From 2013 to 2022, China's exports to the 10 ASEAN countries were close to those to RCEP member countries. The exports to Japan declined year by year but the exports of China to Australia, South Korea, and New Zealand were stable. From 2013 to 2022, China's exports to RCEP member countries steadily increased as shown in Fig. 2. The proportion of China's exports to Japan decreased from 28.49 in 2013 to 17.63% in 2022. The proportion of those in the 10 ASEAN countries increased steadily from 46.30 to 56.96%. The exports to ASEAN countries increased and accounted for half of China's exports to RCEP countries. In 2022, The proportion of China's exports to RCEP members accounted for 17.63, 16.47, and 14.72% of China's total exports totaling 48.82%. The countries with a proportion of exports higher than 5% of the total exports of China included Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Australia. China's exports to these countries accounted for 47.14% of those to RCEP member countries. Laos, New Zealand, Brunei, Myanmar, and Cambodia showed less proportions than 4.3%.

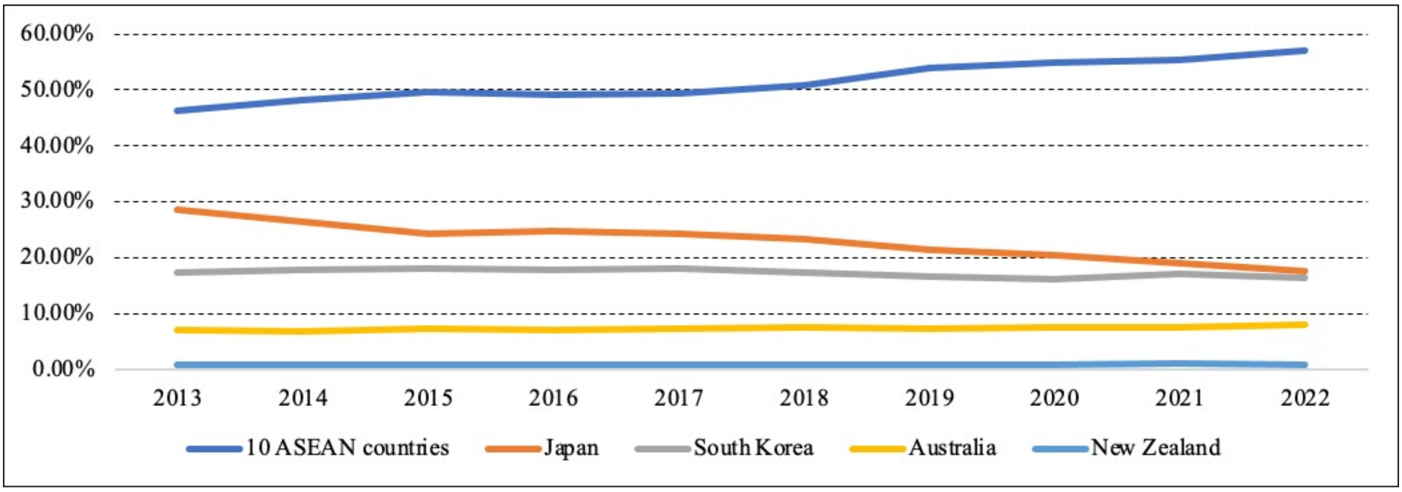


Fig. 2. Proportion of China's exports to RCEP member countries in China's total exports (Source: Based on the China Statistical Yearbook (2013-2022)).

4. Indicators for Development Level of Digital Trade

4.1. Indicators and Measurement Methods

Based on the definitions of digital trade by the WTO, IMF, and OECD, four level-one indicators were defined including digital delivery trade capability, digital ordering trade capability, digital technology innovation capability, and digital governance system in this study. Six second-level indicators included digital delivery services, digital market, digital technology, digital innovation, digital government, and digital security, while eleven third-level indicators were defined to evaluate the development level of digital trade in RCEP member countries (Table 1).

Table 1. Defined indicators for the level of development of digital trade in RCEP member countries in this study.

Level 1 indicators	Level 2 indicators	Level 3 indicators	Indicator symbols	Data source
Digital delivery trade capability	Digital delivery services	Imports of digital delivery services (Million US dollars)	X_1	United Nations Conference on Trade and Development (UNCTAD)
		Digital delivery services export volume (Million US dollars)	X_2	
Digital order trade capability	Digital market	Digital market index	X_3	Chinese Academy of Social Sciences
Digital technology innovation capabilities	Digital technology	Digital technology index	X_4	
		ICT services as a percentage of total trade in services (exports)	X_5	UNCTAD
		ICT services as a percentage of total trade in services (imports)	X_6	
	Digital innovation	Number of patent applications filed by residents	X_7	World Development Indicators (WDI)
		Frontier Technology Readiness index	X_8	UNCTAD
Digital governance system	Digital government	E-government development index	X_9	UN
	Digital security	ICT regulatory tracker index	X_{10}	ITU

Credit information index	X_{11}	WDI

Based on the literature review result, the entropy method was used to weigh the indicators of the development level of digital trade and then calculate it. Guan *et al*. (2023) used the entropy method to weigh each index and avoid the bias caused by subjective weighting and key information loss caused by principal component analysis. Therefore, The entropy method was used in this study to measure the development level of digital trade in RCEP member countries, too. The entropy method was applied through the following process.

