INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS & SOCIAL SCIENCES

Vol 15, Issue 7, (2025) E-ISSN: 2222-6990

Evaluating Cross-Border E-Commerce Development and Trade Potential between China and RCEP Countries: An Ecosystem-Based Gravity Model Approach

Lili Zhang[1,2*], Muhammad Asraf Bin Abdullah[2], Min Huang[1], Lihong Dai[1]

[1]School of Business and Trade, Anhui Technical College of Industry and Economy,Hefei, Anhui, China, [2]Faculty of Economics and Business, Universiti Malaysia Sarawak (UNIMAS), Kuching, Sarawak, Malaysia

*Corresponding Author Email: 21010197@unimas.my

Email: amasraf@unimas.my

To Link this Article: http://dx.doi.org/10.6007/IJARBSS/v15-i7/26034 DOI:10.6007/IJARBSS/v15-i7/26034

Published Date: 29 July 2025

Abstract

This study explores the development level and trade potential of cross-border e-commerce (CBEC) between China and its Regional Comprehensive Economic Partnership (RCEP) partners. Based on the CBEC ecosystem theory, a composite development index is constructed using Principal Component Analysis (PCA), incorporating key variables such as logistics performance, information flow, and digital infrastructure. An extended gravity model, estimated through the Generalized Method of Moments (GMM), is applied to panel data covering the period from 2013 to 2022. The empirical results underscore the crucial role of logistics and information flow in promoting CBEC growth across the region. China maintains a leading position due to its superior infrastructure, while countries like Laos remain constrained by infrastructural and economic limitations. The study finds that CBEC development in partner countries significantly enhances their trade with China, whereas China's own CBEC level has a limited effect on overall trade volumes. Additionally, while partner countries' per capita GDP does not exhibit a significant influence, China's per capita GDP positively affects trade flows, and geographic distance has a weak but statistically significant negative impact. The analysis also reveals untapped CBEC trade potential in countries such as Japan and South Korea, indicating the need for targeted policy interventions to strengthen digital infrastructure, reduce trade frictions, and foster deeper e-commerce integration within the RCEP framework.

Keywords: Cross-Border E-Commerce, RCEP, Trade Potential, Extended Gravity Model, GMM

Introduction

In recent years, cross-border e-commerce (CBEC) has emerged as a critical driver of international trade, revolutionizing the way businesses and consumers engage in global commerce. With the advent of the digital economy, CBEC has not only facilitated easier access to international markets but also significantly lowered the barriers to trade for small and medium-sized enterprises (SMEs). The Regional Comprehensive Economic Partnership (RCEP), which includes China and 14 other Asia-Pacific nations, represents one of the world's largest free trade agreements, further emphasizing the importance of understanding CBEC dynamics within this framework.

The importance of CBEC lies in its ability to enhance trade efficiency, reduce costs, and expand market reach. Despite its potential, significant disparities exist among RCEP member countries in terms of CBEC development. Factors such as logistical performance, information flow, digital infrastructure, and economic policies play critical roles in shaping the CBEC landscape. For instance, while China leads in CBEC development due to its advanced logistics and network infrastructure, other countries like Laos struggle with infrastructural and economic challenges.

Existing literature extensively discusses the determinants of CBEC, highlighting the pivotal roles of logistics, information technology, and supportive policies. Studies emphasize the importance of robust ICT infrastructure and government support in fostering CBEC growth. Additionally, the Technology-Organization-Environment (TOE) framework identifies critical factors such as internet speed, online payment security, and user-friendly platforms. However, there is limited research on the comprehensive assessment of CBEC trade potential between China and its RCEP partners, particularly considering the varied levels of development across these countries.

This study aims to fill this gap by evaluating the CBEC development levels and trade potential between China and RCEP partner countries from 2013 to 2022. Utilizing an extended gravity model and Principal Component Analysis (PCA), this research integrates core explanatory variables such as logistics performance, information flow, and digital infrastructure. The study's objective is to identify key determinants influencing CBEC trade potential and provide actionable insights for policymakers to enhance trade cooperation within the RCEP framework.

Overall, this research seeks to contribute to the existing body of knowledge by offering a nuanced understanding of CBEC dynamics and highlighting areas for policy intervention to maximize trade potential. The findings underscore the need for improved logistics, infrastructure, and digital economy frameworks, aiming to foster a more equitable and efficient CBEC environment among RCEP member countries.

This study is motivated by the growing urgency to understand and quantify the digital trade dynamics within the RCEP framework, especially given the region's diversity in infrastructure and digital readiness. Despite the strategic importance of CBEC in facilitating regional economic integration, there remains a lack of comprehensive assessments that simultaneously evaluate development levels and trade potential in a unified framework.

The key contributions of this research are twofold. First, it constructs a novel CBEC development index based on ecosystem theory using PCA, incorporating multidimensional factors such as logistics performance, information flow, and digital infrastructure. Second, it applies an extended gravity model using GMM estimation to identify untapped CBEC trade potential between China and RCEP partners. Together, these approaches provide a more systematic and data-driven understanding of the CBEC landscape in the Asia-Pacific region.

Literature Review

In the era of rapid digital transformation, cross-border e-commerce (CBEC) has become an essential component of global trade, fundamentally altering how businesses, particularly small and medium-sized enterprises (SMEs), access international markets. By reducing entry barriers and streamlining operations, CBEC has enabled broader participation in global commerce. The Regional Comprehensive Economic Partnership (RCEP), comprising China and 14 other Asia-Pacific economies, offers a vast framework within which the dynamics of CBEC development warrant close examination.

The expansion of CBEC is largely driven by its capacity to improve transaction efficiency, cut operational costs, and diversify trade channels. Nevertheless, RCEP countries exhibit considerable disparities in CBEC maturity. Logistics performance, information exchange capabilities, digital infrastructure, and regulatory environments all significantly affect a nation’s engagement in cross-border e-commerce. China has emerged as a frontrunner due to its well-established infrastructure and integrated digital systems, whereas others, such as Laos, face substantial development constraints that hinder participation in digital trade.

