An Empirical Analysis of the Level of Cross-border E-commerce Development on China's Export Trade: 11 Countries in Southeast Asia as an Example

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Abstract*:* The flourishing development of cross-border e-commerce has brought an opportunity to expand and improve the quality of China's export trade. This article uses principal component analysis by collecting panel data of 11 Southeast Asian countries from 2010 to 2019 tomethod to measure and assess the level of cross-border e-commerce development of the 11 countries. The paper then uses the trade gravity model. The paper then constructs a model based on theoretical assumptions to empirically analyse the impact of their cross-border e-commerce levels on China's export trade. The study found that the level of cross-border e-commerce in Southeast Asia has a positive effect on China's exports, and that the level of cross-border e-commerce development is uneven across Southeast Asia. The empirical analysis provides a factual basis for China's export trade in the post-epidemic period, and China should improve the level of cross-border e-commerce development so as to promote the transformation and upgrading of export trade.

Keywords*:* cross-border e-commerce; export trade; trade gravity model; principal component analysis

1. Background and Significance of the Study

At present, the scale of China's cross-border e-commerce has ranked first in the world, at the same time, in recent years, the country actively promote "silk road e-commerce" international cooperation, China has with the "one belt and one road" along a number of countries to establish a bilateral e-commerce cooperation mechanism.

In response to the policy, the emergence of cross-border e-commerce for agricultural products is the inevitable requirement for China's agriculture to "go out" and "come in" under the "One Belt, One Road" construction strategy. During the epidemic period, the export situation was worrying and embarrassing due to customs clearance and policies, so the cross-border e-commerce platform can be used to improve the export situation and make up for the shortcomings, which has strong practical significance. Therefore, in line with the development trend of cross-border e-commerce, responding to the call of the national top-level strategy, actively using the new mode of cross-border e-commerce to carry out trade with Southeast Asian countries can promote the development of China's export trade and cultivate new trade development momentum. An analysis of the relationship between the level of cross-border e-commerce development in Southeast Asian countries and China's export trade can provide a corresponding policy basis for promoting China's export trade.

2. Review of the Literature

Regarding the research on cross-border e-commerce, Ren Zhixin, Li Wanxiang [1] discussed the strategy of cross-border e-commerce to boost the transformation and upgrading of foreign trade and affirmed the importance of cross-border e-commerce earlier. After that, E Libin, Huang Yongsheng, Lai Youwei, Wang Kaician and Cai Jing analyzed the opportunities and challenges faced by cross-border e-commerce in China and put forward policy recommendations for the development of cross-border e-commerce from the main aspects such as customs clearance, payment, government and enterprises, regulatory system, laws and regulations [2-4]. The rapid development of cross-border e-commerce has been followed by richer research results on cross-border e-commerce, mainly focusing on the domestic and international logistics and distribution system of cross-border e-commerce [5-9]; government regulation [10-11]; and government policies in the context of "One Belt, One Road" [12-13]. Research on the impact of cross-border e-commerce on international trade. Scholars at home and abroad have conducted a lot of research on the trade effects of cross-border e-commerce, but at present, scholars have not reached a consistent conclusion. The current mainstream view is that cross-border e-commerce can promote the growth of trade. Ma Shuzhong, Ju Xuenan, Yang Min and Lai Youwei all believe that cross-border e-commerce has a positive effect on international trade [14].

Caroline & Freund [15] argue that the development of the Internet has made it possible for both sides of a transaction to be concluded at a very low cost, and that the Internet, as a new type of trade intermediary, has reduced the number of intermediaries, thus saving the costs associated with intermediaries and increasing the possibilities for companies to export abroad. The development of cross-border e-commerce has therefore facilitated trade, created new trade intermediaries and reduced transaction costs by reducing the number of intermediaries. This paper builds the basis of a cross-border e-commerce level measurement system by referring to Santiago & Pradas and Yang Jianqiang, Zheng Bixia and Yang Li Van [16,17]. And combine the cross-border e-commerce development process to construct a new measurement system and conduct factor analysis, before using stata16 to conduct an empirical analysis on the level of cross-border e-commerce development and China's export trade.

