An Empirical Study on The Impact of Cross-Border E-Commerce on China's Export Structure

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Abstract: This paper uses time series data from 2005 to 2020, takes cross-border e-commerce trade volume as the explanatory variable, and selects the proportion of mechanical and electrical products that can represent the significant characteristics of China's export structure in total export as the explained variable to build a VAR model. The main conclusions are as follows: there is a cointegration relationship between the original sequence data series of export proportion of electromechanical products and the logarithmic sequence of cross-border e-commerce trade volume after first-order difference. The VAR model with 3 order lag is constructed, and the fitting effect is good and the model is stable. The proportion of mechanical and electrical products responds to the development of cross-border e-commerce with a fluctuation range of 1% and periodic fluctuations in 4 years. The testing model can determine that the development of cross-border e-commerce is the Granger cause of the proportion change of mechanical and electrical products. The research results of this paper can provide reference for related researches on the promotion effect of cross-border e-commerce on China's export.

Keywords: Cross-border e-commerce, China's export trade, VAR model.

1 Introduction

China's exports are facing trade protectionism and sluggish growth due to the impact of COVID-19. The rapid growth of cross-border e-commerce in recent years is considered to be an important driving force to boost export growth and promote China's new pattern of dual development.

Some scholars have conducted empirical studies on the interaction effect of cross-border e-commerce in promoting foreign trade [2] [3]. Wang selected the transaction scale of cross-border e-commerce and the total amount of import and export trade to collect relevant data and conduct VAR test on the relationship between them [6]. Chai uses the time series data of China's cross-border e-commerce transaction volume, online shopping users and import and export trade volume to establish VAR model and empirically analyze the interaction effect between China's cross-border e-commerce and foreign trade [1]. Transaction cost reduction is an important mechanism for cross-border e-commerce to promote trade growth [5]. Ma analyzed the mechanism of cross-border e-commerce to reduce transaction costs [4]. Many scholars analyzed

ICIDC 2022, June 17-19, Qingdao, People's Republic of China

DOI 10.4108/eai.17-6-2022.2322839

the mechanism of cross-border e-commerce to promote the double cycle. They proposed that the growth of cross-border e-commerce could optimize the allocation of factor resources [7]. The optimal allocation mechanism of factor resources for cross-border e-commerce has become the theoretical basis for formulating relevant policies [8].

However, there are few empirical studies on the optimal allocation of cross-border e-commerce promotion factor structure. The change of export product structure will cause the change of factor structure. The most significant characteristic of the change of China's export product structure is the increase of the proportion of electromechanical products exported. Exports of mechanical and electrical products increased from 13.59 percent in 1992 to 44.41 percent. In the initial stage of cross-border e-commerce, the proportion of mechanical and electrical products exported rose by 18.16%.

Is there an interactive relationship between the development of cross-border e-commerce and China's export structure? In order to explore this problem, VAR model was constructed with the proportion of mechanical and electrical products in China's total export as the dependent variable and the volume of cross-border e-commerce trade as the independent variable to conduct empirical analysis.

2 Model construction and data description

2.1 The VAR model

Vector autoregressive model is widely used to analyse the interaction between two variables. The most prominent advantage of this model is that it does not have any prior constraints. All variables in the model are treated as endogenous variables, and endogenous variables perform regression on lagged terms of all endogenous variables in the model, so as to estimate the dynamic relationship of all endogenous variables, which can avoid subjective inference leading to errors or omissions in the division of endogenous and endogenous variables. The basic form of VAR model is:

$$Y_t = \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \ldots + \beta_i Y_{t-i} + \varphi X_t + \varepsilon_t,\ t=1, 2, \ldots n \tag{1}$$

Where, Y_t is the endogenous variable vector, X_t is the exogenous variable vector. i is the lag order, β_i is the coefficient, and ε_t is the disturbed column vector.