For *m* samples and *n* evaluation indicators, the original data matrix is established as

$$X = \{x_{ij}\}m \times n(0 \leq i \leq m, 0 \leq j \leq n) \quad (1)$$

In the entropy method, positive and negative indicators exist, and the positive indicators were used in this study.

$$Z_{ij} = \frac{X_{ij} - min(X_j)}{max(X_j) - min(X_j)} \quad (2)$$

The weight of different indicators is calculated as

$$P_{ij} = \frac{Z_{ij}}{\sum_{i=1}^{m} Z_{ij}} \quad (3)$$

The entropy of different indicators is defined as

$$e_j = -k \sum_{i=i}^{m} P_{ij} ln(P_{ij}) \quad (4)$$

The information utility values for different indicators are calculated as

$$d_j = 1 - e_j \quad (5)$$

The weights of each indicator are calculated using

$$W_j = \frac{d_j}{\sum_{i=1}^{n} d_j} \quad (6)$$

The composite score of each data is calculated using

$$s_i = \sum_{i=1}^{n} W_j \times P_{ij}(i = 1, 2, \cdots m) \quad (7)$$

Due to the lack of data from Brunei, Cambodia, and Myanmar, the data of the remaining 11 countries were collected from the UNCTAD database, the Chinese Academy of Social Sciences, and the World Bank database from 2013 to 2022. The data of the digital market index and the Digital Technology Index in 2022 were not included as they were not updated yet. To ensure the integrity of the data, Yang's (2023) method of processing the missing values in the indicator and the linear interpolation method were adopted. The weight of each index is presented in Table 2.

Table 2. Indicator system for the level of development of digital trade in RCEP member countries.

Level 1 indicators	Level 2 indicators	Level 3 indicators	Indicator symbols	Weight
Digital delivery trade capability	Digital delivery services	Imports of digital delivery services (Million US dollars)	X_1	0.139
		Digital delivery services export volume (Million US dollars)	X_2	0.159
Digital order trade capability	Digital market	Digital market index	X_3	0.017
Digital technology innovation capabilities	Digital technology	Digital technology index	X_4	0.036
		ICT services as a percentage of total trade in services (exports)	X_5	0.095
		ICT services as a percentage of total trade in services (imports)	X_6	0.086
	Digital innovation	Number of patent applications filed by residents	X_7	0.357

		Frontier technology readiness index	X_8	0.024
Digital governance system	Digital government	E-government development index	X_9	0.027
	Digital security	ICT regulatory tracker index	X_{10}	0.017
		Credit information index	X_{11}	0.043

4.2. Development Level of Digital Trade

The levels of digital trade development of RCEP member countries from 2013 to 2022 were ranked as presented in Table 3. On the whole, huge differences were found in the level, and a “digital divide” between countries was observed. Japan, South Korea, Singapore, Australia, Malaysia, and New Zealand had higher levels. Japan showed the highest development level of digital trade with an average score of 0.68. Japan’s score remained between 0.60−0.72 for ten years with the highest score of 0.72. The Philippines, Indonesia, Thailand, Vietnam, and Laos showed low levels of digital trade development. The average level of Vietnam and Laos was less than 0.10.

Using the echelon ranking method (Hou and Jie, 2023), the development level of digital trade in the eleven countries was grouped into three echelons. In the first echelon, Japan, South Korea, and Singapore were found with an average score of 0.37−0.68; in the second echelon, Australia, Malaysia, and New Zealand were found with an average score of 0.17−0.19; In the third echelon, the Philippines, Indonesia, Thailand, Vietnam and Laos were placed with an average score of 0.05−0.14.

Table 3. Scores of digital trade development level of RCEP member countries from 2013 to 2022.

Countries	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Average Scores
Japan	0.62	0.65	0.65	0.67	0.68	0.69	0.72	0.71	0.72	0.70	0.68
South Korea	0.41	0.42	0.43	0.43	0.43	0.44	0.46	0.47	0.51	0.52	0.45
Singapore	0.29	0.32	0.31	0.32	0.35	0.37	0.39	0.43	0.47	0.48	0.37
Australia	0.17	0.17	0.17	0.17	0.18	0.18	0.19	0.22	0.24	0.24	0.19
Malaysia	0.15	0.15	0.16	0.17	0.17	0.17	0.18	0.20	0.21	0.20	0.18
New Zealand	0.13	0.15	0.15	0.16	0.16	0.17	0.17	0.20	0.21	0.20	0.17
Philippines	0.10	0.11	0.11	0.13	0.14	0.14	0.15	0.18	0.19	0.18	0.14
Indonesia	0.09	0.10	0.11	0.11	0.13	0.14	0.15	0.18	0.20	0.20	0.14
Thailand	0.09	0.09	0.10	0.11	0.11	0.12	0.13	0.13	0.13	0.14	0.11
Vietnam	0.05	0.06	0.07	0.07	0.07	0.08	0.09	0.13	0.16	0.14	0.09
Laos	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.06	0.13	0.20	0.05

To compare the digital trade development level of RCEP member countries from 2013 to 2022, a trend chart was drawn as shown in Fig. 3. Huge differences were observed in the level of digital trade development among RCEP member countries. The level increased from 2013 to 2022, indicating the improvement of the level in the past decade. The levels of Japan and South Korea were the highest for a decade and increased every year. In contrast, Australia, New Zealand, and ASEAN countries showed less increase between 0.1 and 0.25. From 2019 to 2022, the development of digital trade in these three regions increased significantly similar to Laos, Vietnam, and Indonesia. This showed that developing countries in RCEP had potential in the development level of digital trade.