3. Measuring the Level of Cross-Border E-Commerce Development in 11 Southeast Asian Countries

3.1. Selection of Indicators

Santiago & Pradas [16] established a five-level assessment index system from the cross-border e-commerce transaction process, covering online marketing capability, electronic payment, customs efficiency, logistics efficiency and legal basis. Based on factor analysis, Yang Jianqiang, Zheng Bixia and Yang Lihua [17] also build a five-level evaluation index system from two major directions, including online marketing, international electronic payment, electronic customs clearance, international e-commerce logistics and e-commerce law. In this paper, based on the above-mentioned scholars, and combined with the development process of cross-border e-commerce, the level of Internet communication technology represents the development level of e-commerce to a certain extent, and customs clearance and delivery will also reduce transaction costs to a certain extent, thus promoting its development. Therefore, this set of evaluation index system containing three primary indicators and nine secondary indicators is constructed, as shown in the following Table 1.

Table 1. Construction of an indicator system for the level of cross-border e-commerce development

Tier 1 indicators	Serial number	Secondary indicators	Data sources
Level of Internet development	1	Secure Internet servers (per million people)	EPS data platform database
	2	Number of telephone lines per 100 people (number)	
Ease of clearance	3	Quality of port infrastructure, WEF (1=very underdeveloped to 7=very developed and efficient according to international standards)	
	4	Burden of customs procedures, World Economic Forum (WEF) (1=very inefficient, 7=extremely efficient)	
Logistics efficiency	5	Ability to track enquiry shipments (1=low, 5=high)	Guotaian CSMAR Database
	6	Ease of arranging competitively priced freight (1=low, 5=high)	
	7	Liner Shipping Related Index (maximum value in 2004 = 100)	
	8	Efficiency of the customs clearance process (1=low, 5=high)	
	9	Combined score (1=low, 5=high)	

3.2. Principal Component Analysis

Principal component analysis aims at transforming multiple indicators into a few composite indicators using the idea of dimensionality reduction. This method is good at extracting most of the useful information from the many indicators, simplifying them and thus determining the weight of each indicator. This paper uses SPSS. 26 to do the data processing and analysis.

3.2.1. Data processing

Due to the need to collect data for 11 countries in Southeast Asia for the decade 2010-2019, it is difficult to collect data on the one hand, and on the other hand, the data published on official platforms are not complete. So there are inevitably missing data, and this paper uses the ordinal mean method to interpolate the missing values.

Secondly, due to the disparity in the development of 11 countries in Southeast Asia in terms of the level of internet communication technology, customs clearance efficiency and logistics efficiency, there are large fluctuations between the data, in order for the data to all be converted into a standard measurement value without a scale. In order to solve the problem that the different magnitudes cannot be compared, we should standardise the raw data and eliminate the magnitudes to make them comparable. In this paper, we use the 'Z-score standardisation' method:

With n samples and p indicators, the data matrix $X=(Xij)n\times p$ is obtained, where i=1, 2, ... , n, j=1, 2, ... , n, j=1, 2, ... , p, and the data are normalised using the Z-score method Z=(xij-xj)/Sj, where xj is the mean of the jth indicator and Sj is the standard deviation of the jth indicator. This standardisation method is good at eliminating the influence of dimensionality, greatly reducing the volatility of the data and making the indicators more comparable with each other.

3.2.2. KMO and Bartlett's Test

Before proceeding with the factor analysis, it was necessary to perform a KMO test on the data to determine if the data was suitable for factor analysis. The results are shown in the Table 2 with a statistical KMO value of 0.871, which is close to 0.9, indicating that the index data is ideal and suitable for the next step of factor analysis. Also, the Bartlett sphericity test results in a

significance of 0.000, which rejects the original hypothesis and satisfies the prerequisites for principal component factor analysis.