While existing research has addressed many enabling conditions for CBEC—including ICT adoption, internet penetration, and policy support—most studies tend to focus on fragmented dimensions or country-specific cases. There is a marked lack of holistic assessments that measure bilateral CBEC trade potential across the diverse RCEP region, especially considering the development asymmetries that persist among member countries.
To bridge this gap, the present study adopts the CBEC ecosystem theory and constructs a comprehensive development index via Principal Component Analysis (PCA), incorporating indicators related to logistics, digital infrastructure, and information flow. This index is embedded within an extended gravity model framework, which is estimated using the Generalized Method of Moments (GMM). The aim is to systematically evaluate how these ecosystem factors shape bilateral trade performance and to offer targeted insights for narrowing the digital divide and fostering deeper e-commerce integration among RCEP nations.

The CBEC ecosystem is now widely understood as a multidimensional socio-economic system. Its success is contingent not only on digital platforms but also on a complex interplay of technological, organizational, and institutional factors. Previous studies underscore the role of high-quality ICT infrastructure, secure and efficient logistics, streamlined customs processes, and supportive regulatory environments. According to the Technology-Organization-Environment (TOE) framework, key drivers of CBEC include communication network quality, transaction security, platform usability, and the broader digital readiness of both governments and enterprises. The significance of foreign direct investment, robust payment systems, and mobile internet accessibility has also been empirically validated.

However, persistent challenges—such as high logistics costs, transport delays, and legal uncertainties—continue to hinder CBEC expansion in less developed economies. Several researchers have emphasized the necessity of strengthening electronic marketing channels, fostering talent in digital trade, and upgrading legal and institutional frameworks to support smoother cross-border transactions. Additionally, demand-side factors like consumer market size, tourism activity, and import openness have been found to positively affect CBEC exports, while geographic distance remains a notable constraint.

Accurate evaluation of CBEC development levels requires systematic metrics. Early frameworks, such as that proposed by Yang et al. (2014), focused on transaction-stage indicators including marketing, logistics, customs, payments, and legal regulation. Later refinements by Li et al. (2020) extended the framework to six dimensions—spanning platform services, credit risks, talent development, and international digital marketing—comprising over 20 indicators. Yet, many economies still lack comprehensive systems for evaluating CBEC progress. International bodies like the OECD (2007) have suggested basic indicators such as internet and mobile penetration as proxies, while more recent studies have employed composite indices derived from ICT usage, broadband coverage, education levels, and tertiary enrollment.

Principal component analysis (PCA) has gained traction as a method for index construction. Song (2021) utilized PCA to incorporate variables such as internet users, mobile subscribers, and education quality in assessing CBEC development. Shen (2023) conducted a factor analysis of G20 countries, applying 11 indicators that included logistics, informatization, customs efficiency, and digital potential. However, CBEC evaluation within the RCEP framework remains underdeveloped and often relies on partial measures like internet penetration or digital literacy alone.

As digitalization becomes a key arena of global competition, there is an urgent need for more holistic assessments of its role in international trade. The digital economy—defined as an economy fundamentally reliant on internet-based technologies—demands metrics that reflect not only infrastructure, but also institutional capacity and market readiness. In this study, a customized indicator system is developed based on the TIMG index, which captures the structure of digital technology, infrastructure development, market access, and governance quality.

The concept of trade potential in CBEC refers to the unrealized portion of bilateral trade that could be achieved under optimal conditions. Scholars such as Armstrong (2007) and Shu (2018) describe it as the gap between theoretical trade volumes and actual observed flows, influenced by factors including technological constraints, capital-labor efficiency, and spatial limitations. In this research, CBEC trade potential is defined as the difference between actual trade and the maximum attainable volume given existing infrastructure, geography, and digital maturity.

The gravity model remains the dominant analytical tool in trade potential studies. Based on GDP and trade costs (especially distance), it has been widely applied and extended to incorporate CBEC-specific variables. Enhancements by Kong and Dong (2015), as well as Zhang et al. (2016), have improved the model's precision in capturing e-commerce dynamics.

Empirical findings reveal that trade flows between China and ASEAN members are positively associated with digital trade readiness, while distance exerts a minor but negative influence. Shen (2023) emphasizes that China's CBEC exports to G20 countries are significantly shaped by per capita income, logistics performance, and tariff structures. Furthermore, Nilsson (2000) and Egger (2002) propose a classification scheme for trade potential: values above 1.2 indicate "re-engineering potential," values between 0.8 and 1.2 suggest "development potential," and those below 0.8 reflect "significant untapped potential." Research applying this framework identifies high CBEC potential between China and countries such as Singapore and Malaysia, with emerging opportunities in Vietnam, the Philippines, and Laos. More developed markets like Japan and South Korea exhibit strong reconfiguration potential due to their advanced infrastructure yet underutilized trade linkages.

This integrated review underscores the strategic importance of evaluating CBEC trade potential through both structural and relational lenses. While existing literature provides useful frameworks, further research is needed to comprehensively map trade gaps across all RCEP members and assess the compound effect of digital asymmetries and distance-related trade frictions.

Methodology and Data

Construction of CBEC Index System

To evaluate the development level of cross-border e-commerce (CBEC), this study constructs a comprehensive indicator system grounded in the theoretical framework of the CBEC ecosystem. Drawing on both prior academic research and the national e-commerce demonstration city evaluation indicators (pilot version), the system captures key dimensions relevant to cross-border e-commerce performance. Principal Component Analysis (PCA) is employed to aggregate and reduce dimensionality across the variables, as represented in Equation (1):

$$F_i = a_{1i}X_1 + a_{2i}X_2 + \cdots + a_{pi}X_p \quad (1)$$

$X_1, X_2, \cdots X_p$ represents the index of each individual, $a_{1i}, a_{2i}, \cdots a_{pi}$ represents P constant vectors, F_i represents the linear combination of P index vectors $X_1, X_2, \cdots X_p$ of data matrix X (i.e., comprehensive index vector).

In developing the indicator system, the study emphasizes both data reliability and accessibility. Due to the lack of granular CBEC platform-level data, trade volumes of physical goods are used as proxies for transaction scale. Specifically, the import and export volumes of goods represent the activity of leading CBEC participants. For core stakeholders such as producers and consumers, the model uses manufacturing value added and the number of internet users, respectively, to reflect supply and demand capabilities.

