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Article

An empirical test of the impact of multidimensional shocks of trade war on the comprehensive performance of cross-border e-commerce based on principal component analysis

Hongqing Lai *

Foshan Poly Technic, Foshan, Guangdong, 528200, China; lleis@126.com

Abstract: By analyzing the relationship between multidimensional shocks of trade war and on the comprehensive performance of cross-border e-commerce, it can help the policy makers of China's cross-border e-commerce to better follow the different degrees of importance, and give the corresponding policy recommendations in a targeted manner. Based on the panel data of China's listed cross-border e-commerce companies from 2013 to 2022, this paper measures the comprehensive performance of cross-border e-commerce by combining the principal component analysis method, and then constructs a multi-period double-difference model to test the impact of trade war multi-dimensional impact on the comprehensive performance of cross-border e-commerce, quasi-natural experiments with the establishment of trade war multi-dimensional impact test zones. It is found that when the level of trade war multidimensional shocks increases by 1%, the level of comprehensive performance of Chinese cross-border e-commerce enterprises is suppressed by 3.85%, i.e., reducing trade war multidimensional shocks can enhance the comprehensive performance of Chinese cross-border e-commerce enterprises. Therefore, cross-border e-commerce exporters and manufacturing enterprises should take early warning precautions, do well to take countermeasures, establish independent brands, form core competitiveness, and accelerate the upgrading and transformation of industries.

Keywords: principal component analysis; multi-period double difference model; cross-border e-commerce comprehensive performance; trade war multidimensional shock

1. Introduction

In recent years, with the rise of international trade protectionism, international trade wars continue to intensify, the United States and China, for example, the United States believes that China's trade surplus with the U.S. is too large, and then frequently take the increase in tariffs and other trade protectionist measures, a series of initiatives to the U.S. and China trade exchanges have brought about a huge impact on the cross-border e-commerce as an emerging international trade model has also been deeply affected by it [1-4].

The trade war to raise tariffs on cross-border retail e-commerce will have a significant impact, especially to the U.S. market, the export of cross-border e-commerce will face a high tax cost, so that the cost of “Made in China” has increased significantly [5-7]. From the export point of view, cross-border exports to the United States of America is very diverse products, on the list of products in a wide range of large-scale layout of the United States overseas warehouse and Amazon and other e-commerce companies have a greater impact [8-9]. From the import point of view, China's counterattack on the tax categories involved in the cross-border e-commerce import sellers are bulk industrial goods field, the consumer for the domestic large-scale aluminum industry enterprises, chemical companies and industrial enterprises [10-12]. The regional market is highly substitutable, which will prompt Chinese corporate

workers to turn to other countries and regions to increase market sourcing efforts. The trade war has simultaneously accelerated the branding and industry reshuffling of cross-border e-commerce, for cross-border e-commerce retailing, branding has been an important trend in recent years, and low-margin sellers and small and micro-enterprises without a great deal of core competitiveness will certainly be eliminated [13-15]. The U.S. tax has made the cross-border retail e-commerce market more and more formalized and higher threshold. The real trend of cross-border e-commerce in the future will be integrated on capital-intensive, resource-intensive, talent-intensive brand enterprises of such scale [16-18]. It can be seen that the multi-dimensional impact triggered by the trade war not only affects the performance of cross-border e-commerce, but also concerns the survival of cross-border e-commerce enterprises, there is no winner in front of the trade war, and only by stopping the trade war and competing in a peaceful manner can we achieve a win-win situation [19-20].

Regarding the impact of trade wars on cross-border e-commerce, it has been the focus of academic research, and the changes in international forms during the three-year period from 2018 to 2020 have once again triggered academic attention to the topic. Shen et al [21] introduced Yiwu's excellent achievements in the field of cross-border e-commerce under the “Belt and Road” initiative, emphasized that it still faces many challenges in the international arena, especially international trade wars that have seriously hindered its good development, and put forward suggestions. Ke et al [22] analyzed the current situation and characteristics of cross-border e-commerce development in China, pointed out that the “Belt and Road” plays an important role in expanding consumer demand and promoting the transformation and upgrading of cross-border e-commerce, and analyzed the problems brought about by the trade war between China and the U.S. with the aim of finding solutions to the problems in order to promote the development of cross-border e-commerce. Giuffrida et al [23] aims to provide support for enterprises to make a strategy for choosing logistics solutions suitable for doing business in China through cross-border e-commerce mode based on trade war risk information. Zhang [24] shows that the development of e-commerce has impacted traditional foreign trade, discusses how to promote traditional foreign trade with the help of cross-border e-commerce and analyzes the development of cross-border e-commerce to promote the countermeasures of foreign trade transformation and upgrading.

To date, as the United States continues to provoke trade wars, 2020 to the present, the academic community has never stopped discussing the topic of “the impact of trade wars on cross-border e-commerce”. Hou [25] describes the current situation of the cross-border e-commerce field and global e-commerce market of the participating enterprises, and critically discusses the international opportunities and threats of cross-border e-commerce, using a SWOT model to assess the strengths and weaknesses of the industry. were critically discussed, and the strengths and weaknesses of the sector were assessed using the SWOT model. Han and Lee [26] examined the influencing factors of cross-border e-commerce exports in China based on the current status and trends of cross-border e-commerce in the country, especially aspects such as trade friction, and made suggestions for the development of cross-border e-commerce through an improved trade gravity model. Al-Fawwaz [27] emphasized the role that e-commerce role in trade and income growth and describes China's investment in the African region, noting that both sides are exploring the role of e-commerce in facilitating the development of trade. Qi [28] describes the complexity of cross-border e-commerce logistics, and also provides suggestions for reducing costs, aiming to provide SMEs with the knowledge they need to be successful in the ever-changing cross-border e-commerce space. Hu [29] presents the the impact of the trade war between the United States and China on the global economic landscape, in which the trade in agricultural products has been severely impacted, resulting in a significant decline in the total trade in agricultural products between China and the United States, and provides effective suggestions for ensuring national food security and stabilizing the development of the agricultural economy.

