The Relationship between Foreign Trade and Regional Economic Growth: Based on Cointegration - Granger Causality Test

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Abstract—Under the background of economic globalization, development of foreign trade has a significant impact on the economic development of a country or region. This paper uses empirical analysis to explore relationship between foreign trade and regional economic growth of the Pearl River Delta region from 2010 to 2019. Correlation and Granger causality tests find that both export trade and import trade in the PRD have a significant positive effect on regional economic growth, but the promotion of export trade is more prominent, which is the Granger cause of economic growth. Ordinary Least Square method and cointegration test reveals a long-term equilibrium relationship is existed between GDP and total foreign trade and exports in the PRD, but there is no long-term equilibrium relationship with imports[1].

Keywords-Ordinary Least Square; Foreign trade; Regional economic development; Granger; Cointegration test

1 INTRODUCTION

Under the background of economic globalization, economic growth has always been paid attention to by people, and foreign trade has a significant impact on economic growth. Since China acceded to the WTO, imports and exports have increased rapidly, becoming the world's largest foreign trading country. As a link between China and the world economy, foreign trade has promoted the continuous development of China's economic development. The PRD is adjacent to Hong Kong and Macau and faces Southeast Asia. It uses its geographical advantages and government policy support to participate in international trade actively, realize effective industrial transfer with developed countries, and become the most dynamic region with market development prospects in mainland China. In 2019, the GDP of the PRD region reached 8.6 trillion yuan, and the total import and export trade volume were 0.68 billion yuan.

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It can be seen that the foreign trade of the PRD region has a profound impact on economic development.

Since the reform and opening-up, Guangdong Province has become the largest foreign trade province. At the same time, the speed of foreign trade and economic growth in the PRD region has exceeded that of most regions or cities in China, and the contribution of foreign trade to the economic growth of the PRD region in China is also very significant. In recent years, due to the Sino-US trade war and the impact of COVID-19, China's foreign trade in various provinces and regions has been affected to varying degrees, especially in the PRD region. Therefore, it is of practical significance to select the PRD region as the representative to study the relationship between regional economic growth and foreign trade and enrich the relevant theoretical studies.

2 LITERATURE REVIEW

Foreign trade, also known as import and export trade, refers to the exchange of goods, services, and technology between countries, regions, and regions. It consists of two parts: import and export. Foreign trade connects countries with higher levels of commodity production development and makes countries with lower levels of production development join the exchange link through foreign trade. Participating in the international division of labor through foreign trade will make full use of the resources of various countries to improve the economic efficiency of enterprises, absorb advanced management and scientific and technological achievements, enhance economic strength, and ensure the smooth progress of social reproduction activities. Qu Ruxiao (2008) combines China's actual national conditions to import and trade products that lack relative advantages, save the limited resources in society, and use them in the production of products with certain relative advantages before exporting them, which can maximize the overall benefits, thus saving the country's limited resources and improving labor productivity [1].

In studying the relationship between foreign trade and economic growth, most scholars believe that foreign trade can better promote economic growth. Liao Jinzhong and Deng Haibin (2006) used static empirical analysis to conclude that China's import trade is essential in promoting economic growth [2]. Wu Hansong (2008) studied the relationship between China's import and export and economic growth and concluded that imports and exports promoted economic growth. Li Chenghan (2013) empirically analyzed the results that foreign trade of Asian emerging countries plays a catalytic role in the national economy [3]. Zhang Jie (2016) found in the analysis of the contribution of foreign trade to economic growth in Guangdong Province that Guangdong Province is highly dependent on foreign trade, the elasticity of foreign trade exports is greater than 1, and foreign trade plays a positive role in the economy of Guangdong Province [4].

Wu Dongsheng, Yu Lu [5], and Yang Yiping (2019) [6], combined with compound quantile regression, put forward an improved two-stage quantile regression estimation method and used the proposed method to analyze the impact of foreign trade on economic growth. Research shows that foreign trade has a positive impact on economic growth, and the higher the degree of foreign trade openness, the greater the impact on economic growth. In the post-crisis era, Cheng Jiayun and Xue Lanting (2021) discussed the relationship between foreign trade and

economic growth in Anhui Province [7]. Economic growth in Anhui mainly comes from its GDP growth, but both export trade and import trade have a significant role in promoting Anhui's economic growth. Import trade has played a more significant role in Anhui's economy, particularly in recent years compared with export trade. When considering the impact of international trade on economic growth within the framework of heterogeneous firms, the impact of openness on growth depends on the impact of openness on the marginal cost of innovation (R. E. Baldwin and F. Nicoud, 2008) [8]. When Kaushal and Pathak (2015) studied the relationship between India's foreign trade and economic growth, they found that economic growth led to trade opening [9]. Lai Dihui and Wu Xiaofei (2019) concluded in the study of the relationship between Tianjin's foreign trade and economic growth based on the VAR model that there is a two-way promotion of Tianjin's foreign trade and economic growth [10].