The evaluation also incorporates supportive infrastructure. Logistics performance is assessed through six sub-indicators from the World Bank's Logistics Performance Index (LPI), encompassing customs efficiency, infrastructure quality, shipment tracking, and delivery timeliness. For information flow, this study leverages the ITMG Index developed by the Chinese Academy of Social Sciences (2023), which consists of four sub-dimensions: digital technology, infrastructure, market, and governance. In terms of financial support, the number of commercial banks and per capita net national income are adopted to reflect capital flow within the ecosystem.

The panel dataset spans from 2013 to 2022 and includes 12 representative RCEP member countries, selected based on data completeness and comparability. Table 1 presents the full indicator composition, primary and secondary variable groupings, and data sources.

Table 1
Indicator Composition of CBEC System

Species	Primary Indicators	Secondary Indicators	Data Source
Leading Species	Scale of goods import and export transactions	Import volume of goods (LS1)	World Bank Database
		Export volume of goods (LS2)	World Bank Database
Key Species	Manufacturers and Consumers	Manufacturing value added (KS1)	World Bank Database
		Individuals using the Internet (KS2)	World Bank Database
Supporting Species	Logistics Performance	Ability to track and trace consignments (LP1)	World Bank Database
		Competence and quality of logistics services (LP2)	World Bank Database
		Ease of arranging competitively priced shipments (LP3)	World Bank Database
		Efficiency of customs clearance process (LP4)	World Bank Database
		Frequency with which shipments reach consignee within scheduled or expected time (LP5)	World Bank Database
		Quality of trade and transport-related infrastructure (LP6)	World Bank Database
	Information Flow	Digital technology (IF1) Digital Infrastructure (IF2) Digital Market (IF3) Digital Governance (IF4)	Chinese Academy of Social Sciences (CASS)
	Cash Flow	Number of commercial banks (CF1)	International Monetary Fund Database
		Per capita net national income (CF2)	World Bank Database

Given the breadth of variables within the CBEC development framework, multicollinearity poses a potential challenge when integrating them directly into regression models. Excessive correlation among indicators may distort estimation results and obscure meaningful relationships. To mitigate this, PCA is applied to extract a set of uncorrelated principal components, ensuring that the dimensionality reduction does not compromise explanatory power. This approach allows for a more parsimonious and interpretable empirical analysis of the CBEC development index across RCEP countries.

Extended Gravity Model

The gravity model was first introduced into international trade analysis by Tinbergen (1962) and Pöyhönen (1963), who demonstrated that trade flows between two countries are positively associated with their economic size and inversely related to the geographical distance between them. Since then, the model has undergone significant refinements and has become one of the most widely adopted tools for analyzing bilateral trade flows and forecasting trade potential. Its standard functional form is expressed as follows in Equation (2):

$$T_{ijt} = \frac{A \cdot Y_{it} \cdot Y_{jt}}{D_{ij}} \tag{2}$$

Where T_{ijt} represents the bilateral trade volume between country i and country j in year t, A is a constant, Y_{it} represents the GDP of country i in year t, Y_{jt} represents the GDP of country j in year t, and D_{ij} represents the distance between country i and country j.

Subsequent enhancements to the model have incorporated additional variables to improve explanatory power. Bergstrand (1985) introduced factors such as national income levels and exchange rates, while Hamilton (1992) added per capita GDP, common language, and trade agreements. More recent refinements—such as those proposed by Zhang (2020)—have included trade facilitation measures and trade dependence indices, reflecting the growing complexity of global trade dynamics.

The gravity model now serves as a robust empirical tool for evaluating trade competitiveness, estimating trade volumes, and identifying determinants of international trade flows. In this study, an extended version of the model is developed to reflect the digital trade environment. Specifically, it integrates CBEC development level, common borders, and shared language as explanatory variables alongside conventional economic and geographic indicators. The revised functional form is specified in Equation (3):

$$\begin{aligned} lnTre_{jt} = \alpha + \beta_1 lnTre_{jt-1} + \beta_2 \ln CBEC_{it} + \beta_3 \ln CBEC_{jt} \\ + \beta_4 lnPGDP_{it} + \beta_5 lnPGDP_{jt} + \beta_6 lnDistoil_{ijt} + \varepsilon_j \end{aligned} \tag{3}$$

Where i represents China, j represents RCEP partner countries, and t denotes time. "ln" indicates logarithm in the equation for all variables to standardize the dataset. Further, $\mathrm{Tre}, \mathrm{CBEC}, \mathrm{PGDP}, \mathrm{Distoil}$ and ε_j represent cross-border e-commerce trade, cross border e-commerce development level, per capital gross domestic product, trade distance and the error term, respectively.

Since bilateral CBEC trade data between China and RCEP members is not directly observable, this study follows the estimation methodology employed by iResearch. CBEC trade volume with each partner is inferred by proportionally allocating China's total CBEC trade according to its conventional trade structure. The estimation formula is shown in Equation (4):

$$Tre_{jt} = \frac{Ex_{jt} * Exe_{it}}{Ex_{it}} + \frac{Im_{jt} * Ime_{it}}{Im_{it}} \tag{4}$$

Where Exe_{jt}, Ime_{jt} and Tre_{jt} respectively represent China's cross-border e-commerce export, import and total trade volume with RCEP partner countries. Ex_{jt}, Im_{jt} and denote China's export and import volume with RCEP partner countries. Ex_{it} and Im_{it} represent China's total export and import volume. Exe_{it} and Ime_{it} indicate China's total cross-border e-commerce export and import transaction scale.

To explore the dynamics of CBEC trade flows and address potential endogeneity issues, this study applies dynamic panel modeling techniques using the Generalized Method of Moments (GMM). This estimation strategy strengthens the model's robustness by accounting for unobserved heterogeneity, simultaneity, and reverse causality, which are common in trade-related panel datasets.

Calculation of Trade Potential Value of CBEC

In order to quantify CBEC trade potential, the study compares estimated trade volumes from the extended gravity model with actual CBEC trade flows. The ratio between observed and predicted values provides a measure of trade realization, calculated as:

$$Trade\ Potential\ Value = \frac{actual\ trade\ volume}{theoretical\ trade\ volume} \quad (5)$$

A classification benchmark is adopted based on Nilsson (2000) and Egger (2002): values greater than 1.2 indicate “trade saturation” or excess realization, values between 0.8 and 1.2 reflect “normal potential,” and ratios below 0.8 reveal “significant untapped potential.” This classification assists in identifying bilateral trade relationships where substantial growth opportunities remain unrealized.