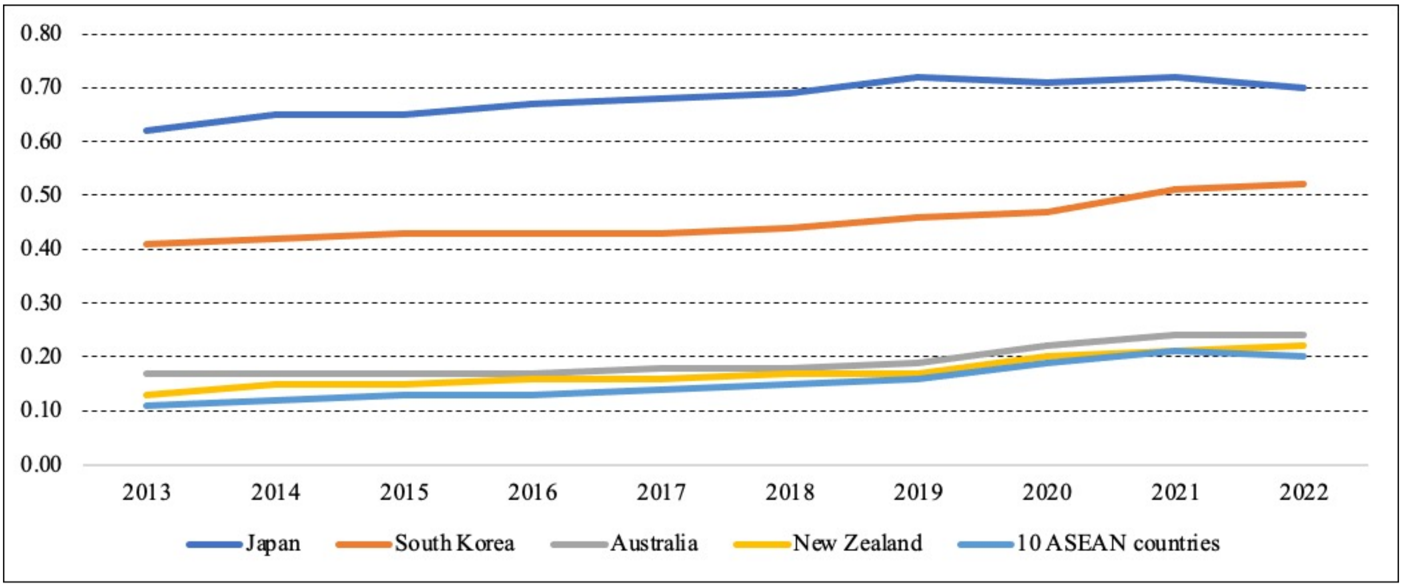


Fig. 3. Trend chart of the development level of digital trade in RCEP member countries from 2013 to 2022.

5. Impact of Development Level of Digital Trade on Trade Efficiency

5.1. Model Establishment

Compared with the traditional gravitational model, the Stochastic Frontier Analysis method separates the trade inefficiency term (μ) from the random error term (v) and considers the determinants of trade potential and trade efficiency (He and Wang, 2023). In this study, Frontier 4.1 was used to split the random perturbation term in the Stochastic Frontier Gravity Model into a random error term and trade inefficiency term to construct the trade inefficiency model with which the impact of the development level of digital trade on China's export efficiency was evaluated.

The Stochastic Frontier Gravity Model consists of the traditional gravitational model and the trade inefficiency model. The traditional gravitational model estimates the expected trade flow without considering efficiency, while the trade inefficiencies model determines factors related to trade efficiency and quantifies non-efficiency factors that lower the trade flow than the theoretical maximum trade flow. The non-efficiency factors include the reduction of trade flow due to technological backwardness, policy obstacles, and other factors. Long-term invariant natural factors are incorporated into the traditional gravitational model while dynamic factors are into the trade inefficiency model.

The basic formulae of the Stochastic Frontier Gravity Model are as follows.

$$T_{ijt} = f(x_{ijt}, \beta) exp(v_{ijt} - \mu_{ijt}), \mu_{ijt} \geq 0 \quad (8)$$

$$lnT_{ijt} = lnf(x_{ijt}, \beta) + v_{ijt} - \mu_{ijt} \quad (9)$$

$$T^*_{ijt} = f(x_{ijt}, \beta) + exp(v_{ijt}) \quad (10)$$

$$TE_{ijt} = T_{ijt}/T^*_{ijt} = exp(-\mu_{ijt}) \quad (11)$$

In Eq. (8), T_{ijt} represents the actual trade volume of country i to country j in year t, while X_{ijt} refers to the various factors that affect the actual trade volume, β the relevant parameters, v_{ijt}, and μ_{ijt} are the random error term and the trade inefficiency term, respectively. They are independent of each other, where v_{ijt} obeys the standard normal distribution and μ_{ijt} obeys the truncated normal distribution. Equation (9) is derived from Eqs. (8) and (10) when $\mu_{ijt} = 0$. There is no trade inefficiency term in the model, that is, the trade between the two countries reaches an optimal level. T^{*}_{ijt} is the trade potential, that is, the ideal trade volume between country i and country j in year t. When there is a gap between the actual trade volume and the trade potential between the two countries, the formula for estimating trade efficiency becomes Eq. (11) which is derived from Eq. (10).

Battese and Coelli proposed a time-varying model in which μ changes with individuals and time (Gu and Ren, 2023). Therefore, the Stochastic Frontier Gravity Model includes a time-varying model and a time-invariant model. The time-varying model is defined as

$$\mu_{ijt} = \{exp[-\eta(t-T)]\}\ \mu_{ij} \tag{12}$$

where μ_{ijt} obeys a truncated normal distribution, η is the parameter to be estimated, when $\eta > 0$ and $\eta < 0$ indicate that the trade non-efficiency term decreases and increases over time respectively, and when $\eta = 0$, the trade non-efficiency term does not change with time.

To explore the impact of the development level of digital trade in RCEP member countries on the efficiency of China's exports, the panel data of China and RCEP member countries from 2013 to 2022 were used. Natural factors such as economic scale, population size, and geographical distance which do not change for a long time were integrated into the main model (He *et al*., 2021; Han and Rao, 2023).

$$\boldsymbol{lnT_{ijt} = \beta_0 + \beta_1 lnGDP_{it} + \beta_2 lnGDP_{jt} + \beta_3 lnpop_{it} + \beta_4 lnpop_{jt} + \beta_5 lnDis_{ij} + \beta_6 bord_{ij} + \beta_7 lang_{ij} + v_{ijt} - \mu_{ijt}} \tag{13}$$

where i represents China, j represents the trading partner, and t represents the year. In Eq. (13), T_{ijt} is the value of China's exports to RCEP member countries in year t, v_{ijt} is the random error term, μ_{ijt} is the trade inefficiency term, and the other variables are detailed in Table 4.