In this paper, the comprehensive performance of cross-border e-commerce measured by principal component analysis is selected as an explanatory variable, and the experimental area of trade war multidimensional shocks is selected as a core explanatory variable. On this basis, the relationship between trade war multidimensional shocks and comprehensive performance of cross-border e-commerce is empirically investigated by combing the panel data from 2013 to 2022 under the framework of the fixed-effects model. Subsequently, a series of robustness tests such as parallel trend test, placebo test, PSM-DID, elimination of disruptive policies and constructed instrumental variables are further carried out on the results of the benchmark regression, and the heterogeneity of the results in different regions is analyzed, so as to provide decision-making references for the in-depth implementation of the national strategies such as the innovation-driven development and the comprehensive promotion of comprehensive cross-border e-commerce development.

2. Comprehensive performance measurement of cross-border e-commerce based on principal component analysis

2.1. Indicator selection and data sources

2.1.1. Selection of performance evaluation indicators

Considering the availability and completeness of the data of this comprehensive enterprise performance evaluation, the selection of evaluation indexes mainly draws on the research results about enterprise performance, and at the same time, refers to the main indexes displayed by Oriental Fortune Network's financial analysis of listed enterprises for the year of 2022, and finally selects 4 first-level indexes and 12 second-level indexes after comprehensive combing, and the indicators for the comprehensive performance evaluation of cross-border e-commerce enterprises are shown in Table 1.

Table 1. Comprehensive performance evaluation indicators.

Serial	Primary indicator	Secondary indicator
1	profitability	X1: Return on equity
		X2: Total assets net profit
		X3: Return on capital
2	Financial risk	X4: Asset ratio
		X5: Mobility ratio
		X6: Cash flow ratio
		X7: Speed ratio
3	Operational capacity	X8: Current asset turnover
		X9: Total asset turnover
		X10: Operating capital turnover
4	Growth ability	X11: Total business revenue growth
		X12: The business assembly is growing this year

2.1.2. Sample Sources and Data Processing

According to the Basic Specification for E-commerce Platforms issued by the commerce departments of Chinese provinces and municipalities, and the Results of Industry Classification of Listed Companies in the March Quarter of 2022 published on the official website of the China Securities Regulatory Commission (CSRC), listed cross-border e-commerce enterprises are classified into three categories: (1) third-party cross-border e-commerce platform enterprises: mainly providing cross-border e-commerce enterprises with online product display, information dissemination, online aggregation, online trading, online or mobile payment and other online transaction services; (2) cross-border e-commerce operating enterprises: carrying out cross-border e-commerce activities through third-party platforms or self-built platforms; (3) cross-border e-commerce service enterprises: providing cross-border e-commerce enterprises with, for example, hardware and software support, third-party payment, logistics, distribution and warehousing.

Based on the definition of cross-border e-commerce listed enterprises in the previous section, using the cross-border e-commerce concept section in the official website of Flush, a total of 80 relevant listed enterprises are derived. On this basis, through the description of cross-border e-commerce business layout by conceptual analysis, company profile, business scope of operation, etc., excluding 30 enterprises that will be transformed or whose business involves cross-border e-commerce only after 2020, and excluding 5 ST and *ST enterprises, 45 A-share listed cross-border e-commerce enterprises in 2020~2022 are finally selected as the samples, including 5 platform enterprises, 25 operating enterprises, and 15 service enterprises.

SPSS24.0 software was utilized to process the collected data information. In order to ensure the accuracy and comparability of the data, the data were first standardized to eliminate the influence of the scale on the analysis results.

2.1.3. Data validity tests

In order to examine the degree of authenticity of the design indicators on the measurement of content, this paper carries out the validity test of the indicator data, the results show that the KMO value of the data indicators is 0.788, and the value of Bartlett's spherical test is 2988.956, which corresponds to a P-value of 0.000, which passes the test of significance, indicating that the indicators are of good validity and are suitable for factor analysis.

2.2. Principal Component Analysis Methods

In this paper, we mainly use the method of principal component analysis [30] to measure the comprehensive performance of cross-border e-commerce, and the specific principles and steps are as follows:

2.2.1. Basic principles

s evaluation factors $X_1, X_2, X_3, \cdots, X_s$, matrix $X = (X_1, X_2, \cdots, X_s)$. Orthogonal transformation of vectors in the matrix to get s vertical direction axes, transforming multiple correlated variables into uncorrelated unique variables for multidimensional variable downscaling.

2.2.2 Basic steps

(1) Establish the original data matrix

m represents the total number of evaluation years, n represents the total number of evaluation indicators, and the raw data constitute the matrix X as follows:

$$X = \begin{bmatrix} X_{11} & X_{12} & \cdots & X_{1n} \\ X_{21} & X_{22} & \cdots & X_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ X_{m1} & X_{m2} & \cdots & X_{mn} \end{bmatrix} \tag{1}$$

(2) Normalization of base data

Standardizing the basis using equation (2) eliminates the effects of different scales in the data itself:

$$X_{ij} = \frac{X_{ij} - \overline{X}_j}{s_j} (i = 1, 2 \ldots, m; j = 1, 2 \ldots, n) \tag{2}$$

where X_{ij} is the element in matrix X , $\overline{X}_j$ is the mean of the j th indicator, and S_j is the standard deviation of the j th indicator.