Results and Discussion

Measurement of CBEC Development Level

To validate the suitability of the selected variables for Principal Component Analysis (PCA), both the Kaiser-Meyer-Olkin (KMO) measure and Bartlett’s test of sphericity were conducted. As shown in Table 2, the KMO statistic reaches 0.858, significantly exceeding the commonly accepted threshold of 0.7, thereby indicating strong sampling adequacy. Additionally, Bartlett’s test returns a highly significant result ($\chi^2 = 3887.212$, df = 120, $p < 0.001$), confirming the existence of sufficient correlations among variables for PCA application.

Table 1
KMO and Bartlett’s Test Summary

Measure	Value
Bartlett's Test of Sphericity χ^2	3887.212
Degrees of Freedom (df)	120
p-value	< .001
Kaiser-Meyer-Olkin (KMO)	0.858

Data source: Obtained through STATA18 software calculation

The PCA results, presented in Table 3, show that the first two principal components have eigenvalues exceeding the threshold value of 1, confirming their statistical significance. Together, these two components explain 82.08% of the total variance in the CBEC development dataset, suggesting a high level of explanatory adequacy.

Table 2
Total Variance Explanation

Component	Eigenvalue	Proportion	Cumulative
Comp1	10.0054	0.6253	0.6253
Comp2	3.1281	0.1955	0.8208
Comp3	0.8422	0.0526	0.8735

Source: Obtained through STATA18 software calculation

The component loadings for the first two principal components (Comp1 and Comp2) were derived by standardizing the respective component scores with the square root of their eigenvalues. These loadings define the relative contribution of each indicator to the composite dimensions. The corresponding equations are presented as:

$$Comp1=0.0396*LS1+0.041*LS2+0.03*KS1+0.0799*KS2+0.0947*LP1+0.0955*LP2+0.0819*LP3+0.0916*LP4+0.0916*LP5+0.0958*LP6+0.0922*IF1+0.0838*IF2+0.0809*IF3+0.0871*IF4+0.0565*CF1+0.0759*CF2 \quad (6)$$

$$Comp2=0.2881*LS1+0.2851*LS2+0.2953*KS1-0.0854*KS2-0.0129*LP1-0.0158*LP2+0.0327*LP3-0.0548*LP4-0.036*LP5-0.0037*LP6-0.005*IF1+0.0307*IF2+0.1002*IF3-0.1154*IF4-0.099*CF1-0.1447*CF2 \quad (7)$$

These two principal components reflect the underlying structure of CBEC development among the 12 RCEP partner countries. To generate a unified index, a weighted aggregation of these components is performed, and the final normalized scoring function is expressed as:

$$CBEC=0.0953*LS1+0.0956*LS2+0.0898*KS1+0.0391*KS2+0.0666*LP1+0.0665*LP2+0.0676*LP3+0.0547*LP4+0.059*LP5+0.0695*LP6+0.0666*IF1+0.0686*IF2+0.0824*IF3+0.0375*IF4+0.0188*CF1+0.0225*CF2 \quad (8)$$

From this equation, the aggregate weights of the broader indicator categories were derived by summing the normalized weights of their corresponding sub-indicators. The resulting contributions are as follows: trade volume (LS) accounts for 19.09%, key actors such as manufacturers and consumers (KS) contribute 12.89%, logistics performance (LP) comprises 38.39%, information flow (IF) makes up 25.51%, and capital flow (CF) accounts for 4.13%.
By substituting the original indicator values into the composite index equation, the CBEC development scores for each RCEP member country were calculated. These scores serve as the basis for the final classification and comparative ranking of CBEC development levels among the selected countries, as presented in Tables 4 and 5.

Table 3
Development Level of CBEC in RCEP Countries

Country	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
AUS	0.4561	0.4459	0.4472	0.4474	0.439	0.4339	0.4432	0.4576	0.4925	0.3273
CHN	0.8344	0.8291	0.8668	0.9414	1.053	1.2216	1.2653	1.3424	1.6864	1.4985
IDN	-0.4344	-0.6938	-0.7233	-0.7383	-0.5994	-0.4063	-0.4225	-0.4204	-0.3819	-0.3308
JPN	0.3604	0.7573	0.7696	0.8163	0.8625	0.9465	0.9303	0.9069	0.9162	0.7545
KOR	0.4317	0.3572	0.4283	0.4707	0.4376	0.4392	0.4589	0.5165	0.609	0.1651
LAO	-1.2998	-1.8714	-1.9697	-2.0771	-1.7422	-1.4872	-1.5132	-1.5473	-1.5823	-1.3698
MYS	-0.5292	0.0005	-0.0393	-0.0806	-0.1451	-0.2	-0.1051	0.0114	0.1421	0.2113

NZL	0.0809	0.0867	-0.0159	-0.1173	0.1087	0.3356	0.2787	0.2309	0.2069	-0.138
PHL	-0.6651	-0.8624	-0.8726	-0.9083	-0.8355	-0.7436	-0.6562	-0.5342	-0.4448	-0.2363
SGP	0.2992	0.6095	0.6815	0.7797	0.7666	0.7306	0.7977	0.9026	1.0333	0.8118
THA	-0.0518	-0.3813	-0.4157	-0.4313	-0.3038	-0.1857	-0.1287	-0.0781	-0.0282	-0.1873
VNM	-0.6598	-0.766	-0.8174	-0.8363	-0.6855	-0.4222	-0.375	-0.3211	-0.2837	-0.2708

Note: A negative sign indicates below the average level.