Table 2. KMO and Bartlett's test

KMO values		.871
Bartlett Sphericity Test	Approximate cardinality	1723.752
	Freedom	36
	Significance	.000

3.2.3. Total variance explained

According to the Table 3, the eigenvalue of the first component is 7.036 greater than 1 and the cumulative variance contribution of the first component is 78.174%, which exceeds the criterion of 75%, which indicates that this one principal component contains most of the information of the sample data with less omitted information. Therefore, the extraction of this one principal component is very effective.

Table 3. Explanation of total variance

Total variance explained						
Ingredients	Initial Eigenvalue			Extraction of sum of squares of loads		
	Total	Percentage variance	Cumulative %	Total	Percentage variance	Cumulative %
1	7.036	78.174	78.174	7.036	78.174	78.174
2	.868	9.642	87.816			
3	.621	6.902	94.718			
4	.178	1.975	96.693			
5	.132	1.469	98.162			
6	.062	.690	98.852			
7	.053	.588	99.440			
8	.045	.495	99.935			
9	.006	.065	100.000			

3.2.4. Component score ccoefficient matrix

The principal component analysis yielded a matrix of component score coefficients for the relevant indicators, and the composite score for each indicator was calculated using the proportion of the variance of each principal component to the cumulative variance extracted as the weights. Because we extracted only one principal component, the final composite score weights for the nine selected indicators were obtained and the results are shown in Table 4.

Table 4. Component score coefficient matrix

Component score coefficient matrix	
Indicator meaning	Component 1
Zscore (secure internet servers (per million people))	.069
Zscore (number of telephone lines per 100 people (in units))	.116
Zscore: liner shipping related index (max 2004 = 100)	.131
Zscore: quality of port infrastructure, WEF (1=very underdeveloped to 7=very developed and efficient according to international standards)	.133
Zscore: burden of customs procedures, World Economic Forum (WEF) (1=very inefficient, 7=very efficient)	.127
Zscore: Ability to track enquiry shipments (1=low, 5=high)	.133
Zscore: ease of arranging competitively priced freight (1=low, 5=high)	.130
Zscore: efficiency of the customs clearance process (1=low, 5=high)	.139
Zscore: overall score (1=low, 5=high)	.138

This results in a table of component coefficients for each indicator of the level of cross-border e-commerce development (Table 5).

Table 5. Component coefficients for each indicator of the level of cross-border e-commerce development

Serial number	1	2	3	4	5	6	7	8	9
F-Integrated	0.069	0.116	0.131	0.133	0.127	0.133	0.130	0.139	0.138

3.3. Cross-border E-commerce Development Level Measurement Results and Analysis

The weights of each indicator in Table 5 are used to obtain an index of the level of cross-border e-commerce development of a country, as in Eq.

$$\begin{aligned} \text{CBED} = {} & 0.069F_1 + 0.116F_2 + 0.131F_3 + 0.133F_4 \\ & + 0.1257 + 0.133F_6 + 0.30F_7 \\ & + 0.139F_8 + 0.138F_9 \end{aligned}$$

Using SPSS.26, the standardised coefficients of each indicator were dissimilarly substituted into the formula to calculate the index of cross-border e-commerce development level of 11 Southeast Asian countries from 2010 to 2019. The specific numerical results are shown in Table 6.

Table 6. Cross-Border E-Commerce Development Level Index for 11 Countries in Southeast Asia, 2010-2019

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Brunei	-0.07	-0.1	-0.09	-0.09	-0.12	-0.11	0.03	-0.22	-0.22	-0.03
Singapore	2.38	2.33	2.43	2.32	2.21	2.34	2.51	2.61	2.53	2.79
Malaysia	0.98	1.06	1.15	1.02	1.26	1.17	1.15	1.16	0.94	1.14

Thailand	0.5	0.42	0.25	0.4	0.5	0.38	0.34	0.37	0.5	0.4
Indonesia	-0.29	-0.05	-0.07	-0.04	0.02	-0.15	-0.11	-0.02	0.11	-0.08
Laos	-0.94	-0.95	-0.9	-0.79	-0.77	-0.9	-1.12	-1.01	-0.53	-0.62
Philippines	-0.2	-0.31	-0.28	-0.25	-0.09	-0.23	-0.37	-0.29	-0.27	-0.22
East Timor	-0.98	-0.83	-0.84	-0.89	-0.88	-0.88	-0.83	-0.9	-0.83	-0.84
Vietnam	-0.04	0.02	-0.04	0	0.09	0.05	-0.02	0.08	0.23	0.06
Cambodia	-0.95	-0.58	-0.59	-0.62	-0.52	-0.72	-0.49	-0.74	-0.72	-0.67
Myanmar	-1.24	-1.2	-1.12	-1.17	-1.3	-1.21	-1.05	-1.19	-1.26	-1.19