(3) Correlation matrix for data normalization:

$$R = \left| r_{jk} \right|_{p*p} \tag{3}$$

where r_{jk} is the correlation of indicator j for indicator k .

(4) Matrix eigenvalues and eigenvectors

Calculate the matrix eigenvalues $\lambda_i (i = 1, 2, \ldots, n)$ according to the equation $| R - \lambda_j | = 0$, where $\lambda_n \geq 0$, and find the eigenvectors $a_i (i = 1, 2, \ldots, n)$ of the eigenvalues λ_i , $a_i = (a_{1i}, a_{2i}, \ldots, a_{ni})$.

(5) Calculate the number of principal components

Determining the number of principal components is based on the principal component contribution rate and cumulative contribution rate, and the principal component F variance contribution rate is calculated by equation (4):

$$P_i = \frac{\lambda_i}{\sum_{i=1}^{p} \lambda_i} \tag{4}$$

The cumulative variance contribution is:

$$P = \sum_{i=1}^{p} P_i (i = 1, 2, \ldots, P) \tag{5}$$

Those with a cumulative contribution of variance of 85% or more are selected as principal components, and their eigenvalues $\lambda_1 \ldots \lambda_P$ correspond to the eigenvectors $a_i = (a_{1i}, a_{2i}, \ldots, a_{ni})$. I.e.:

$$\text{Principal component } F_i = a_{1i} X_1 + a_{2i} X_2 + \cdots + a_{ni} X_{ni} (i = 1, 2, \cdots, P) \tag{6}$$

(6) Calculate the principal component composite score

Using equation (7), the standardized raw variables are brought into the F_i expression to obtain the principal component score e_i, and the number of principal components is determined to be t and the composite score:

$$Z = \sum_{i=1}^{t} e_i G_i \tag{7}$$

where G_i is the eigenvalue contribution of the principal component.

2.3. Comprehensive performance evaluation of cross-border e-commerce enterprises

2.3.1. Empirical evaluation studies

According to the correlation coefficient matrix of the original variables, the factors were extracted by principal component analysis. The total variance interpretation results are shown in Table 2, which shows that the cumulative variance contribution rate of the four factors reaches 86.034%, indicating that the four extracted factors can better express the information embedded in the 12 secondary indicators in the original data. After rotating the component matrix, the principal component 1 with the highest correlation is X5, X6, X7, X4, which is defined as the solvency of cross-border e-commerce listed enterprises (. Principal component 2 with the highest correlation is X3, X2, X1, which is defined as the profitability of cross-border e-commerce listed companies. The principal component 3 with the highest correlation is X11, X12, which is defined as the growth ability of cross-border e-commerce listed companies. The principal component 4 with the highest correlation is X9, X8, X10, which is defined as the operational capability of cross-border e-commerce listed companies.

Table 2. The total variance explains the result.

Factor	Initial eigenvalue			Extraction load squared			Rotational load squared		
	Total	Var/%	Cum/%	Total	Var/%	Cum/%	Total	Var/%	Cum/%
1	4.124	34.367	34.367	4.124	34.367	34.367	3.525	29.375	29.375
2	2.691	22.425	56.792	2.691	22.425	56.792	2.889	24.075	53.45
3	1.965	16.375	73.167	1.965	16.375	73.167	2.111	17.592	71.042
4	1.544	12.867	86.034	1.544	12.867	86.034	1.799	14.992	86.034
5	0.919	7.658	93.692						
6	0.392	3.267	96.959						
7	0.138	1.15	98.109						
8	0.119	0.992	99.101						
9	0.052	0.433	99.534						
10	0.033	0.275	99.809						
11	0.019	0.158	99.967						
12	0.004	0.033	100						

The matrix of component score coefficients was obtained using regression and the matrix of component score coefficients is shown in Table 3.

Table 3. Component score coefficient matrix.

Project	**1**	**2**	**3**	**4**
X_1	-0.045	0.335	-0.012	-0.029
X_2	-0.05	0.344	-0.021	-0.024
X_3	-0.058	0.361	-0.019	-0.027
X_4	-0.184	-0.083	-0.04	0.009
X_5	0.324	-0.09	-0.034	0.085
X_6	0.311	-0.063	-0.029	0.053
X_7	0.3	-0.067	-0.003	0.03
X_8	0.007	-0.03	0.003	0.461
X_9	0.045	-0.052	-0.003	0.495
X_{10}	0.061	-0.023	-0.036	0.248
X_{11}	-0.028	-0.015	0.493	-0.021

X_{12}	-0.02	-0.018	0.499	-0.028

According to Table 3, the score function for a single common factor $F_i(i=1,2,3,4)$ was analyzed and found:

$$F_1 = -0.045X_1 - 0.050X_2 + \ldots - 0.020X_{12} \quad (8)$$

$$F_2 = 0.335X_1 + 0.344X_2 + \ldots - 0.018X_{12} \quad (9)$$

$$F_3 = -0.012X_1 - 0.021X_2 + \ldots + 0.499X_{12} \quad (10)$$

$$F_4 = -0.029X_1 - 0.024X_2 + \ldots - 0.028X_{12} \quad (11)$$

From the principal component rotated sum of squares loaded into the corresponding variance contribution rate as weights, the comprehensive performance evaluation function (regression equation) of cross-border e-commerce enterprises is constructed as:

$$F = 0.3278F_1 + 0.2813F_2 + 0.1977F_3 + 0.1932F_4 \quad (12)$$

Where F is the comprehensive performance score of cross-border e-commerce enterprises, $F_i(i=1,2,3,4)$ is the score of each factor. The scores of the above factors are brought into the evaluation function to evaluate the comprehensive performance of the enterprise.