Table 4
Ranking of CBEC Development Level in RCEP Countries

Country	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
AUS	2	4	4	5	4	5	5	5	5	4
CHN	1	1	1	1	1	1	1	1	1	1
IDN	8	9	9	9	9	9	10	10	10	11
JPN	4	2	2	2	2	2	2	2	3	3
KOR	3	5	5	4	5	4	4	4	4	6
LAO	12	12	12	12	12	12	12	12	12	12
MYS	9	7	7	6	7	8	7	7	7	5
NZL	6	6	6	7	6	6	6	6	6	7
PHL	11	11	11	11	11	11	11	11	11	9
SGP	5	3	3	3	3	3	3	3	2	2
THA	7	8	8	8	8	7	8	8	8	8
VNM	10	10	10	10	10	10	9	9	9	10

Figure 1 highlights the notable disparities in cross-border e-commerce (CBEC) development among RCEP member states. China consistently secures the top position throughout the observed period, reflecting its dominant role and substantial capacity in CBEC. Trailing behind, Singapore and Japan occupy the second tier, while South Korea and Australia form a moderately developed group. Countries such as New Zealand, Malaysia, Thailand, the Philippines, Indonesia, and Vietnam generally remain below the average development level, with New Zealand marginally exceeding the mean. Laos consistently ranks at the bottom, indicating persistent underdevelopment in its digital trade ecosystem. These results point to significant structural differences across RCEP countries, likely stemming from unequal levels of economic advancement, digital infrastructure, and logistics capabilities.

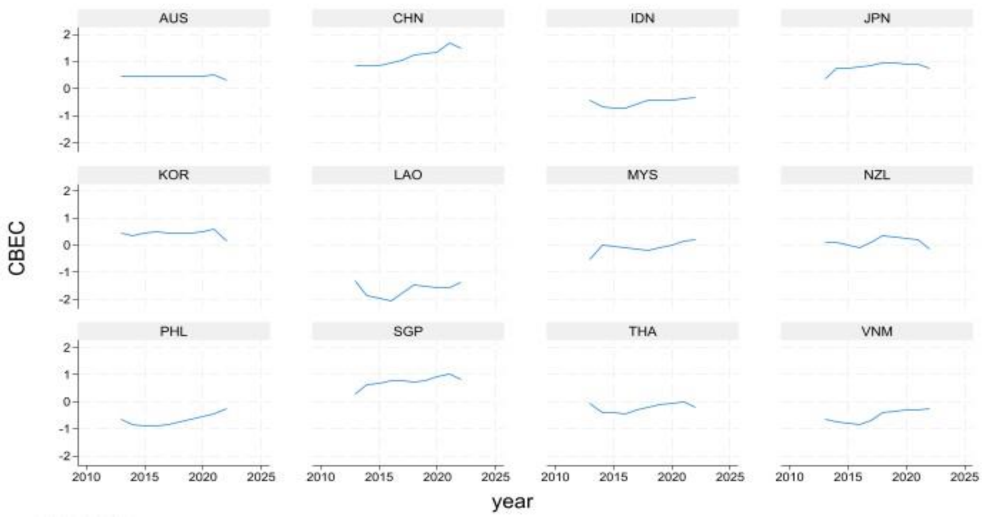

Figure 1: Trends in CBEC Development Levels in RCEP Countries

The temporal analysis in **Figure 1** further reveals that CBEC development across the RCEP bloc followed an upward trajectory from 2013 to 2022. China maintained a clear lead, showing strong year-on-year growth, driven by its well-established logistics and digital infrastructure. Singapore, as one of the region's most developed economies, sustained a stable and high-level performance. Although growth was slower in Japan, South Korea, and Australia, their CBEC development levels remained robust. In contrast, several lower-performing economies—namely Malaysia, the Philippines, Indonesia, Vietnam, and Laos—demonstrated varying degrees of improvement over the decade. Despite a slight decline in 2022 for some countries, the overall trend suggests rising engagement in cross-border e-commerce, indicating considerable room for future expansion among late movers.

Empirical Analysis

Table 6 presents the results of the two-step System GMM estimation for total cross-border e-commerce (CBEC) trade potential between China and its RCEP partner countries. The model includes lagged dependent variables and key explanatory factors such as CBEC development levels, per capita GDP, and trade-adjusted distance.

Table 6

Two-Step System GMM Estimation Results for CBEC Total Trade Potential

Variable	Coefficient	Std. Error	T-value	P-value	95% Confidence Interval
$lnTre_{ij}$ (Lagged)	1.1264***	0.2276	4.95	0.001	[0.6193, 1.6335]
$lnCBEC_i$	-1.7571**	0.7037	-2.50	0.032	[-3.3250, -0.1891]
$lnCBEC_j$	0.2040***	0.0364	5.60	0.000	[0.1228, 0.2851]
$lnPGDP_j$	-0.1810	0.1467	-1.23	0.246	[-0.5079, 0.1459]
$lnPGDP_i$	1.4562***	0.4492	3.24	0.009	[0.4554, 2.4570]
lnDistoil	-0.1729*	0.0888	-1.95	0.080	[-0.3707, 0.0250]
Constant	-11.8955*	5.9150	-2.01	0.072	[-25.0750, 1.2839]
AR(1) p-value	0.090				
AR(2) p-value	0.343				
Hansen J-test p-value	0.482				
Sargan test p-value	0.293				

Note: * $p<0.05$, ** $p<0.01$, *** $p<0.001$

The positive and significant coefficient of the lagged trade volume ($lnTre_{ij}$) suggests strong trade inertia—previous trade flows are highly predictive of current volumes. China's per capita GDP ($lnPGDP_i$) also exhibits a substantial positive effect, underscoring the role of domestic economic strength in driving total CBEC trade.

Interestingly, the development level of China's own CBEC ecosystem ($lnCBEC_i$) is negatively associated with total trade volume, significant at the 5% level. This may indicate a substitution effect, where improvements in domestic digital commerce capabilities reduce dependency on international CBEC. In contrast, CBEC development in partner countries ($lnCBEC_j$) is positively correlated with total trade, suggesting that external digital readiness enhances bilateral e-commerce flows.

The partner country's per capita GDP ($lnPGDP_j$) has an insignificant and slightly negative coefficient, implying that wealthier economies do not necessarily engage in higher CBEC volumes with China. Distance, adjusted by oil prices (lnDistoil), shows a weak but significant negative effect, aligning with the traditional gravity model prediction that greater transport costs reduce trade intensity.