The Figure 1 is drawn from the data in the table above, from which it is clear that the development level of cross-border e-commerce in 11 countries in Southeast Asia from 2010 to 2019 is comparatively higher than that of Singapore, Malaysia and Thailand. These countries have comparative advantages in terms of internet communication technology, customs clearance efficiency, logistics efficiency, infrastructure and government policies. Other countries, such as Timor-Leste, Brunei, Laos and Myanmar, have a relatively low level of development, with negative figures and a relatively tortuous development trend in the last decade, indicating that the development of cross-border e-commerce in these countries is still worrying.

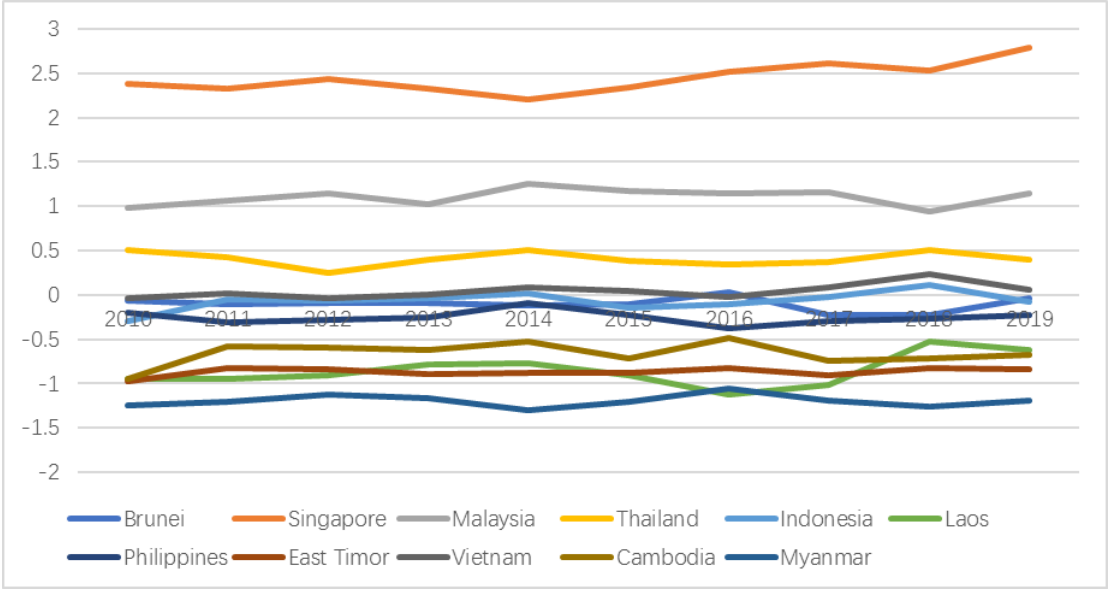

Figure 1. Comparison of Cross-border E-Commerce Development Level Indexes for 11 Countries in Southeast Asia, 2010-2019.

Faced with this current situation, Singapore, Malaysia and Thailand should take advantage of their leading position to continuously improve the development of cross-border e-commerce related software and hardware facilities, standardise processes and systems, so as to increase their own economic incomes.