2.3.2. Comprehensive performance level analysis

According to the above formula for cross-border e-commerce enterprise performance evaluation indicators, using the same principles and methods, the calculation can obtain the performance evaluation indicator scores of 45 enterprises from 2020 to 2022, and the comprehensive performance of enterprises is shown in Table 4.

The comprehensive performance score is greater than 0, indicating that the performance level of the enterprise is higher than the industry average, and less than 0, indicating that the performance level is lower than the industry average. Analyzing the results from the table, among the selected sample enterprises, the enterprises with comprehensive performance scores greater than 0 in 2022 accounted for 31/45, in 2021 accounted for 28/47, and in 2020 accounted for 26/45, i.e., the majority of enterprises in 2020~2022 have comprehensive performance scores of less than 0. On the one hand, it indicates that the comprehensive performance of the majority of enterprises in the three years is lower than the average, and the performance level of China's listed cross-border e-commerce enterprises' performance level is low. On the other hand, it indicates that the performance level of enterprises in the industry is very uneven, and the performance level of leading enterprises is very high, which pulls up the overall performance level of the industry. Among the top 10 enterprises in terms of comprehensive performance scores, five cross-border e-commerce domestic service provider enterprises have been on the list for three years. Except for Sinotrans Development, which belongs to the logistics industry, the remaining four belong to the Internet software and services industry.

Table 4. Comprehensive performance rating of cross-border e-commerce companies.

Corporate name	2022 Score	Corporate name	2021 Score	Corporate name	2020 Score
12	4.816	35	1.917	21	-1.076
42	3.313	43	1.304	20	2.452
19	0.253	36	1.126	33	1.301
17	2.968	9	-0.929	30	1.361
37	-1.654	14	-1.564	32	-1.208
15	0.961	27	1.247	22	0.962
23	0.226	5	-0.508	29	-0.19
24	3.794	12	-1.217	36	0.338
5	-1.721	28	-1.497	1	2.401
18	-0.164	15	0.016	27	-0.518
1	0.567	24	1.137	44	1.627
31	-1.607	38	-1.089	24	-1.761
39	4.601	17	1.321	13	1.649
34	-1.677	10	0.32	2	2.203

10	-1.55	7	0.116	6	-1.294
45	2.919	3	0.588	28	1.66
41	-0.604	11	-1.168	11	-1.447
7	1.136	34	0.087	3	-1.206
36	4.657	6	1.02	19	-1.448
8	1.707	33	2.913	35	0.386
20	1.684	18	2.975	23	0.479
21	4.84	39	2.333	38	0.957
43	1.501	23	0.954	34	-1.291
44	-0.68	21	1.516	16	-1.273
30	2.741	20	-1.016	14	2.528
40	2.926	44	-0.562	15	2.242
22	-1.674	31	1.651	18	1.667
6	-1.591	25	1.148	10	2.515
35	4.648	16	2.276	43	2.456
3	4.419	26	2.839	39	0.758
4	1.993	4	-0.833	7	-1.027
11	2.978	32	2.713	41	2.764
13	1.055	42	2.863	26	2.69
16	0.729	2	0.646	31	-0.95
27	-1.956	37	0.988	4	1.017
38	-1.777	8	1.999	25	-0.028
14	3.717	41	-1.245	40	-1.384
26	-0.658	40	0.863	12	2.056
9	1.485	30	-0.031	17	-1.011
2	4.382	13	-1.066	8	0.816
29	3.869	29	-0.553	42	-0.255
28	3.093	19	-1.225	37	-1.508
25	-1.89	45	-0.008	9	0.49
33	1.92	1	1.558	5	0.577
32	4.703	22	-1.762	45	-0.269

In order to assess the performance level of Chinese cross-border e-commerce enterprises in depth, we analyze some mathematical statistics of the comprehensive performance evaluation indicators. The median and quartile of the variables can reflect the overall level of enterprise performance and avoid the influence of extreme values; the kurtosis coefficient reflects whether the values of the variables are concentrated in a certain range, while the skewness coefficient reflects the degree of asymmetry of their distribution, which can reflect whether the performance level of each enterprise has a certain same trend and the degree of its deviation from the mean value in our analysis. The statistical results are shown in Table 5. Figure 1 shows the statistical analysis of the comprehensive performance scores of cross-border e-commerce enterprises from 2020 to 2022.

Among them, the upper quartile is negative, reflecting that the overall performance level of China's listed cross-border e-commerce enterprises is poor, the performance level in 2021 is slightly better than that in the two years before and after, and the skewness coefficient and kurtosis coefficient of 2020~2022 are basically less than 0, which indicates that the distribution of the performance scores is left-skewed, and there must be a large value of the “outlier” data on the right side of the mean value. "The standard deviations of the three years are similar and not large, reflecting the reality that although there are sometimes individual extreme values in each year, the performance levels of most enterprises do not differ much.

Table 5. Statistical result.