Diagnostic tests confirm the validity of the model. The Hansen J and Sargan tests support the appropriateness of the instruments used, and the AR(2) p-value confirms no second-order autocorrelation.
Using the coefficient estimates, the following predictive equation is derived for total CBEC trade potential:

$$lnTre_{jt} = -11.89533 + 1.1264lnTre_{jt-1} - 1.7571\,ln\,CBEC_{it} + 0.204\,ln\,CBEC_{jt} + 1.4562lnPGDP_{it} - 0.181lnPGDP_{jt} - 0.173lnDistoil_{ijt} \quad (9)$$

Based on this model, theoretical trade volumes were estimated for all China–RCEP country pairs and compared against actual observed values to derive trade potential indices.

Table 7
Total Trade Potential Values between China and RCEP Partners

Country	2015-2016	2017-2018	2019-2020	2021-2022	Average
AUS	1.1341	1.3006	1.2711	1.2127	1.2296
IDN	0.8152	1.0304	0.9417	1.1724	0.9899
JPN	0.6774	0.735	0.6793	0.6739	0.6914
KOR	0.7131	0.6864	0.6375	0.7161	0.6883
LAO	1.5453	1.7603	1.5119	1.4244	1.5605
MYS	0.8714	0.9632	1.1222	1.1193	1.019
NZL	1.7005	1.7492	1.654	1.7388	1.7106
PHL	1.1153	0.8902	0.8786	0.8848	0.9422
SGP	1.1367	1.0444	1.2015	1.0824	1.1163
THA	1.1325	0.9668	0.9724	0.9623	1.0085
VNM	0.8537	0.7937	0.8587	0.7374	0.8109

Note: Values closer to or exceeding 1.0 imply higher trade realization and lower untapped potential.

These results reveal substantial heterogeneity in trade potential across countries. New Zealand (1.71), Laos (1.56), and Australia (1.23) display the highest trade realization ratios, suggesting limited scope for future expansion. Conversely, Japan (0.69), South Korea (0.69), and Vietnam (0.81) exhibit significant unrealized trade potential. These countries may benefit from targeted policy interventions aimed at enhancing bilateral CBEC integration.

Table 8
China's CBEC Trade Potential Value with RCEP Partners

Country Name	Total Trade	Classification
AUS	1.2296	Reconstructive Potential
IDN	0.9899	Under Trade
JPN	0.6914	Significant Potential
KOR	0.6883	Significant Potential
LAO	1.5605	Reconstructive Potential
MYS	1.019	Sufficient Trade
NZL	1.7106	Reconstructive Potential
PHL	0.9422	Under Trade
SGP	1.1163	Sufficient Trade
THA	1.0085	Sufficient Trade
VNM	0.8109	Under Trade

Following the widely used benchmark method (Nilsson, 2000; Egger, 2002), trade potential values are categorized as follows:

Significant Potential (TP < 0.8): Substantial room for trade expansion
Under Trade (0.8 ≤ TP ≤ 1.2): Trade is developing but not saturated
Reconstructive Potential (TP > 1.2): Trade exceeds expectations; limited further growth

These classifications offer strategic guidance for policymakers. For countries with "significant potential" (e.g., Japan, South Korea), enhanced infrastructure connectivity and policy alignment may help realize untapped trade capacity. Conversely, "reconstructive" partners may require diversification strategies to maintain balanced growth.

Findings and Discussion

CBEC Development Index of RCEP

From a cross-border e-commerce ecosystem perspective, the empirical results highlight the dominant role of supporting elements in shaping CBEC development. The aggregated weights for Leading Species (19.08%), Key Species (12.84%), and Supporting Species (68.08%) reveal that logistical infrastructure, digital networks, and policy environments contribute overwhelmingly to CBEC capacity—consistent with the findings of Li (2018). Among primary indicators, logistics performance (37.41%) and information flow (26.58%) account for the largest shares, followed by goods trade volume (19.08%), producer–consumer participation (12.84%), and capital flow (4.08%). These results reinforce Zhang's (2021) conceptualization of CBEC as a composite system where digital infrastructure and logistics serve as fundamental enablers. The relatively low weight assigned to capital flow suggests that liquidity and financial availability, while important in macroeconomic contexts, may have limited direct influence on e-commerce trade facilitation—diverging from broader economic theories that often emphasize capital as a central growth factor.

At the secondary level, high-weight indicators such as import/export volumes and manufacturing value-added support He and Wang's (2019) proposition that GDP-linked metrics significantly influence CBEC trade levels. Conversely, cash flow variables exhibit marginal effects, possibly due to the limited granularity of capital usage in digital trade. On a national scale, China's leading CBEC position stems from continuous investment in digital logistics and smart customs, affirming the robustness of the constructed index. Singapore's strong performance is attributed to its liberal policy regime, financial maturity, and globalized industrial base. The observed upward trends in CBEC development across RCEP economies, despite varying speeds, demonstrate progressive integration into the digital trade environment. Discrepancies such as the contrasting results for Australia and South Korea—compared to Shen (2023)—likely arise from differences in sample composition (G20 vs. RCEP), warranting further region-specific investigations. Laos remains at the bottom of the ranking, echoing Song's (2021) assessment of underdeveloped e-commerce infrastructure in several ASEAN nations, where poor connectivity and limited logistics remain key constraints.

CBEC Trade Potential between China and RCEP partners

The empirical findings based on GMM estimation shed light on the differential roles of national digital trade conditions in influencing bilateral CBEC flows. Contrary to expectations, China's CBEC development level exerts a negative influence on total trade volume. This result suggests a potential crowding-out effect where enhanced domestic e-commerce infrastructure may substitute rather than complement foreign trade, aligning with the notion that rapid platform maturity can shift trade inward. In contrast, the development level of partner countries exhibits a strong positive impact on total CBEC trade, particularly in economies with robust digital payment ecosystems and high internet penetration. Evidence from ASEAN economies indicates that improvements in electronic payments and rising incomes significantly facilitate China's exports to these regions. This reinforces the broader policy narrative under the Belt and Road Initiative, which promotes trade liberalization through infrastructure, customs modernization, and digital alignment.