Countries such as Timor-Leste, Brunei, Laos and Myanmar should speed up the pace of developing cross-border e-commerce, increase the financial investment in cross-border e-commerce development, improve the Internet penetration rate and the level of development of communication technology, introduce preferential policies for the development of cross-border e-commerce by the government, strengthen international cooperation and trade negotiations, and seek more cooperation opportunities and trade opportunities, so as to improve trade facilitation and reduce trade costs, thereby improving The government has introduced preferential policies for the development of cross-border e-commerce. As for China's cross-border e-commerce, on the one hand, we should make full use of the low trade costs and trade facilitation brought about by the development conditions in Singapore and Malaysia, and strengthen cross-border e-commerce trade with these countries. On the other hand, countries such as Timor-Leste and Brunei are not yet mature enough to develop cross-border e-commerce, which means that their markets are blank blue ocean markets, meaning that there are many opportunities for development.

4. Empirical Analysis of the Impact of Cross-Border E-Commerce Development Level on China's Export Trade

4.1. Trade Gravity Model

This paper will use the traditional trade gravity model to empirically analyse the impact of the level of cross-border e-commerce development on China's export trade. In the field of international trade, the gravity model has both empirical stability and theoretical foundation. Tinbergen J [18] first confirmed the empirical basis of the gravity model, and then the scholar Anderson J E [19] laid the theoretical foundation of the trade gravity model. That is, the trade flows between two countries are proportional to the size of their economies (their respective GDP) and inversely proportional to the distance to the market, which is the original basic form of the gravity model. Economists have used the formula for gravity and its underlying ideas to build a variety of trade

gravity models. Here, we present the trade gravity model developed by Tinbergen.

$$X_{ij} = K\frac{(Y_i)^a(Y_j)^b}{(1+eD_{ij})^f}$$

In the equation, X_{ij} is the total exports of country i to country j; Y_i and Y_j are the GNP of countries i and j respectively, D_{ij} is the distance between countries i and j, K, e are constants, and a and b are parameters. The formula shows that the size of total exports from country i to country j or the size of trade between country i and country j is proportional to the total GNP of country i and country j and inversely proportional to the distance between the two countries.

The theoretical framework of Anderson's model was further refined by Deardorff A, Eaton J and others [20,21]. As the trade gravity model continues to develop, factors such as population, language, distance, tariffs, whether bordering, and whether agreements are signed are continuously added to the model. Based on the summary of previous studies, this study takes the Cross Border E-commerce Development Level Index (CBED) as the core explanatory variable, introduces GDP, population, and trade distance as numerical variables, and also incorporates whether the country is bordering whether it has a common official language as dummy control variables, and finally sets up the model as follows.

$$lnEX_{ijt} = \beta_0 + \beta_1 CBED_{jt} + \beta_2 lnGDP_{jt} + \beta_3 lnPOP_{jt} + \beta_4 lnDIS_{ij} + \beta_5 LANG_{ijt} + \beta_6 CONTIG_{ij} + \varepsilon_{ijt}$$

The model variables in this are described and sourced in Table 7.

Table 7. Gravity model variable descriptions and data sources

Variables	Expected symbols	Definition	Data sources	Remarks
$EXij,t$	/	Country i's exports to country j in year t	EPS database, China Yearbook (In US$ million)	The dummy variable takes the value "1" for yes and "0" for no
$CBEDj,t$	Uncertainty	Cross-border e-commerce development level index for country j in year t	Measured by the authors to obtain	
$GDPj,t$	Positive	GDP of the importing country in year t	World Bank database (In millions of US dollars)	
$POPj,t$	Positive	Population of the importing country in year t	International Monetary Fund, National Bureau of Statistics of China, compiled by EPS data (in millions)	
$DISij$	Negative	Market distance between the two countries	Calculate the straight-line distance between the two capitals	
LANGij,t	Uncertainty	Availability of a common official language	Wikipedia	
CONTIGij,t	Positive	Is the country bordered by	Geographical map view	

where $Lang_{ijt}$, $Contig_{ij}$ are model dummy variables, "yes" takes the value of "1", "no" takes the value of " 0", and εijt is the random error term.

4.2. Model Regression and Analysis

Omitted variables are almost inevitable due to the limitations of data availability, and panel data can serve the problem of omitted variables to a certain extent and are therefore more convincing than cross-sectional data or time series. The sample was selected for the time period 2010-2019, the sample countries are 11 countries in Southeast Asia, and the total sample size of the panel data is 110 (10 x 110).