Statistical term	2022	2021	2020
Median	1.501	0.646	0.49
Last quartile	-0.658	-0.833	-1.027
Lower quartile	3.313	1.516	1.66
Standard deviation	2.31455	1.40327	1.45443
Deviation	-0.05873	0.10176	0.04263
kurtosis	-1.36161	-1.10718	-1.40394

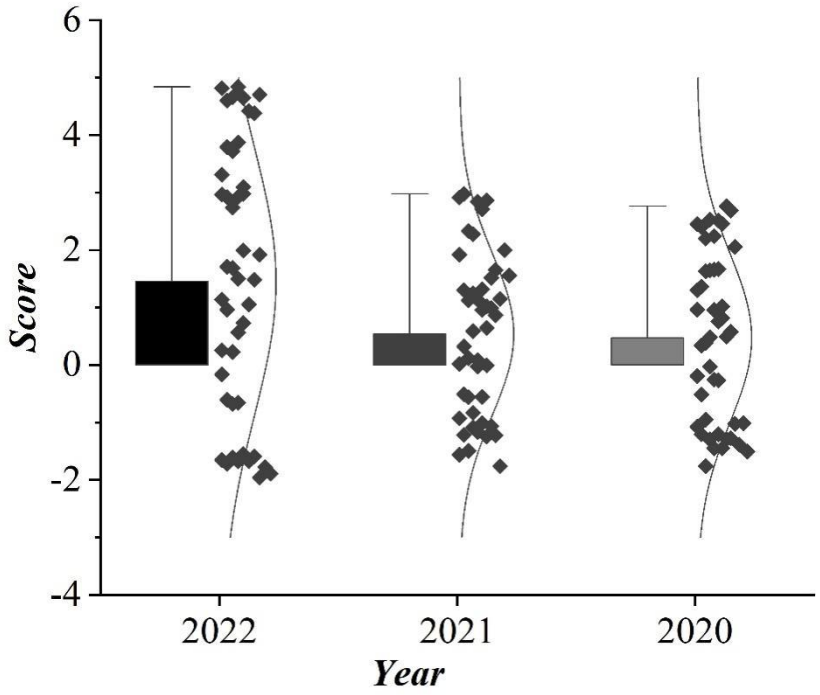

Figure 1. The overall performance scores of cross-border e-commerce enterprises are divided.

3. Modeling the impact of multidimensional shocks of trade wars on the comprehensive performance of cross-border e-commerce companies

3.1. Sample Selection and Data Sources

In this paper, we select the panel data of Chinese A-share listed companies from 2013 to 2023, a total of 10 years. The specific steps of data screening and processing are as follows: first, based on the industry categorization information in the Cathay Pacific database (CSMAR), financial companies were eliminated. Second, companies that experienced ST or *ST treatment during the selected time period, and companies with missing data were eliminated, after which, a shrinking tail was applied at the 1% and 99% levels.

In this paper, the Cathay Pacific database, Wind database and China Statistical Yearbook are used as data sources for the empirical study. The study divides the first three batches of firms with multidimensional shocks from the trade war into an experimental group, while the other firms are regarded as a control group.

3.2. Modeling

Based on related research, this study aims to explore the impact of trade war multidimensional shocks on the comprehensive performance of cross-border e-commerce enterprises. Given the existence of batch variability in the establishment of enterprises subjected to multidimensional shocks of trade wars, this paper adopts the multi-period double-difference method (DID) as a research instrument [31] and uses a panel model that considers the individual and time double fixed effects to conduct the analysis, which is set up as follows:

$$TFP_{it} = \alpha + \beta DID_{it} + \gamma X_{it} + Coporate_i + time_t + \varepsilon_{it} \tag{13}$$

In equation (12), the explanatory variable of this paper is TFP_{it} , which is the comprehensive performance of cross-border e-commerce enterprises. DID_{it} is the core explanatory variable, which represents the estimated quantity in the DID model, i.e., whether or not the i firms are subjected to the multidimensional shocks of trade wars during the year of t , β is the parameter of the policy effect, which reflects the impact of the multidimensional shocks of trade wars on the comprehensive performance of cross-border e-commerce firms, and a positive value and a significant value indicates that the multidimensional shocks of trade wars help to enhance the firms' performance. X_{it} contains all

control variables, $Coporate_i$ refers to the individual fixed effects, $time_t$ represents the time fixed effects, and ε_{it} represents the standard errors.

3.3. Selection of variables

3.3.1. Explained Variables

This paper utilizes the methodology in Section 2 to measure the aggregate performance of cross-border e-commerce firms, denoted as TFP.

3.3.2. Explanatory variables

Setting DID_{it} as the core explanatory variable means creating an interaction term between a policy dummy variable ($Treat$) and a time dummy variable ($Time$). In the $Treat$ variable, firms in the first three batches of trade war multidimensional shocks are assigned a value of 1, while others are assigned a value of 0. In the $Time$ variable, firms are assigned a value of 1 if they are located in one of the first three pilot regions and are in the year of the trade war multidimensional shocks or in the year after, otherwise they are assigned a value of 0. Through the interactions of the two variables, a variable called DID is formed that is used to analyze the policy effects.

3.3.3. Control variables

Considering the financial structure and other characteristics of the company, seven control variables are selected, namely, company size (Size), company's establishment year (Firmage), the proportion of shares held by the first largest shareholder (Top1), gearing ratio (Lev), capital intensity (Capint), cash flow ratio (Cashflow), and the proportion of independent directors (Indep) X_{it}.

3.3.4. Descriptive statistics

Table 6 shows the descriptive statistics of each variable, according to the data analysis in the table, the mean and standard deviation of different variables show significant differences, which indicates that the studied samples show significant diversity and representativeness in breadth and depth, which is sufficient to exclude the research error caused by the insufficient coverage of the samples. Among them, the maximum value of the proportion of independent directors (Indep) is 0.79966, and the minimum value is 0, which indicates that some companies do not have independent directors; the maximum value of the cashflow ratio (Cashflow) is 0.66423, and the minimum value is -1.9782, which reflects the fact that some companies do not have enough liquid assets to pay off their short-term debts, and are exposed to higher financial risks; and the maximum value of the company's Size and the minimum value of the company's Capital Intensity are 0.9782, which reflects that some companies are exposed to higher financial risks. Size) and Capital Intensity (Capint) have standard deviations greater than 1 which indicates that there is a high degree of variability among firms in these two indicators.