Table 4. Variables of the traditional gravitational model .

Variable	Meaning	Expected Sign	Explanation
$\mathbf{GDP_{it}}$	China's GDP in t	+	Reflecting the size of a country's economy and trade potential
$\mathbf{GDP_{jt}}$	GDP of country j in year t	+	
$\mathbf{POP_{it}}$	The size of China's population in year t	+	Reflecting China's export capacity and the size and level of demand in partner countries
$\mathbf{POP_{jt}}$	The size of country j's population in year t	+	
$\mathbf{Dis_{ij}}$	The straight-line distance between China and the capital of country j in year t	-	Reflecting the cost of transportation between the two countries
$\mathbf{bord_{ij}}$	Whether the two countries have a common border	+	Reflecting the ease of trade between the two countries, the value of 1 indicates that there is trade facilitation, and the value of 0 is vice versa
$\mathbf{lang_{ij}}$	Whether the two countries have a common language	+	

The development level of digital trade of RCEP member countries was the explanatory variable in the trade inefficiency model in this study. To ensure comprehensiveness, the short-term variabilities of governance and economic environment in RCEP member countries were selected as control variables. The model,, then, was defined as

$$\boldsymbol{\mu_{ijt} = \delta_0 + \delta_1 DT_{jt} + \delta_2 BF_{jt} + \delta_3 FF_{jt} + \delta_4 TF_{jt} + \delta_5 IF_{jt} + \delta_6 TAX_{jt} + \delta_{57} LSCI_{jt} + \varepsilon_{ijt}} \tag{14}$$

where μ_{ijt} is the trade non-efficiency term, the δ is the parameter to be estimated, ε_{ijt} is the random error term, and the explanations of other variables are detailed in Table 5.

In the traditional gravitational model, GDP and population data from the WDI database were used. The data contained geographical distance, common borders, and common language were collected from the Centre for Prospective Studies and International Information (CEPII) database. For the non-efficiency model, the development level of digital trade was calculated and collated, and the data on commercial freedom, financial freedom, trade freedom, investment freedom, and tariff level were used based on the "Index of Economic Freedom" of the Heritage Foundation and the Wall Street Journal. The data for the Liner Connectivity Index were obtained from the WDI database.

Table 5. Variables in trade inefficiency model.

Variable	Meaning	Expected Sign	Explanation
DT_{jt}	The level of digital trade development in country *j* in year *t*	-	Reflecting the level of digital trade development of various countries
BF_{jt}	Degree of commercial freedom in country *j* in year *t*	-	Reflecting the degree of independent decision-making and free competition of enterprises
FF_{jt}	Degree of financial freedom in country *j* in year *t*	-	Reflecting the level of price stability and financial regulation
TF_{jt}	Degree of trade freedom in country *j* in year *t*	-	Reflecting the ease of trade
IF_{jt}	Degree of investment freedom in country *j* in year *t*	-	Reflecting the degree of development of the financial and capital markets
TAX_{jt}	Tariff levels of country *j* in year *t*	+	Rising tariffs will hinder trade between the two sides
$LSCI_{jt}$	National liner connectivity index of country *j* in year *t*	-	Reflecting the level of transport capacity and infrastructure of the trading country

5.2. Suitability Test of Stochastic Frontier Gravity Model

The Stochastic Frontier Gravity Model is dependent on the function setting, so it is important to conduct the likelihood ratio test to determine the function form before estimating trade efficiency and trade potential (Shi and Li, 2021). The likelihood ratio test of the function form was carried out in the model construction stage to verify the suitability of the model construction in this study. The existence of trade inefficiency was tested for its change over time considering distance, language, and boundary. According to the results in Table 6, the non-existence of trade inefficiency terms and their time invariance was rejected at a significance level of 1%, proving the validity of the time-varying Stochastic Frontier Gravity Model. Similarly, the distance, language, and boundary variables were validated at the 1% significance level, suggesting that these variables must be included in the model.

Table 6. Likelihood test results of stochastic frontier gravitational model.

Null Hypothesis	Constraint Model	Unconstrained Model	Likelihood Ratio	Critical Value at a Significance Level of 1%	Conclusions in the Model
There are no non-efficiency terms	-46.64	54.43	202.14	14.325	Rejected
Non-efficiency items do not change over time	54.43	71.90	34.95	12.483	Rejected
The distance variable is not introduced	61.98	71.90	19.85	10.501	Rejected
No language is introduced	53.45	71.90	36.90	10.501	Rejected
No boundaries are introduced	60.84	71.90	22.12	10.501	Rejected

5.3. Robustness Analysis of Stochastic Frontier Gravity Model

After testing the Stochastic Frontier Gravity Model, China's exports to RCEP member countries from 2013 to 2022 were regressed to verify the robustness of the analysis results using the Ordinary Least Squares (OLS), Time-invariant Model, and Time-varying model results are shown in Table 7. According to the results, the Time-Varying Model in the Stochastic Frontier Gravity Model was selected.