2.2 Variable definitions and data sources

In order to analyse the interactive relationship between cross-border e-commerce and China's export structure, the volume of cross-border e-commerce trade is selected as an explanatory variable, represented by *X*. The proportion of mechanical and electrical products in total exports was selected as the explained variable, represented by *Y*. Descriptive statistical results of sample data is shown in Table 1.

Table 1. Descriptive statistical results of sample data.

Variable	*Y*	ln *X*
Mean	0.4303	0.8826
Max	0.4469	2.5257
Min	0.4148	-0.8439
S.D.	0.0093	1.174

Time series data from 2005 to 2020 were selected. The data of electromechanical industry comes from China Customs and the code is HS84-85. Cross-border e-commerce export volume data comes from Amazon 2021 Cross-border e-commerce market opportunities and Technology Trends white paper data. In order to eliminate the errors that may exist in the data and the heteroscedasticity between the data due to the accumulation of errors, logarithms of explanatory variables are taken.

3 Empirical tests

Empirical test includes the following steps: First, conduct unit root test to ensure the stability of data. Second, through the co-integration test, verify whether there is a long-term equilibrium relationship between variables. Thirdly, the lag order of the model is determined, the VAR model is constructed, and the impact degree and duration of the impact of the independent variable on the dependent variable are determined through the impulse response. Finally, granger causality test is used to test whether there is a causal relationship between variables.

3.1 Stationarity test of time series

Table 2 shows the ADF test results: The ADF statistical values of Y and ln X are both greater than the confidence values at the confidence level of 10%, which cannot reject the unit root null hypothesis, so the data series is not stable.

After the first-order difference, the ADF value of *Y* is less than the confidence value of 5% confidence level, which can reject the null hypothesis, that is, the data series does not exist unit root and is a stationary sequence. The ADF test value of ln *X* is still greater than the confidence value at the 10% confidence level, so the null hypothesis cannot be rejected and the data sequence is still unstable.

After second-order difference, the ADF value of ln *X* is less than the confidence value of 1% confidence level, which can reject the null hypothesis, that is, there is no unit root in this data series and it is a stationary series.

Table 2. ADF test results.

Variable	ADF	Stability
Y	-2.0632	N
ΔY	-3.5611**	Y

ln *X*	-2.4145	N
Δ ln *X*	-2.6441	N
Δ^2 ln *X*	-5.9782***	Y

***, ** and * indicate that variables are stable at 1%, 5% and 10% levels respectively

3.2 Co-integration test

Since the co-integration test can be carried out only when the series of same-order difference is stable, the co-integration test is carried out by using the first-order difference series of cross-border e-commerce trade volume and the original sequence data series of export percentage of electromechanical products. Table 3 shows the Johansen cointegration test results.

First, null hypothesis 1 is tested: there is no co-integration equation in the model. P-values of trace statistics and maximum eigenvalue statistics show that, at the significance level of 5%, rejection of the null hypothesis means that at least one co-integration equation exists. Then, null hypothesis 2 is tested: there is no more than one co-integration equation in the model. The null hypothesis is rejected according to the same rule, which means there are at least two co-integration equations.

Table 3. Johansen cointegration test results.

Number of cointegration equations	Trace statistic value	Maximum eigenvalue statistical value
0	45.9004**	38.6890**
at most 1	7.2114**	7.2114**

** indicate that variables are stable at 5% levels respectively

After inspection, it is found that there is a cointegration relationship between the original sequence data series of export proportion of mechanical and electrical products and the logarithmic sequence of cross-border e-commerce trade volume after first-order difference.

3.3 Determine the lag order

The lag order of VAR model is selected according to the information criterion. If the lag order given by AIC and SC is the same, the lag order is selected as the maximum lag order of the model. If there is a difference between the two, LR can be used for judgment. Since the maximum lag order given by AIC and SC is the same, which is 3 lag order, the model finally selects 3 lag order. The regression results of VAR model are shown in Table 4, and R^2 is 0.9726, indicating good fitting effect.

Table 4. VAR model regression results.