Table 6. Descriptive statistics of variables.

Variable	Mean	Standard deviation	Minimum	Maximum
TFP	9.01222	1.04951	5.73627	13.38802
DID	0.32528	0.46876	0	1
Size	22.10648	1.23292	17.87829	28.25587
Firmage	2.83851	0.34947	1.09823	4.14277
Top1	0.33644	0.14467	0.02207	0.89011
Lev	0.4156	0.08324	0.02723	1.28985
Capint	12.45364	1.06774	6.53884	17.8904
Cashflow	0.04719	0.07011	-1.93782	0.66423
Indep	0.37591	0.05603	0	0.79966

4. Analysis of empirical results

4.1. Analysis of baseline regression results

In order to test the impact of multidimensional shocks of trade wars on the comprehensive performance of cross-border e-commerce, this paper conducts a regression analysis based on the

multi-period double-difference model of equation (2), and the regression results are shown in Table 7. Among them, column (1) is the regression result when no control variables and fixed effects are added, column (2) further controls city and time fixed effects, column (3) is the regression result when control variables are added but city and time fixed effects are not controlled, and column (4) is the regression result when control variables are added and city and time fixed effects are controlled. The core explanatory variables DID (firms subject to multidimensional shocks of trade war) in columns (1) to (4) are all significant and have negative coefficients, indicating that multidimensional shocks of trade war inhibit the comprehensive performance of cross-border e-commerce. In addition, as shown in column (4), the level of comprehensive performance of cross-border e-commerce firms decreases by about 3.85% after being subjected to the multidimensional shock of trade war.

Table 7. The benchmark regression results of the impact model.

Variable	(1)	(2)	(3)	(4)
DID	-0.0185*** (0.0051)	-0.0311* (0.0211)	-0.0533** (0.0331)	-0.0385 (0.0218)
Size			-0.1221*** (0.0355)	-0.1141*** (0.0362)
Firmage			0.5121*** (0.0622)	0.5073*** (0.0611)
Top1			-0.2888** (0.1223)	-0.2876** (0.1213)
Lev			-0.6161 (0.6442)	-0.6159 (0.6122)
Capint			1.0224** (0.5123)	1.0211** (0.4074)
Cashflow			0.0025 (0.0025)	0.0011 (0.0018)
Indep			0.0281* (0.5711)	0.0287* (0.5705)
Urban and time-fixed effects	NO	YES	NO	YES
Constant term	-3.8812*** (0.0041)	4.1124*** (0.0015)	-1.5243** (0.6624)	-0.6112 (0.8552)
R^2	0.0002	0.0071	0.0311	0.0348

4.2. Robustness Tests

4.2.1. Parallel trend test

The premise of using the double difference method is that the experimental group and the control group have the same trend before the implementation of the policy, if the trend of urban innovation and entrepreneurship changes in the experimental group and the control group before the establishment of the trade war multidimensional shock experimental zone is not the same, it will lead to inaccurate model estimation, so it is necessary to carry out the parallel trend test. To this end, this paper establishes the following model:

$$TFP_{it} = \gamma_0 + \sum_{k=-M}^{N} \gamma_k DID_{i,t-k} + C'X_{i,t} + Coporate_i + time_t + \varepsilon_{i,t} \tag{14}$$

Where M , N denotes the number of periods before and after the establishment of the trade war multidimensional shock zone, respectively. If the DID before the establishment of the trade war multidimensional shock zone is significant, there is a significant difference between the change trend of the experimental group and the control group before the implementation of the trade war multidimensional shock pilot policy, and if the DID before the shock is not significant, the parallel trend test is passed. Figure 2 shows the results of the parallel trend test, it can be seen that the experimental group and the control group have the same trend of change before the implementation of the policy, therefore, the double difference model of this paper passed the parallel trend test.

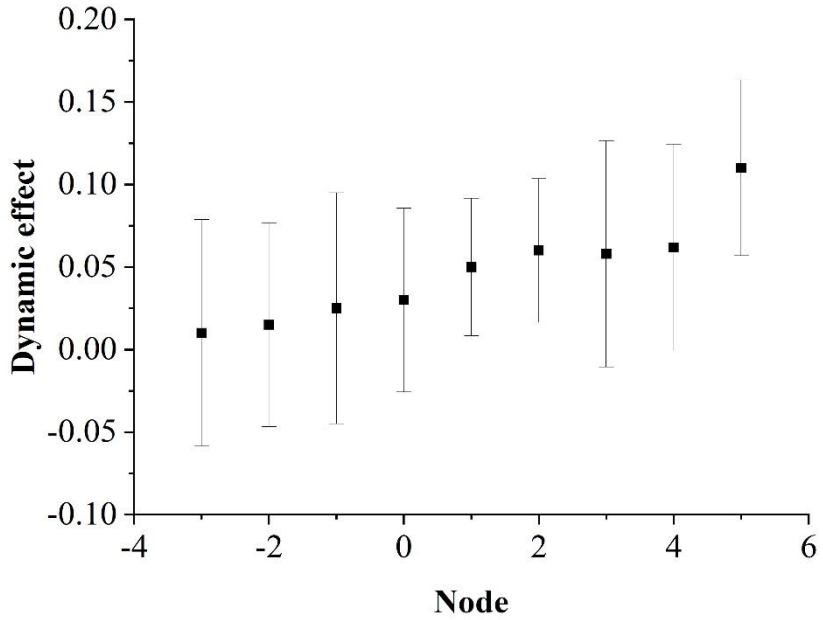

Figure 2. Parallel trend test results.