The γ value of both the time-invariant model and the time-varying model was 0.98 and statistically significant at the significance level of 1%. This indicated that the fluctuation of the composite error term was mainly due to the influence of the trade inefficiency term. This finding is important in understanding the composition of the error term in the model, indicating the dominance of the trade inefficiency in the overall error and the gap between the actual export volume between China and RCEP member countries. The theoretical export value was estimated from the trade non-efficiency term, rather than other external influences. The time-varying model η was -0.57 and was significant at the 1% level. This indicated that the trade inefficiency term changed with time, reflecting the applicability of the time-varying model. The η value was less than zero, indicating that from 2013 to 2022, the degree of inefficiency of China's section to RCEP member countries increased, China's obstruction to China's section to RCEP partner countries increased, and China's export efficiency to RCEP member countries decreased.

The time-varying model results in Table 7 showed that in terms of the economic scale, GDP_{it} and GDP_{jt} were important (a significance level of 1%), and the positive coefficients indicated that the economic scale of China and RCEP member countries significantly increased the level of China's exports to them and China's economic scale played a great role in promoting exports. The impact of China's population size (POP_{it}) on exports was significantly negative at the significance level of 1%, probably because when the Chinese population increased, domestic demand increased accordingly, and exports decreased; On the contrary, the population of the trading partner country (POP_{jt}) significantly impacted China's exports, indicating that when the population of the partner country increased, the demand for Chinese export products increased, which in turn promoted China's exports to the partner countries.

Geographical distance (Dis_{ij}) negatively affected China's exports at a significant level of 1%, which was in line with the expectation that as geographical distance increased, transportation costs rose, thus hindering China's esports. The border ($bord_{ij}$) and common language ($lang_{ij}$) were significantly positive at the significance level of 1%, indicating that they significantly promoted China's exports to RCEP member countries. This showed that the border and common language are important in bilateral trade.

Table 7. Regression results of stochastic frontier gravitational model.

Estimation method	**OLS model**		**Time-invariant model**		**Time-variant model**	
Variable	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value
Con	1149.55***	2.79	1149.89***	1130.79	1273.59***	11.86
$lnGDP_{it}$	3.84***	3.36	3.89***	48.28	4.79***	14.12
$lnGDP_{jt}$	0.81***	17.51	0.65***	10.64	0.81***	11.72
$lnPOP_{it}$	-45.24**	-2.84	-45.31***	-427.15	-50.53***	-12.02
$lnPOP_{jt}$	0.24**	5.85	0.47***	9.48	0.10*	1.68
$lnDis_{ij}$	-0.29***	-4.31	-0.20*	-2.56	-0.52***	-4.55
$bord_{ij}$	1.31***	12.14	1.59***	13.01	1.37***	8.17
$lang_{ij}$	0.76	5.09	0.72***	6.61	0.87***	3.35
σ^2	0.15		1.27*	1.46	0.53	1.03
γ	—		0.98***	119.43	0.98***	55.24
η	—		—		-0.57***	-6.95
Log-likelihood	-46.64		59.18		71.90	
LR test	—		196.48		273.09	

Note: *, **, *** representing statistically significant at the 10%, 5%, and 1% levels.

5.4. Estimation of Trade Inefficiencies Model

Since the existence of trade inefficiencies and their time-varying variation were verified, the one-step method was adopted for regression analysis on the trade inefficiencies model, and the results are shown in Table 8. The result of the regression analysis showed a γ value of 0.99 at a significance level of 1% and indicated that the difference between China's actual export and theoretical volumes to RCEP member countries was caused by trade inefficiency factors rather than random errors. This also highlighted the important role of trade inefficiencies in explaining trade volume deviations. The regression coefficient of the development level of digital trade (DT_{jt}) was -1.13, which showed its negative relationship with trade inefficiency at a significant level of 10%. This also implied that the improvement of the development level of digital trade significantly promoted the efficiency of China's exports to

RCEP partner countries. For every 1% increase in the level of development in digital trade to RCEP partner countries, China's inefficiency in exports decreased by 1.13%.

Contrary to expectations, the degree of commercial freedom (BF_{jt}) and financial freedom (FF_{jt}) were significant at a significance level of 1% and positively impacted trade inefficiencies (negative effects on trade efficiency), probably because high levels of commercial and financial freedom led to more capital flows. Such freedom and capital flow caused instability in financial markets, especially in countries with weaker financial regulations. In addition, unstable capital liquidity and regulatory differences in financial markets also affected the efficiency of China's exports to RCEP member countries. The trade freedom (TF_{jt}) was not significant in the trade inefficiency model, indicating that trade freedom did not affect the efficiency of China's exports to RCEP member countries. A significant negative correlation between the degree of investment freedom (IF_{jt}) was observed at a significant level of 1%, indicating that the degree of investment freedom promoted the cross-border capital flow, the efficient allocation and utilization of resources, and the trade efficiency of China. The impact of tariff level (TAX_{jt}) on trade inefficiency was not significant. Amid increasing regional integration, the impact of tariff level on trade was being weakened and was no longer the dominant factor restricting China's exports to RCEP member countries. The liner connectivity index ($LSCI_{jt}$) was significantly negative at a significant level of 1%, indicating that RCEP member countries had enough maritime technical facilities and shipping capabilities, which significantly improved the efficiency of China's exports.

Table 8. Regression analysis results of trade inefficiency model.

Stochastic Frontier Gravity Model			**Trade Inefficiency Model**		
Variable	Coefficient	t-value	Variable	Coefficient	t-value
Con	1,149.98***	1,150.59	Con	-3.17***	-2.78
$\mathbf{lnGDP_{it}}$	3.85***	40.15	$\mathbf{DT_{jt}}$	-1.13*	-1.78
$\mathbf{lnGDP_{jt}}$	0.45***	18.93	$\mathbf{BF_{jt}}$	0.03***	3.15
$\mathbf{lnPOP_{it}}$	-44.78***	-390.07	$\mathbf{FF_{jt}}$	0.07***	4.46
$\mathbf{lnPOP_{jt}}$	0.05*	1.95	$\mathbf{TF_{jt}}$	-0.01	-1.21
$\mathbf{lnDis_{ij}}$	-0.27***	-7.58	$\mathbf{IF_{jt}}$	-0.03***	-3.61
$\mathbf{bord_{ij}}$	0.44***	7.09	$\mathbf{TAX_{jt}}$	-0.01	-0.38
$\mathbf{lang_{ij}}$	0.84***	14.49	$\mathbf{LSCI_{jt}}$	-0.04***	-11.97
Log-likelihood	55.29		σ^2	0.05***	6.61
LR test	188.69		γ	0.99***	85.48

Note: *, **, *** representing statistically significant at the 10%, 5%, and 1% levels.