	Y	Δ*ln X*
	-0.5633	9.8781
Y (-1)	(0.1498)	(6.1145)
	[-3.7605]	[1.6155]
Y (-2)	-1.1332	3.8680

	(0.2335)	(9.5309)
	[-4.8532]	[0.4058]
	0.2179	1.4979
Y (-3)	(0.0935)	(3.8187)
	[2.3296]	[0.3922]
	-0.0433	0.2539
Δ*ln X* (-1)	(0.0124)	(0.5071)
	[-3.4853]	[0.5008]
	-0.1101	1.1158
Δ*ln X* (-2)	(0.0171)	(0.6978)
	[-6.4446]	[1.5990]
	-0.1107	0.2758
Δ*ln X* (-3)	(0.0239)	(0.9765)
	[-4.6286]	[0.2824]
	1.1306	-6.7058
C	(0.1372)	(5.6006)
	[8.2403]	[-1.1973]
R^2	0.9726	0.4923

The numbers in parentheses are the standard error values, and the numbers in square brackets are the values of the T statistic.

Inverse root test of AR characteristic polynomial with lag order 3 was conducted for VAR model. Figure 1 shows that all the unit roots fall within the unit circle, indicating that the model is stable.

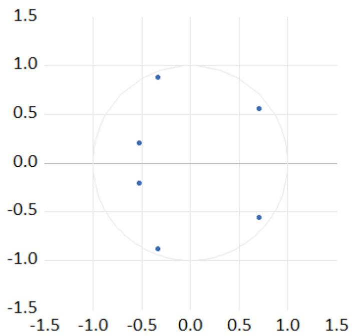

Fig. 1. Inverse root test of AR characteristic polynomial.

3.4 Impulse response analysis

Response of *Y* to ln *X* shows the Response of export structure to the impact of cross-border e-commerce trade volume, see Figure 2. The development of cross-border e-commerce had a negative impact on the proportion of export of electromechanical products in the first four periods, a positive impact from the fifth period to the ninth period, and a negative impact in the tenth period. The amplitudes of both positive and negative shocks are within 0.01. The response of the export structure to the development of cross-border e-commerce shows the characteristics of periodic fluctuation in 4 years.

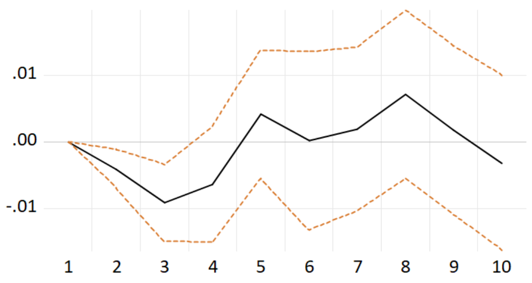

Fig. 2. Response of Y to ln X.

Response of ln X to Y shows the Response of cross-border e-commerce trade volume to the impact of export structure, see Figure 3. The impact of the increase in the proportion of mechanical and electrical products in the export structure on the development of cross-border e-commerce also presents a fluctuating trend. The first phase has negative impact, the second phase is positive impact, the third phase is negative impact, the fourth phase to the eighth phase has positive impact, and after the ninth phase, it becomes negative impact. The amplitude of negative shock is greater than that of positive shock.

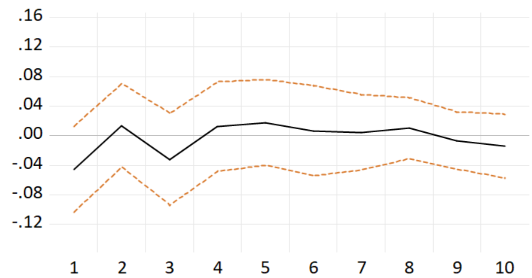

Fig 3: Response of ln X to Y.

3.5 Granger causality test

The granger causality test is also reliable by using the time series with the same order difference and stability. Therefore, the granger causality test is conducted by using the first-order difference series of cross-border e-commerce trade volume and the original sequence of the export share of three mechanical and electrical products, just like the co-integration test. Paired Granger causality test results is shown in Table 5.