4.2.2. Placebo test

Drawing on the practice of related scholars, this paper conducts a placebo test by setting up a dummy experimental group by taking a non-pilot city closest to the pilot city of the trade war multidimensional shock zone as the experimental group. The results of the robustness test are shown in Table 4. The placebo test is shown in column (1), and the DID is not significant, indicating that the double difference model of this paper passes the placebo test. In addition, this paper also uses random sampling 2000 times to conduct the placebo test, constructing dummy variables for spurious grouping to estimate equation (13), and the results of the placebo test are shown in Figure 3. The estimated coefficients of the spurious trade war multidimensional shock zones set up are distributed around 0, and the true estimated coefficients are to the right of the value of 0, which is significantly beyond the estimated value of the placebo test. This result further supports the rationality of the double-difference model setup in this paper.

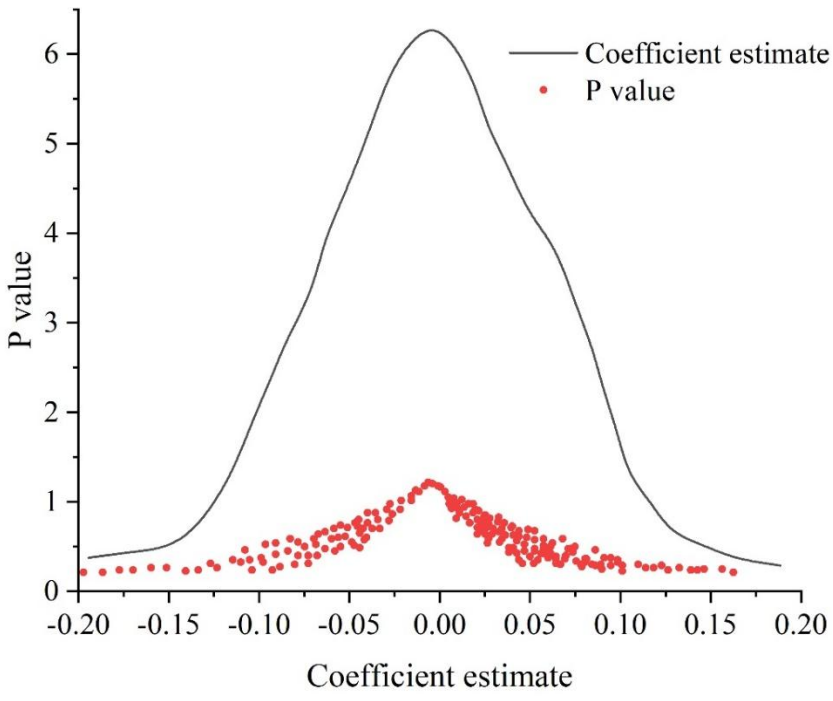

Figure 3. Placebo test results.

4.2.3. PSM-DID

In order to improve the comparability of the pilot cities (experimental group) and non-pilot cities (control group) in the multidimensional shock zone of trade war, this paper uses the PSM-DID method to analyze in order to test the robustness of the benchmark regression results. In this paper, the control variables in Equation (13) are used as matching variables, and the experimental and control groups are re-matched using kernel matching, and the regression is re-run using the matched data, and the results are shown in Column (2) of the table.The DID is significant and the coefficients are negative, which indicates that the baseline regression results in this paper are robust.

4.2.4. Removal of disruptive policies

During the sample period of this paper, the policies with high correlation with cross-border e-commerce and trade war multidimensional shocks mainly include the pilot policies of Smart City, Pilot Free Trade Zone, National Comprehensive Pilot Zone of Big Data, National E-commerce Demonstration City, Broadband China, National New District and Innovative City. In order to eliminate the impact of the above disruptive policies, this paper introduces dummy variables for the above seven policies in the benchmark regression model for regression, and the regression results are shown in Table Column (3). The DID is significant and the coefficient is negative, and the size of the coefficient does not change much compared with the benchmark regression results (-0.0376), indicating that other disruptive policies did not affect the inhibitory effect of the multidimensional shocks of the trade war on the comprehensive performance of cross-border e-commerce, which further verifies the robustness of the benchmark regression results of this paper.

4.2.5. Constructing tool variables

As it is difficult to find suitable instrumental variables for the establishment of trade war multidimensional shock zones, this paper draws on the identification method of utilizing heteroskedasticity to construct instrumental variables proposed by related scholars to deal with the possible endogeneity problem. The regression results of column (4) in Table 8 show that the impact of trade war multidimensional shocks on the comprehensive performance of cross-border e-commerce enterprises is significant and the coefficients are negative, indicating that the results of the benchmark regression in this paper are robust.

Table 8. Robustness test results.

Variable	Placebo test	PSM-DID	Eliminate interference policies	Constructor variable
	TFP(1)	TFP(2)	TFP(3)	TFP(4)
DID	-0.0088 (0.0385)	-0.0459** (0.0238)	-0.0376* (0.0211)	0.1178** (0.0523)
Constant term	-0.6643 (0.8823)	-0.6233 (0.8433)	3.8825 (0.1981)	0.0001 (0.0058)
Regional effect	Control	Control	Control	Control
Time effect	Control	Control	Control	Control
R^2	0.0338	0.0342	0.0386	0.0326

4.3. Analysis of regional heterogeneity

The comprehensive performance of cross-border e-commerce is rooted in the level of development of cross-border e-commerce, which is quite dependent on the level of regional economic development. Therefore, the regional influence of geographic location characteristics and cross-border e-commerce in each city may lead to the heterogeneity of trade war multidimensional shock policy effects. For this reason, the effects of trade war multidimensional impact policy will be further explored from the perspective of regional heterogeneity. The trade war multidimensional shock zones are distributed in three regions of East, Central and West China, which provides conditions for regional heterogeneity analysis. Therefore, this paper divides the sample into two sub-samples of east and central-west, which denote economically developed and economically underdeveloped regions, respectively. This reduces the problem of too small a sample size to some extent, and reduces the possibility of bias in the results of the heterogeneity test. Table 9 shows the results of the regional heterogeneity test for the trade war

multidimensional shock zone policy.