Interestingly, partner countries' per capita GDP does not significantly influence trade volume, suggesting that wealth alone does not drive CBEC performance. Instead, trade growth appears more sensitive to digital readiness and institutional efficiency. Conversely, China's per capita GDP shows a robust positive relationship, reflecting the capacity of wealthier economies to engage in cross-border consumption and reduce trade transaction costs. The distance variable, adjusted by oil prices, reveals a negative impact on total CBEC trade at a 10% significance level. While this effect is not significant when analyzing imports and exports separately, the aggregated impact confirms the deterrent role of physical distance—particularly where logistics systems are underdeveloped. Even with improved delivery speeds, higher freight and customs-related costs continue to suppress transaction volumes.
Furthermore, the study identifies substantial untapped CBEC potential between China and technologically advanced economies such as Japan and South Korea. Traditional trade frameworks remain dominant, suggesting that the full potential of digital trade integration has not yet been realized. Initiatives such as the Electronic World Trade Platform (eWTP) could help activate new trade flows by improving logistics coordination and enhancing consumer trust. For countries like Australia, New Zealand, and Laos—categorized under "reconstructive potential"—the findings highlight missed opportunities. In Australia, many SMEs remain disconnected from CBEC channels despite strong product-market fit. New Zealand shows promise in agricultural and manufacturing sectors, but challenges in cross-border logistics and infrastructure persist. Laos, although currently underdeveloped, may

benefit significantly from Belt and Road infrastructure investments, which could improve trade facilitation and open new digital trade corridors.

Conclusion and Enlightenment

Conclusions

This study offers a comprehensive evaluation of the cross-border e-commerce (CBEC) development landscape and trade potential between China and its RCEP partners, yielding several important conclusions.

First, from an ecosystem perspective, the development of CBEC is primarily driven by supporting components—particularly logistics performance and information flow. China's leadership position is attributed to its advanced logistics networks and digital infrastructure, whereas countries such as Laos remain constrained by underdeveloped infrastructure and economic limitations.

Second, the empirical results indicate that China's own CBEC development level has limited influence on expanding total trade volumes, possibly due to a domestic substitution effect. In contrast, improvements in the CBEC capacities of partner countries significantly enhance their bilateral trade with China. While the per capita GDP of RCEP partners does not show a statistically significant impact, China’s per capita GDP positively affects total CBEC trade. Additionally, distance-adjusted trade costs exhibit a modest but significant negative impact, reflecting the role of logistics frictions in constraining trade flows. The presence of untapped CBEC trade potential—particularly with countries such as South Korea and Japan—points to substantial opportunities for future trade expansion through targeted facilitation measures.
In summary, the findings emphasize the importance of strengthening logistics systems, enhancing digital connectivity, and reducing structural trade frictions to unlock greater CBEC trade potential within the RCEP region. Policies focused on eliminating technical barriers, expanding digital infrastructure, and deepening regional economic integration will be essential to fully capitalize on these opportunities.

Practical Implication

Drawing on the empirical evidence, this study proposes a set of targeted policy recommendations to foster CBEC development and maximize trade potential among China and its RCEP partners.

First, improving the logistics environment and digital connectivity should be prioritized. Governments are encouraged to invest in cross-border logistics infrastructure, upgrade customs clearance efficiency, and implement digital solutions that support real-time data exchange and transparency across supply chains.

Second, to leverage China’s economic strength, national policies should support initiatives that promote income growth and productivity—particularly through the development of domestic consumption and the empowerment of small and medium-sized enterprises (SMEs). Enhancing these factors will create a more resilient and inclusive CBEC ecosystem.

Third, addressing trade frictions caused by geographic and logistical distances is essential. Regional collaboration should focus on reducing transport costs through strategic investments in multimodal transportation, cross-border e-commerce hubs, and smart port technologies. The establishment of free trade zones and special economic zones can further incentivize participation by lowering transaction costs and offering regulatory support. Collectively, these strategies offer practical pathways for transforming CBEC into a powerful engine for sustainable trade and digital integration within the Asia-Pacific region.

Acknowledgements
This work was financially sustained by the University Humanities and Social Sciences Research Project of Anhui Province of China (Project No. 2023AH052667) , the Training Program for Outstanding Young Teachers in Anhui Province of China (Project No. gxyqZD2022134) and the Education and Teaching Research Program of Anhui Society for Vocational and Adult Education (Project No. AZCJ2023003).

References
Armstrong, S. P. (2007). Measuring trade and trade potential: A survey. Crawford School Asia Pacific Economic Paper, 2007(368).

Bergstrand, J. H. (1985). The Gravity Equation in International Trade: Some Microeconomic Foundations and Empirical Evidence. The Review of Economics and Statistics, 1985. 67(3): p. 474-481.

Chen, N. (2022). Analysis of the Correlation between Cross-Border E-Commerce and Economic Growth Based on Hierarchical Multilevel Gray Evaluation Model. Journal of Mathematics, 2022. 2022.

Chen, T. T. (2020). An Empirical Study on China's Assessment of the Cross-Border E-commerce Development Potential in ASEAN Countries under the Background of the Belt and Road Initiative: Based on a Two-Stage Trade Gravity Model. Journal of Commercial Economics, 2020(22): p. 80-83.

Derindağ, Ö. F. (2022). Rise of Cross-Border E-Commerce: A Systematic Literature Review. Journal of Applied And Theoretical Social Sciences, 2022. 4(3): p. 352-372.

Egger, P. (2002). An Econometric View on the Estimation of Gravity Models and the Calculation of Trade Potentials. The World Economy, 2002. 25(2): p. 297-312.

Gomez-Herrera, E., Martens, B., & Turlea, G. (2014). The drivers and impediments for cross-border e-commerce in the EU. *Information Economics and Policy, 28*, 83–96.

Hamilton, C. (1992). Opening up international trade in Eastern Europe (L. A. Winters, Ed.). Stockholm: Institute for International Economic Studies.

Han, J., & Lee, T. (2022). The influence factors of China’s cross-border e-commerce export trade using gravity model. *Journal of Korea Trade, 26*(5), 56–75.

He, Y., & Wang, J. (2019). A panel analysis on the cross-border e-commerce trade: Evidence from ASEAN countries. *The Journal of Asian Finance, Economics and Business, 6*, 95–104.