5.5. Trade Efficiency

Using the trade inefficiency model, China's overall export efficiency and its export efficiency to RCEP member countries from 2013 to 2022 were estimated based on the results of the one-step method (Table 9). The average score of China's export efficiency to RCEP member countries was 0.73. The overall score of the export efficiency was higher. The export efficiency for each RCEP member country showed a significant difference. The top four countries in China's export efficiency to RCEP member countries were South Korea, Singapore, Japan, and Thailand, and the average export efficiency of those countries was higher than 0.90; Malaysia, Vietnam, Australia, the Philippines, and Indonesia showed an average export efficiency of 0.66−0.89, and New Zealand and Laos presented an average export efficiency of less than 0.3. New Zealand and Laos had a certain degree of resistance to China's exports but this also indicates that they have potential for exports, which needs to be paid attention to. To compare the trend of China's export efficiency to RCEP member countries, a trend chart was drawn as shown in Fig. 4. China's export efficiency to South Korea was the highest among RCEP member countries. The export efficiency to Australia and ASEAN increased with fluctuations, and that to New Zealand was low with a slight and steady increase. Since 2020, China's export efficiency to Japan has decreased, which needs special attention.

According to the results of the time-varying model, the resistance of RCEP member countries against China's exports has increased over time except for several countries, which resulted in increased trade costs. The export efficiency of China was affected by COVID-19 in 2020 with the global supply chain significantly disrupted. With the implementation of the RCEP agreement, the member countries needed to adjust their policies and regulations to adapt to the new rules, which reduced the export efficiency of China.

Table 9. Estimation of China's export efficiency to RCEP member countries.

Countries	Year										Average scores
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	
South Korea	0.94	0.97	0.97	0.94	0.96	0.97	0.96	0.97	0.96	0.95	0.96
Singapore	0.97	0.98	0.98	0.95	0.96	0.96	0.97	0.98	0.85	0.97	0.96
Japan	0.96	0.97	0.94	0.92	0.95	0.96	0.93	0.95	0.84	0.76	0.92
Thailand	0.81	0.85	0.91	0.88	0.9	0.92	0.92	0.97	0.98	0.98	0.91
Malaysia	0.94	0.94	0.89	0.75	0.81	0.83	0.89	0.95	0.96	0.97	0.89
Vietnam	0.60	0.76	0.77	0.71	0.8	0.87	0.92	0.98	0.96	0.90	0.83
Australia	0.72	0.76	0.76	0.70	0.78	0.84	0.80	0.90	0.85	0.87	0.80
Philippines	0.53	0.6	0.67	0.73	0.76	0.79	0.85	0.92	0.92	0.88	0.77
Indonesia	0.69	0.72	0.63	0.57	0.62	0.70	0.69	0.63	0.69	0.70	0.66
New Zealand	0.23	0.26	0.26	0.26	0.27	0.29	0.27	0.29	0.31	0.29	0.27
Laos	0.09	0.09	0.06	0.05	0.07	0.06	0.07	0.06	0.05	0.06	0.07