The Pearson correlation coefficients and descriptive statistics for all variables are presented in Table 8. The correlation coefficient results are consistent with the empirical results of the gravity model, i.e., China's exports to 11 Southeast Asian countries are positively proportional to the GDP and population size of the importing countries and inversely proportional to the geographical distance from the importing port capital, and $CBEDjt$ represents a country's level of cross-border e-commerce development. In the Pearson correlation coefficient analysis, the core control variable $CBEDjt$ was significant and initially supported the research hypothesis. The dummy variable Contigij is largely and significantly at the 1% level and also has a significant and positive correlation coefficient with $EXijt$, suggesting that territorial bordering helps to expand the country's exports. In contrast, Langijt is significant and has a poor effect, suggesting that the presence of a common official language has little effect on the dependent and explanatory variables. In addition, the variance inflation factor (VIF) for all variables is less than 10, which, combined with the correlation coefficients, rules out the possibility of multiple co-linearities.

Table 8. Correlation coefficients and descriptive statistics

Variables	$EXijt$	$CBEDjt$	$GDPjt$	$POPjt$	$DISij$	Langijt	Contigij
$EXijt$	1						
$CBEDjt$	0.462***	1					
$GDPjt$	0.955***	0.420***	1				
$POPjt$	0.753***	-0.118	0.767***	1			
$DISij$	-0.254***	0.308***	-0.104	-0.310***	1		
Langijt	-0.00400	-0.351***	-0.120	0.176*	-0.651***	1	
Contigij	0.390***	0.872***	0.344***	-0.0810	0.357***	-0.289***	1

Average value	13.56	-0.01	11.26	2.89	8.20	0.27	0.18
Standard deviation	2.05	0.97	1.92	1.91	0.26	0.45	0.39
Minimum value	8.36	-1.20	6.78	-0.94	7.75	0.00	0.00
Maximum value	16.10	2.39	13.93	5.59	8.61	1.00	1.00
VIF	-	7.73	7.38	6.42	4.69	2.10	2.05
Sample size	110	110	110	110	110	110	110

Note: *, **, *** denote p-tests significant at the 10%, 5% and 1% levels respectively, VIF is the variance inflation factor.

4.3. Regression Results and Robustness Tests

4.3.1. Analysis of regression results

When dealing with panel data, there are three general types of regression models that are currently popular: fixed effects regression models, random effects regression models, and mixed regressions. For this reason, a comparison of the three model regressions was required. The regression results and test results are collated as shown in Table 9.

Table 9. Regression results and test results

Explained variables	Fixed Effects (FE)	Random effects (RE)	Mixed regression (OLS)
$CBEDjt$	-0.086	0.430***	0.500**
	(-0.089)	(-0.071)	(-0.19)
$GDPjt$	1.309***	1.079***	0.665***
	(-0.116)	(-0.1)	(-0.1060
$POPjt$	2.511***	-0.052	0.259**
	(-0.609)	(-0.077)	(-0.088)
$DISij$	omitted	-1.19	-1.701**
		(-0.844)	(-0.546)
Langijt	omitted	0.365	-0.058
		(-0.522)	(-0.4180
Contigij	omitted	-0.334	0.325
		(-0.268)	(-0.380)
Observations	110	110	110
Year fixed	Yes	Yes	Yes
National fixed	Yes	Yes	Yes
Goodness of fit R2	0.69	0.67	0.967

Note: ***, **, * are significance levels passed at 1%, 5% and 10% respectively, with t-values in brackets.

The regressions were first run using a fixed effects model, which resulted in insignificant core variables, and the data for the three variables $DISij$, Langijt, and Contigij were ignored because the geographical distance, whether they share a border, and whether they share a common language are three variables do not usually change over time and are automatically removed under fixed effects estimation (full covariance). The shortcoming of fixed-effects models lies in their inability to estimate regression coefficients for variables that do not change over time. In contrast, random effects model regressions are compared to mixed regression models where the core variables $CBEDjt$ and $GDPjt$ are both significant and have no neglected values, the mixed regression fit is better and the other variables are more significant.