From the table, it can be seen that the regression coefficient of the policy effect on the comprehensive performance of cross-border e-commerce in the eastern region is 1.121 and is significant at the 1% level, which indicates that the policy of the multidimensional shock zone of the trade war in the east plays a significant inhibitory role in the level of the comprehensive performance of cross-border e-commerce in the east, but the policy effect of the policy in the central and western regions is not significant. This indicates that the policy in the developed eastern region plays an inhibitory role in promoting consumption, while the policy in the developed central and western regions of the integrated test zone does not play an inhibitory role in promoting consumption. This result implies that the impact of the trade war multi-dimensional impact zone policy on the level of consumption will differ according to regional differences. Therefore, by further increasing the construction of the central and western pilot zones, to help accelerate the development of cross-border e-commerce in the central and western regions, can effectively stimulate the consumption potential of the residents of the central and western regions, the central and western regions need to firmly grasp this new economic growth point, to narrow the gap with the eastern region.

Table 9. Regional heterogeneity survey.

Variable	TFP	
	Eastern region	Central and western region
DID	-1.121*** (0.258)	0.177 (0.122)
Constant term	-15.338*** (4.511)	-6.518 (7.225)
Regional effect	Control	Control
Time effect	Control	Control
R^2	0.911	0.589

5. Conclusion

This paper investigates the relationship between trade war multidimensional shocks on the comprehensive performance of cross-border e-commerce companies by constructing a cross-border e-commerce comprehensive performance measurement model based on principal component analysis and a fixed effects analysis model of trade shocks.

This paper finds that, controlling for other explanatory variables to keep the conditions the same, if the level of multidimensional shocks from the trade war is increased by 1%, the level of comprehensive performance of Chinese cross-border e-commerce firms will decrease by 3.85%, so that the reduction of the level of multidimensional shocks from the eye trade war will significantly increase the value of China's exports of cross-border e-commerce firms. In addition the regression coefficient of the policy effect of the eastern region on the comprehensive performance of cross-border e-commerce is 1.121 and is significant at the 1% level, which indicates that the policy of the multidimensional impact zone of the eastern trade war plays a significant inhibitory role in the level of the comprehensive performance of cross-border e-commerce in the east, but the policy effect in the central and western regions is not significant.

In the environment of the U.S.-China trade war, China's cross-border e-commerce exporters and the corresponding manufacturing industries should take early warning precautions and take countermeasures.

(1) Establishing independent brands and forming core competitiveness, export e-commerce companies should grasp the quality of products, control product costs, and hold on to their original advantages. Products based on quality, under the premise of ensuring quality, strict control of production costs, logistics costs.

(2) Enterprises should emphasize the issue of intellectual property rights. In this trade war, the U.S. side has repeatedly emphasized the issue of intellectual property rights. In the future, there is no doubt that the protection of knowledge products will become stronger and stronger. In this regard, Chinese e-commerce enterprises should pay attention to avoiding goods that may infringe intellectual property rights when choosing goods to avoid the risk of infringement. Chinese manufacturing enterprises should focus on independent research and development and design, from “Made in China” to “Created in China”, and strive to independently research and develop core technologies, perhaps only by independently designing products and building independent brands can we get rid of the low-end competition pattern of price competition. The only way to get rid of the low-end competition pattern of price competition is to design products independently and build independent brands.

(3) Relying on independent platforms and avoiding policy risks, the government should foster and develop China-led cross-border e-commerce platforms. The government participates in the development of international trade rules of the game, for China in international trade to obtain more initiative, the right to speak. And enterprises can also establish their own independent website, with more free development space, to avoid the risk of policy changes in the third-party platform.

(4) Accelerate industrial clustering, industrial upgrading and transformation, e-commerce penetration triggers the transformation of traditional foreign trade, cross-border e-commerce to drive the development of industrial clustering, and promote the upgrading and transformation of traditional industries. Make China's upstream suppliers from the original rough to fine-tuning type of transformation, from the traditional production of processing gradually transition to branding.

The trade war has also given China's cross-border e-commerce enterprises a profound lesson in peace and security, which is the hard principle of development. The trade war may force the supply-side industrial reform, and become an opportunity for China's manufacturing industry to upgrade and transform.

Fundin

1.2024 Educational Teaching Reform Research & Practice Project of Guangdong Provincial Higher Vocational Education Teaching Management Special Committee： Research on the Construction of High-level Professional Groups Based on the "Triple-Chain Coupling" of the Industrial Chain, Professional Chain, and Talent Chain — A Case Study of Foshan Higher Vocational （GDGX202401043）

2.2023 Discipline Co-construction Project of the Guangdong Provincial Philosophy and Social Sciences Planning: Research on the Construction Mechanism and Implementation Path of Professional Groups Based on the "Triple-Chain Coupling" of Industrial Chain, Talent Chain, and Professional Chain — A Case Study of Vocational Colleges and Industrial Development in the Pearl River Delta（GD23XJY05）

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