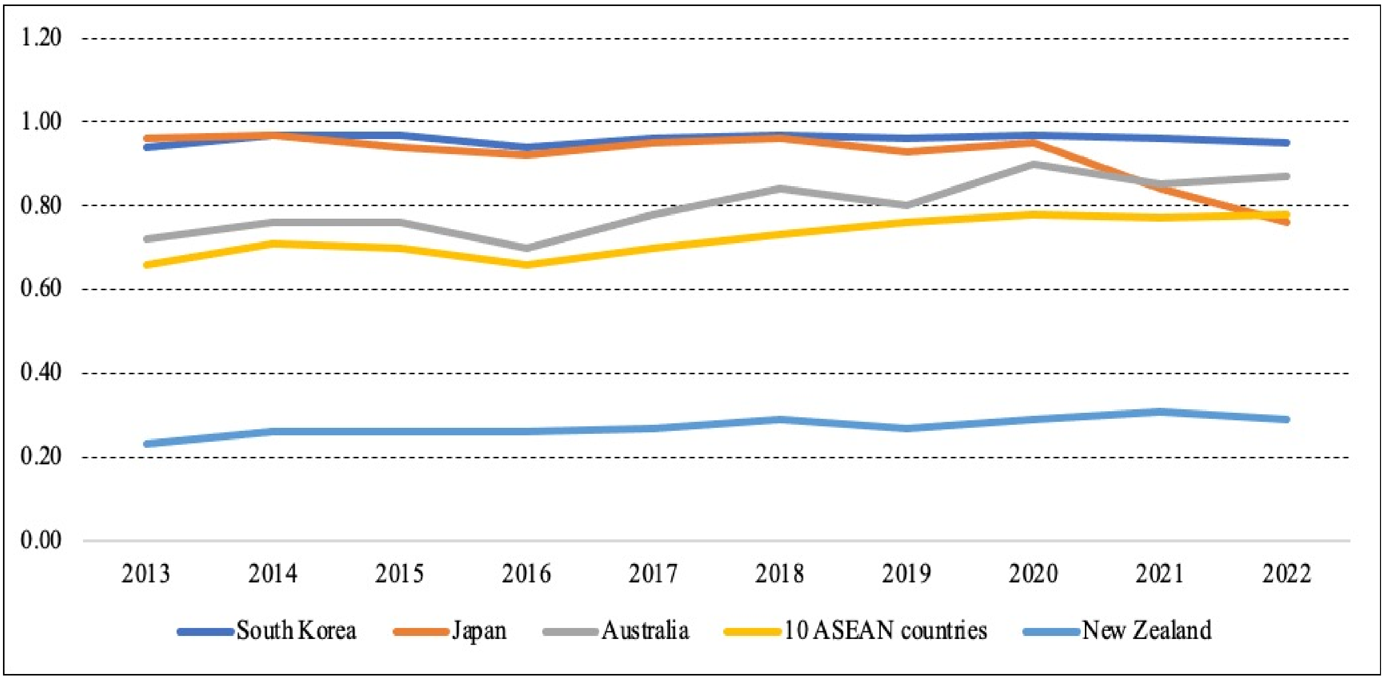


Fig. 4. China's export efficiency to RCEP member countries from 2013 to 2022.

6. Conclusions and Recommendations

An index evaluation system was established to measure the development level of digital trade of RCEP member countries by using the entropy method, the non-trade efficiency model, the time-varying stochastic Frontier gravity model, and the trade non-efficiency model. The efficiency of China's exports to RCEP member countries from 2013 to 2022 was estimated using the models. The performance of the models was validated through the regression analysis.

The development level of digital trade in RCEP member countries increased as a whole but with a difference between the member countries. Three echelons were found for the countries: countries at a high level (Japan, South Korea, and Singapore), countries at a middle level (Australia, Malaysia, and New Zealand), and countries at a low level (the Philippines, Indonesia, Thailand, Vietnam, and Laos). The result of the stochastic frontier gravity model showed that export efficiency differentiated depending on the economic size, population, common border, and language which positively influenced China's exports. Geographical distance and the size of China's population negatively affected China's exports. The development level of digital trade increased the export efficiency of China, indicating a promoting effect of the development level of digital trade. Commercial and financial freedom decreased China's trade efficiency, which was not expected, indicating that the high degree of such freedom of RCEP member countries caused financial market instability and affected China's export efficiency negatively. Investment freedom and liner connectivity significantly increase export efficiency, that is, a developed capital market and transportation facilities improved the efficiency of China's exports to RCEP member countries. China's export efficiency to different RCEP member countries was significantly different. China's export efficiency to South Korea, Singapore, Japan, and Thailand was higher than that to Malaysia, Vietnam, Australia, the Philippines, and Indonesia, and New Zealand and Laos. New Zealand and Laos seem to have potential for China's exports. The time-varying model presented that the resistance of RCEP member countries to China's exports increased over time, especially from 2020 to 2022, which decreased China's export efficiency in several RCEP member countries. COVID-2019 and the implementation of RCEP were the main causes of such a decrease.

Differences in the level of digital trade in the RCEP member countries were confirmed in this study, and it was found that improving the development level of digital trade in trading partner countries can promote China's export efficiency. Therefore, China must help RCEP member countries develop digital trade under the RCEP digital trade rules. It is also necessary for China to strengthen cooperation with RCEP member countries by cooperating in R&D and design, e-commerce, big data, and other fields. The RCEP member countries, New Zealand and Laos must be provided with assistance in terms of digital technology to promote the improvement of their levels of digital trade.

China must improve its export efficiency. For South Korea, Singapore, Japan, and Thailand, there is little room for export expansion but China needs to optimize the structure of exports by considering advantages and improving the quality of products to maintain high export efficiency. For Malaysia, Vietnam, Australia, the Philippines, and Indonesia, industries with the advantages and possibility of cooperation must be further developed to improve export efficiency. For New Zealand and Laos, export promotion measures such as targeted marketing and services must be implemented. Commercial and financial freedom negatively affected China's export efficiency. Most RCEP member countries are still developing, and their financial regulatory systems are not mature. Though excessive commercial and financial freedom may lead to financial market fluctuations, China needs to help the countries have more prudent management and commercial and financial policies to stabilize their financial markets and trade. As investment freedom and transportation facilities can improve the efficiency of China's exports, China needs to increase investment in RCEP member countries by simplifying the investment process and improving investment transparency and efficiency. China and RCEP member countries must cooperate for the construction of transport and logistics facilities including ports and roads to improve logistics management capabilities by using advanced digital technologies, such as blockchain and the Internet of Things.

Due to the impact of COVID-2019, China's export efficiency to several RCEP member countries decreased along with the implementation of the RCEP agreement as the member countries needed to adjust their policies and regulations to adapt to the new trade. In this regard, China must actively strengthen communication with RCEP member countries to formulate more flexible trade policies based on common interests.

Funding: This research received no external funding.

Data Availability Statement: United Nations Conference on Trade and Development (UNCTAD) (https://unctadstat.unctad.org/datacentre/), Chinese Academy of Social Sciences (http://ifb.cssn.cn/newpc/zxsj/202306/t20230627_5663365.shtml), World Development Indicators (WDI) (https://datacatalog.worldbank.org/search/dataset/0037712), United Nations (UN) E-government Development Index (https://publicadministration.un.org/egovkb/en-us/About/Overview/-E-Government-Development-Index), International Telecommunication Union (ITU) (https://datahub.itu.int/query/). All the websites are accessible on March 7, 2024.

Conflicts of Interest: The author declares no conflict of interest.