Therefore, a mixed regression model was chosen to work better.

According to the mixed model regression, the estimated coefficient of impact of the level of cross-border e-commerce development in 11 Southeast Asian countries on our export trade is significant at the 5% level. And the coefficient of influence is 0.5, indicating that for every unit increase in the level of cross-border e-commerce, while the trade volume of exports will increase by 0.5 units. Thus indicating that the higher the level of cross-border e-commerce development in the importing country, the more it contributes to the increase in our trade exports. This also corroborates that our exports to Singapore, Buyai West Asia and Thailand are in the top three levels of the 11 countries in Southeast Asia.

In addition, at the same time, we are concerned that the coefficients of the other variables are also consistent with the signs we would expect. gdp has a positive effect on our export trade, the higher the gdp of the importing country, the greater the purchasing power and the greater the demand for trade, for every 1 unit increase in the gdp of the importing country, the volume of our exports rises by 0.665 units. The population of the importing country has a significant boost to our exports, with each unit increase in population increasing the volume of our trade exports to that region by 0.259 units. Distance has a significant deterrent effect on trade flows, as greater distance and correspondingly higher transport costs are detrimental to increased trade, specifically, for every 1% increase in distance between two trading countries, the volume of exports decreases by 1.7%. The dummy variable of being bordered or not also has a boosting effect on the volume of exports, in line with the previous expectations.

4.3.2. Robustness tests

Robustness testing is a very important part of empirical analysis and aims to test the stability and reliability of evaluation methods and the explanatory power of indicators. For example, the stability of the measurement results is examined by changing the sample interval (fire to remove extreme values), the form of the function, the measurement method, control variables, changing definitions, data sources, etc. Only robust results are convincing, and this paper uses both changing the sample interval and lagging the variables by one period to test the robustness of the regression results.

(1) Change the sample interval. As 2014 was the most rapidly developing year for cross-border e-commerce, it was called the first year of cross-border e-commerce by many industry insiders. To avoid the possibility of serious data bias, this paper will exclude the 2014 data and regress the baseline model, and the regression results are shown in Table 10. The coefficient sign and significance level of the core explanatory variable Cross Border E-Commerce Development Level (CBED) are the same as the regression results of the benchmark model, verifying that the previous regression results are robust.

Table 10. Regression results 1

Explained variables	Mixed regression (OLS)	Mixed regression (robust testing)
$CBEDjt$	0.500**	0.552**
	(-0.19)	-0.187
$GDPjt$	0.665***	0.629***
	(-0.1060	-0.106
$POPjt$	0.259**	0.293***
	(-0.088)	-0.087
$DISij$	-1.701**	-1.682**
	(-0.546)	-0.541
Langijt	-0.058	-0.092
	(-0.4180	-0.419
Contigij	0.325	0.272
	(-0.380)	-0.373
Observations	110	110
Year fixed	Yes	Yes
National fixed	Yes	Yes
Goodness of fit R2	0.967	0.968

(2) Considering lag. Considering that the impact of the level of cross-border e-commerce development in importing countries on China's export trade may have certain lagging problems, in order to make the estimation results more realistic and valid. Therefore, this paper replaces the core explanatory variables $CBED_{jt}$ are all replaced with new variables with a one-period lag $CBED_{jt}$ lag, and conduct robustness tests on the benchmark model, and the regression results are shown in Table.

5. Conclusions of the Study

This paper constructs a numerical model of exports with cross-border e-commerce development level, measures the index of cross-border e-commerce development level of 11 Southeast Asian countries from 2010-2019 using principal component analysis, and examines whether and how the level of cross-border e-commerce development affects the level of export trade using an extended trade gravity model, based on the results of this paper's theoretical and empirical research. The following three research conclusions are drawn.