According to the P value of F statistic, judge whether to reject the null hypothesis of Granger causality test. According to the P value of LM (1) test, it is judged whether the random error term of Granger causality test model in each lag period has first-order sequence correlation, and the excluded random interference term has sequence correlation.

The results show that for the null hypothesis of "Δln X is not the Granger cause of Y" (H1) in the lag stage 1, lag stage 2 and lag stage 3 models, the P value of F statistic is less than 0.05, then the null hypothesis is rejected at the significance level of 5%, and the development of cross-border e-commerce is considered to be the Granger cause of the increase in the proportion of electromechanical products. For the null hypothesis that " Y is not the Granger cause of $\Delta \ln X$ " (H2), and the P value of F statistic is greater than 0.05, the null hypothesis is accepted at the significance level of 5%, and the growth of the proportion of electromechanical products is not the Granger cause of the development of cross-border e-commerce.

At the significance level of 10%, LM (1) test of lag 1 phase model and 1% significance level of lag 2 phase model reject the null hypothesis that the random error term of the model does not have sequence correlation, that is, the random error term of the test model has sequence correlation. The LM (1) test of lag phase 3 model could not reject the original false at the significance level of 1%, 5% and 10%, and there was no sequence correlation in the random error term of the test model.

Table 5. Paired Granger causality test results.

Lag	Null hypothesis	F/P	LM(1)/P	Results
1	H1	0.0012***	0.0997*	Reject
	H2	0.7219	0.1304	Accept
2	H1	0.0074***	0.0018***	Reject
	H2	0.1228	0.4847	Accept
3	H1	0.0004***	0.9325	Reject
	H2	0.4868	0.4195	Accept

***, ** and * indicate that variables are stable at 1%, 5% and 10% levels respectively

Finally, according to the results of the three lag periods, the development of cross-border e-commerce is the Granger cause of the increase in the proportion of electromechanical products.

4 Result analysis

The stationarity test results of time series show that the first-order difference series of proportion data of electromechanical products and the second-order difference series of trade volume data of cross-border e-commerce are stable. The co-integration test results show that there is a co-integration relationship between the original sequence data series of export proportion of electromechanical products and the logarithmic sequence of cross-border e-commerce trade volume after first-order difference. According to the same lag order of AIC and SC, the VAR model was finally constructed by selecting the lag order of 3, and the determination coefficient R2 was 0.9726, indicating good fitting effect. The AR characteristic polynomial inverse root test results show that the model is stable. Impulse response analysis results show that the proportion of mechanical and electrical products in response to the development of cross-border e-commerce shows a cyclical fluctuation of 4 years, and the impact range is less than 1%. Granger causality test results show that the three-stage lag test model can determine that the development of cross-border e-commerce is the Granger cause of the proportion change of electromechanical products.

5 Conclusions

In this paper, the trade volume of cross-border e-commerce is taken as the explanatory variable, and the proportion of mechanical and electrical products in total export is taken as the explained variable. The VAR model is constructed by using the time series data from 2005 to 2020. Through the test, it is found that there is a cointegration relationship between the original sequence data series of export proportion of mechanical and electrical products and the logarithmic sequence of cross-border e-commerce trade volume after first-order difference. The VAR model constructed with a lag of 3 orders has good fitting effect and is stable. The proportion of electromechanical products responds to the development of cross-border e-commerce with a fluctuation range of 1% and periodic fluctuation in 4 years. The test model can determine that the development of cross-border e-commerce is the Granger cause of the proportion change of electromechanical products.

This paper finds that the rapid development of cross-border e-commerce has a limited impact on the export structure of electromechanical products. If the effect on product structure is small, then the effect on the allocation of factors used to produce those products is small. This conclusion can provide reference for those who believe that cross-border e-commerce can greatly promote the optimal allocation of factors. How can the development of cross-border e-commerce further guide the change of product structure and promote the optimal allocation of factors.

Acknowledgements: This research is financially supported by the 2022 Economic and management academy team project of Dalian university: Research on the path of cross-border e-commerce connecting "internal and external circulation" in the era of digital economy.

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