References

1. Armstrong, S. (2007). Measuring Trade and Trade Potential: A Survey. *Asia Pacific Economic Papers*, 368.
2. Chen, B. W. (2024). International Law Governance for Digital Trade. *Co-Operative Economy & Science*, *8*, 85–87.
3. Chen, H. Q. (2020). Can the Signing of "Free Flow of Cross-border Data" Promote Digital Trade Effectively: An Empirical Study Based on OECD Data on Trade in Services. *International Economics and Trade Research*, *36*(10), 4–21.
4. Chen, W. B., & Meng, L. (2023). Estimation of Trade Efficiency and Potential between China and the Belt and Road Countries. *Statistics & Decision*, *39*(20), 125–130.
5. Fan, X. (2020). The Development of Digital Economy and the Efficiency and Uncertainty of International Trade. *Finance & Trade Economics*, *41*(8), 145–160.
6. Farrell, M. J. (1957). The Measurement of Productive Efficiency. *Journal of the Royal Statistical Society*, *120*(3), 253–290.
7. Feng, Z. X., & Duan, D. Y. (2022). Study on the Evaluation of Digital Trade Development and the Influencing Factors-Based on Panel Data of 49 Countries. *Journal of Beijing University of Technology (Social Sciences Edition)*, *22*(4), 100–117.
8. Gu, X. M., & Ren, S. S. (2023). Research on China's Import Potential from Emerging Market Countries from the Perspective of Trade Efficiency-Measure Based on Time-varying SFA Model. *Intertrade*, *10*, 3–15.
9. Guan, H. P., Guo, B. H., & Zhang, J. W. (2023). Digital Trade, Technological Diffusion and Labor Skill Structure. *International Economics and Trade Research*, *39*(5), 89–106.
10. Han, Z. G., & Rao, Y. F. (2023). Research on the Influence of the Development Level of Digital Economy on the Efficiency of China's Foreign Trade. *Prices Monthly*, *4*, 41–48.
11. He, H., Lan, S. S., & Chen, G. H. (2021). Study on the Trade Potential of China and ASEAN Countries Based on the Perspective of Trade Efficiency. *Journal of Guangxi University (Philosophy and Social Science)*, *43*(5), 122–128.
12. He, M. Y., & Wang, W. (2023). Research on Section Potential and Trade Efficiency of China's Vegetables. *Northern Horticulture*, *21*, 144–150.
13. Hou, J., & Jie, Y. (2023). Research on the Impact of the Development Level of Digital Trade in RCEP Member Countries on China's Cross-border E-commerce Exports. *Prices Monthly*, *10*, 77–84.
14. Li, B. W., & Liu, Y. S. (2023). Digital Trade Potential and Influencing Factors in the Asia-Pacific Region. *Asia-pacific Economic Review*, *3*, 65–72.
15. Li, J., Li, X. L., & Wang, T. (2021). Digital Trade Concept, Development Trend and Countermeasures. *Intertrade*, *5*, 12–21.
16. Lin, C. (2024). Research on the Impact of Digital Trade Development on Industrial Structure Upgrading-Heterogeneity Analysis based on Different Economies. *Journal of Commercial Economics*, *6*, 173–176.
17. Ma, K. Y. (2023). Comparative Analysis of RCEP and CPTPP Digital Trade Rules and the Development Trend of China's Digital Trade. *Market Modernization*, *19*, 35–38.
18. Ming, H., & Zhu, Z. Q. (2023). Can the Development of Digital Trade Improve the Efficiency of China's Agricultural Exports? Empirical Evidence Based on Agricultural Importing Countries. *Journal of Sichuan Agricultural University*, *41*(5), 945–951.
19. Mo, F. N., & Chen, Y. W. (2024). Exploration on the Export Potential of China's Digital Service Trade to RCEP Countries. *Contemporary Economic Management*, *4*, 63–70.
20. Shi, J. F., & Li, B. W. (2021). Trade Efficiency and Trade Potential of Four Northeast China Provinces with Four Northeast Asia Countries. *Research on Financial and Economic Issues*, *4*, 98–107.
21. Wang, Y. F., Liu, J., & Jin, C. (2023). Systematic Measurement, Evolution Trend and Spatial Correlation of Regional Digital Trade Development Level in China. *The World of Survey and Research*, *2*, 13–22.
22. Weber, R. H. (2010). Digital Trade in WTO-Law Taking Stock and Looking Ahead. *Asian Journal of WTO International Health Law and Policy*, *5*(1), 1–24.
23. Xu, M. N., Shen, Y. L., & Peng, Y. (2024). Does High-quality Digital Connectivity Drive the Export Growth of Digital Services: The Empirical Evidence from the Expansion of International Submarine Cables. *Statistical Research*, *3*, 100–114.
24. Yang, X. Y. (2023). Research on the Construction and Evaluation of Beijing Digital Trade Business Environment Index System. *Science Technology and Industry*, *23*(2), 151–156.
25. Zhang, H. Y. (2024). Research on the Development of Digital Trade in China under the New Development Pattern of Dual Circulation. *Industrial Innovation Research*, *1*, 53–55.
26. Zhang, J. G., & Zhang, P. (2017). A Study on Trade Efficiency and Its Determinants between China and "Belt and Road" Countries. *International Economics and Trade Research*, *33*(8), 4–23.
27. Zhang, J. P. (2024). The Reform of the World Trade Organization and the Role of the "Global South". *Contemporary World*, *1*, 30–34.
28. Zhang, W. K. (2024). Research on the Impact of Digital Trade Development on the Quality of China's Export Products-An Analysis of Mesomeric Effect Based on the Degree of Openness. *Journal of Commercial Economics*, *2*, 138–141.

29. Zhang, Y. J., & Zhang, Y. X. (2024). Impact of Digital Trade on the Upgrading of Residents' Consumption. *Journal of Capital University of Economics and Business*, *26*(1), 66–80.
30. Zhou, S. Q., & Yi, C. J. (2024). An Investigation into the Impact of Digital Technology on Upgrading the Divisional Position of Manufacturing in Global Value Chains. *Journal of Chongqing University of Technology (Social Science)*, *5*, 25–39.