Hu, G. L., Lu, X. H., & Huang, L. H. (2009). An essay on e-business ecosystem and its evolutionary path: With focus on the phenomenon of e-business industrial cluster in China. *Economic Management Journal, 31*(6), 110–116.

Huang, J. (2019). *Research on the evaluation of cross-border e-commerce development in Guangdong Province based on ecosystem theory* (Master’s thesis). South China University of Technology.

Jin, S., & Wang, X. (2022). Impact of cross-border e-commerce on China's aquatic product export. In *Proceedings of the 2022 13th International Conference on E-business,* *Management and Economics* (pp. 67–71). Beijing, China: Association for Computing Machinery.

Kong, Q. F., & Dong, H. W. (2015). Trade facilitation and trade potential of countries along "One Belt One Road" route. *Journal of International Trade, (12)*, 158–168.

Li, J. B., Chen, M. D., & Qin, C. L. (2020). Research on the evaluation of the development level of China's cross-border e-commerce: Analysis based on fuzzy analytic network process. *Price: Theory & Practice, (11)*, 157–160.

Li, X. G., & Wang, Q. F. (2018). Research on symbiotic coupling mode and mechanism of cross-border e-commerce logistics industry chain based on public overseas warehouse. *China Business and Market, 32*(9), 41–48.

Liu, H. H. (2021). Construction and development strategy of cross-border e-commerce ecosystem in era of digital economy. In *Proceedings of the 2021 7th International Conference on Education and Training Technologies* (pp. 60–65). Macau, China: Association for Computing Machinery.

Liu, Z. J. (2006). Research on enterprise ecological networks based on industrial clusters. *Research on Economics and Management, (1)*, 61–64.

Moore, J. F. (1999). *The decline of competition: Leadership and strategy in the business ecosystem era*. Beijing: Beijing Publishing House.

Nazir, M. A., & Azam, R. M. (2020). Barriers to adopting electronic commerce for small and medium-sized enterprises in emerging economies. *Emerging Markets Journal, 10*(2), 43–55.

Nilsson, L. (2000). Trade integration and the EU economic membership criteria. *European Journal of Political Economy, 16*(4), 807–827.

OECD. (2007). *OECD science, technology and industry scoreboard 2007*.

Poyhonen, P. (1963). A tentative model for the volume of trade between countries. *Weltwirtschaftliches Archiv, 90*, 93–100.

Shen, H. H., & Chen, J. (2020). Empirical research of business development potentiality of cross-border e-commerce between China and the Belt & Road countries. *Finance, 6*(3), 1.

Shen, J. S. (2023). *Research on the development potential of cross-border e-commerce between China and G20 member states* (Master's thesis). Hebei University of Economics and Business.

Shu, T. (2018). *Research on Sino-US trade efficiency and potential based on stochastic frontier gravity model* (Master's thesis). Shandong University.

Song, H. X. (2021). *Research on the development potential of cross-border e-commerce in China-ASEAN* (Master's thesis). Hebei University of Economics and Business.

Tansley, A. G. (1935). The use and abuse of vegetational concepts and terms. *Ecology, 16*(3), 284–307.

Tinbergen, J. (1962). *Shaping the world economy: An analysis of world trade flows*. New York: Twentieth Century Fund.

Wang, G., & Cao, Z. (2021). An empirical study on the trade impact of cross-border e-commerce on ASEAN and China under the framework of RECP. *E3S Web of Conferences*.

Wang, M. (2020). Impact of the electronic payment environment of the importing country on China's export trade: Based on panel data of the five ASEAN countries. In *5th International Conference on Economics, Management, Law and Education (EMLE 2019)*. Atlantis Press.

Wang, Z., Chen, Y. M., & Zhang, M. (2021). Measuring the development of the global digital economy: Stylized facts based on TIMG Index. *Chinese Review of Financial Studies, 13*(6), 40–56, 118–119.

Yang, J. Z., & Yu, L. (2014). Analysis on the cross-border e-commerce application of China's foreign trade enterprises. *Contemporary Economic Management, 36*(6), 58–63.

Yang, J. Z., Zheng, B. X., & Yang, L. F. (2014). Research on cross-border e-commerce index system based on factor analysis. *Finance & Trade Economics, (9)*, 94–102.

Zhang, B., Liu, X. J., & Tao, Z. (2015). The study of current situation and operation pattern of the cross-border e-commerce logistics in China. *China Business and Market, 29*(1), 51–56.

Zhang, J. L., Zhang, Y. Z., & Zhang, X. Q. (2016). The current situation and potential evaluation of Sino-German bilateral trade based on gravity model. *World Regional Studies, 25*(6), 18–27.

Zhang, P. F., & Tang, Y. Y. (2020). The impact of digital service level on international bilateral trade along the Belt and Road: An empirical study based on Asian countries. *Journal of Shanghai University of International Business and Economics, 27*(3), 38–46.

Zhang, W. N., Lu, X. J., & Li, M. H. (2019). A study of factors that affect the development of China cross-border electronic commerce. *Humanities & Social Sciences Journal of Hainan University, 37*(3), 57–63.

Zhang, X. (2020). *Effect of Silk Road Economic Belt countries' trade facilitation on Chinese mechanical and electronic export* (Master's thesis). Shandong University.

Zhang, X. H., & Li, D. D. (2020). Research on the coupling development of the digital economy, cross-border e-commerce and digital trade: Application prospect of blockchain technology among them. *Theoretical Investigation, (1)*, 115–121.

Zhang, X. H., & Ma, T. S. (2015). Difficulties and countermeasures about China's cross-border e-commerce logistics. *Contemporary Economic Management, 37*(5), 51–54.

Zhang, X. H. (2021). Construction mechanism and implementation path of cross-border e-commerce ecosystem. *Contemporary Economic Management, 43*(7), 55–60.

Zhang, Y. F., & Wang, C. (2019). Study on cross-border e-commerce export trade potential and its influencing factors: An empirical test based on extended trade gravity model. *West Forum, 29*(5), 85–92.

Zheng, C. F., & Zhang, Y. Q. (2021). Research on influencing factors and potential of China's cross-border e-commerce export. *Journal of Graduate School of Chinese Academy of Social Sciences, (4)*, 63–72.