(1) The level of cross-border e-commerce development has a positive effect on China's export trade

Based on panel data from ten ASEAN countries, the empirical results of the benchmark regression model show that, all else being equal, the level of cross-border e-commerce development has a significant positive effect on China's export trade. Specifically, for every unit increase in the level of cross-border e-commerce development, the volume of China's export trade to that country increases by 0.5 units. Cross-border e-commerce can improve China's exports by increasing the level of trade facilitation, creating low-cost online trade intermediaries and shortening transaction links, while overcoming the adverse effects of trade risks. Therefore, strengthening the internet communication infrastructure, continuously cultivating the number of domestic internet users, improving the logistics system, building a faster and more efficient logistics and transportation network, and thus improving the level of cross-border e-commerce development, can significantly improve China's export trade. China should comprehensively improve the level of cross-border e-commerce, strengthen the construction of infrastructure, improve the penetration rate of the Internet and the level of development of communication technology, while the government should increase preferential policies to speed up the clearance of cross-border goods and improve the rate of delivery to save time costs and thus improve trade facilitation and reduce trade costs. At the same time, in terms of international cooperation, actively promote the "Silk Road E-Commerce" international cooperation, using the policy basis that China has established bilateral e-commerce cooperation mechanisms with a number of countries along the "Belt and Road", and actively use the new mode of cross-border e-commerce to carry out trade with Southeast Asian countries The new mode of cross-border e-commerce can promote the development of China's export trade and foster new trade development momentum.

From Table 11, it can be found that although the coefficients of the lagged period differ in size from those of the benchmark regression, the estimated coefficients of the level of cross-border e-commerce development still pass the 5% confidence level test and the regression results are still significant, and the signs of the coefficients remain unchanged, indicating that the regression results of the benchmark model of this paper are still robust after taking into account the lags.

Table 11. Regression results 2

Explained variables	Mixed regression (OLS)	Mixed regression (robustness test 2)
$CBEDjt$	0.500**	0.455**
	(-0.19)	-0.201
$GDPjt$	0.665***	0.684***
	(-0.1060	-0.102
$POPjt$	0.259**	0.243**
	(-0.088)	-0.085
$DISij$	-1.701**	-1.684**
	(-0.546)	-0.554
Langijt	-0.058	-0.041
	(-0.4180	-0.425
Contigij	0.325	0.386
	(-0.380)	-0.404
Observations	110	110
Year fixed	Yes	Yes
National fixed	Yes	Yes
Goodness of fit R2	0.967	0.966

(2) The overall level of cross-border e-commerce development within the Southeast Asian countries region is low, with large country differences

Based on the main aspects of cross-border e-commerce, the principal component analysis method was used to construct a comprehensive evaluation index containing the foundation of Internet communication technology, customs clearance efficiency and logistics efficiency to scientifically measure the development level of cross-border e-commerce in 11 countries in Southeast Asia. Excluding countries such as Singapore and Malaysia, the overall level is not high, and the gap is still large compared to developed countries such as

Europe and America. And there are great differences among ASEAN countries, with Singapore and Malaysia's cross-border e-commerce development level significantly higher than the remaining eight countries, showing great differences. In response to the uneven level of development of cross-border e-commerce in Southeast Asian countries China's cross-border e-commerce, on the one hand, we should make full use of the low trade costs and trade convenience brought by the development conditions in Singapore and Malaysia, and strengthen cross-border e-commerce trade with these countries. On the other hand, countries such as Timor-Leste and Brunei are not mature enough for cross-border e-commerce development, which means that their markets are blank blue ocean markets, meaning that there are many opportunities for development.

(3) Distance has a significant deterrent effect on trade flows

This is because greater distances and correspondingly higher transport costs are detrimental to increased trade, specifically, for every 1% increase in the distance between two trading countries, the volume of exports decreases by 1.7%. The dummy variable of whether or not one is bordered also has a boosting effect on the volume of exports, while the presence or absence of a common language, which is hypothesised to be insignificant in the empirical analysis, does not have much of an impact. The distance between trading countries is fixed and will not change in the near future, but Chinese cross-border e-commerce practitioners can make use of big data + internet technology to support the seamless connection of the entire logistics process, improve the visualisation of the flow trajectory, and also create a convenient and efficient logistics system and strengthen the construction of "overseas warehouses", thus compensating to some extent for the cost loss caused by distance. The cost loss caused by distance.

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