Hu Yanan, Wang Jintian, and Tian Maogai (2020) took China's provinces as an example, and the researchers obtained a different conclusion from other scholars. In addition to the negative inhibitory impact of economic growth on foreign trade, there are spatial spillover effects within China's eastern, central, and western regions [11]. Fair Ray C. (2020) used a multi-country macroeconomic measurement model to analyze the impact of increased import competition from China on the economy of the US. His research revealed that previous studies may have overestimated the negative impact of increased Chinese import competition on the economy of the US and employment, or underestimated its positive impact [12].

In the last decade, many industries in the PDR region have begun to transfer or upgrade on a large scale, and the economy of the PDR with processing trade as the core is facing tremendous pressure. With this background, this paper endorses the mainstream view that foreign trade promotes economic growth and uses data from the past ten years to study the relationship between foreign trade and economic growth in the PRD region to provide some references for the economic development of the region.

3 MECHANISM ANALYSIS OF FOREIGN TRADE AFFECTING ECONOMIC GROWTH

3.1 Economic Situation of the PRD Region

The PRD region is China's most important foreign trade and economic region. Since the reform and opening-up, its gross domestic product (GDP) has been continuously growing, even reaching 8.6 trillion yuan in 2019, of which Shenzhen, Guangzhou, Foshan, and Dongguan have a total GDP of more than 7 trillion yuan, accounting for 7.1% of the country's total economy. It is thus the PRD region is sustaining its upward momentum. However, with economic globalization, there are new changes in the international flow of industries and capital, numerous advantages of the PRD region are disappearing - the speed of economic development is reduced and the momentum is insufficient. The economic development in the region is facing new opportunities and challenges.

Table 1 GDP of the PRD Region (2010-2019)

Year	GDP (billion yuan)	Year	GDP (billion yuan)
2010	38028.65	2015	62541.37
2011	43890.08	2016	68196.86
2012	47939.11	2017	74953.26
2013	53427.38	2018	80440.72
2014	57844.44	2019	86899.12

3.2 Foreign Trade in the PRD Region

1) Trade Size

Since the reform and opening-up, the PRD region has established an economic development model of "front shop, back factory" for the region and Hong Kong and Macao, which has promoted an export-oriented economic development system dominated by processing trade. Under the background of international capital investment, the PRD region has rapidly developed into an internationally renowned economic and trade zone. The total import and export trade volume of the Pearl River Delta region in 2010 was 5129.521 billion yuan, and the total import and export trade volume in 2019 was 6828.191 billion yuan, which has increased by 33% in the past ten years. This incredible progress also confirms that the PRD region will continue to develop in the past, present, and future (see Table 2).

Table 2 Trade Size in the PRD Region (2010-2019)

Year	TMX (billion yuan)	Year	TMX (billion yuan)
2010	51295.21	2015	60601.68
2011	56580.49	2016	60119.76
2012	59666.89	2017	65090.33
2013	64717.62	2018	68613.78
2014	51115.74	2019	68281.91

(TMX is short for total import and export trade volume)

2) Mode of Trade

From Figure 1, it can be found that among the leading foreign trade modes in the PRD region, general trade accounts for the most significant proportion, and the difference between the processing of supplied materials and the processing of imported materials are not big and small, which indicates that the industrial upgrading of the PRD region is entering the deep-water area.

It also means that the competitiveness of industries in this region is gradually increasing in the international market.

The products exported by the PRD region are mainly cheap and labor-intensive products with low added value, while innovative and technical products with high added value account for a tiny proportion, and thus the product competitiveness is weak and the income is low.

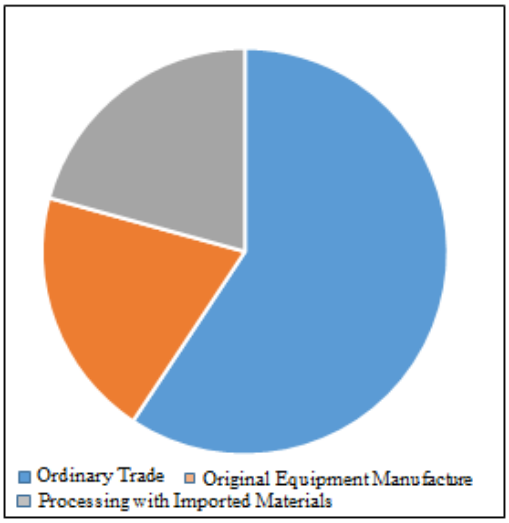

Figure 1 Composition of Foreign Trade Mode in the PRD Region (2017-2019)

3) Degree of Foreign Trade Dependence

The degree of foreign trade dependence is how a country's economy depends on foreign trade for a certain period. It can also reflect the level of a country's economic development and participation in the international economy. In recent years, China's dependence on foreign trade has been increasing. As a typical representative of the export-oriented economy in Guangdong Province and even the whole country, the role of foreign trade in promoting economic development is more obvious. The formula for foreign trade dependence is:

Foreign trade dependence = Total value of import and export /GDP (1)

Import dependence = Value of import/GDP (2)

Export dependence = Value of export/GDP (3)

Since 2010, the degree of foreign trade dependence, export dependence and import dependence of the PRD region have shown a decreasing trend year by year until 2014-2015. However, after 2015, the trend is decreasing again. (See Figure 2)

Regarding market structure, the PRD region is highly dependent on Hong Kong, Japan, and parts of Europe and the Americas, where trade frictions are prone to happen.

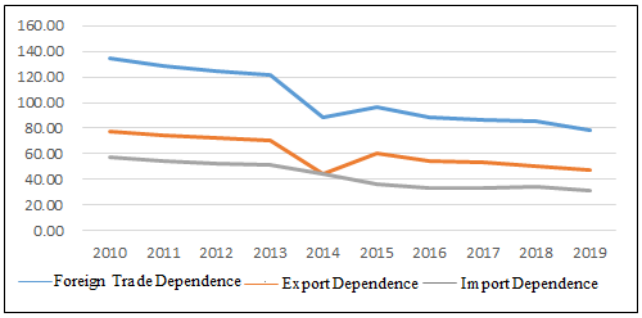

Figure 2 Degree of Foreign Trade Dependence in the PRD Region

3.3 Mechanism Analysis on the Influence of Foreign Trade on Economic Growth

This paper will study the relationship between regional economy and foreign trade from capital accumulation, technological progress, institutional change, human capital accumulation and exchange rate mechanism.

1) Capital Accumulation

As early as the 1800s, Adam Smith pointed out that capital accumulation and economic growth were very closely linked. For foreign export trade, if the rate of return is high, the financial elements of other sectors will flow to the export sector and form the accumulation of capital, which has a vital role in promoting the economic development of a country or region.

2) Technological Progress

Economic growth depends to a great extent on technological progress. Specifically, foreign trade mainly realizes technological progress through technological trade and innovation, promoting economic growth. Countries exchange technical knowledge through foreign trade, improve their own scientific and technological level and production efficiency, save trade costs and increase national income. Foreign trade allows developed countries to acquire more capital to meet the needs of advanced technology research and development and provides opportunities for developing countries to learn and imitate.

3) Changes in Regime

New economists believe that the primary driving force of economic development is the incentives for work, creativity and investment, and the effectiveness of the incentives is affected mainly by the degree of perfection of the system. For example, learning from the reasonable system of foreign enterprises will make the domestic management system more reasonable and perfect. In order to enhance the market competitiveness of domestic products, relevant departments will introduce reasonable systems according to the reality to promote the evolution of domestic products in a more competitive direction, thereby further accelerating the process of economic development.

4) Human Capital Accumulation

Foreign trade allows people to learn knowledge about products and services that they do not possess in the trading process and improve the knowledge base of human capital, learning-by-

doing model, and technology spillovers effect. The technical level in relatively backward developing countries is far lower than that of developed countries. Therefore, it is necessary to actively participate in foreign trade to learn foreign advanced technology and experience. On the one hand, it can save research and development costs and use more funds for other investments. On the other hand, it can accelerate the professional development of human capital, and the final production efficiency will also improve with the improvement of labor quality.

5) Exchange Rate

If the local currency depreciates, the foreign exchange rate rises, and the price of domestic goods does not change much, it will increase the demand for domestic goods and services, and expand the export of domestic goods; on the contrary, if the local currency appreciates and the foreign exchange rate decreases, the price of imported goods expressed in the local currency will increase, thereby affecting the sales of imported goods in the country and inhibiting imports. The exchange rate mainly affects the trade balance through the following ways: first, it affects the import and export trade by changing the relative price of domestic and foreign commodities and then affects the foreign trade balance. Second, the rise and fall of the exchange rate led to changes in the actual price level, affecting the volume of foreign trade, and thus the trade balance. Third, changes in the exchange rate cause changes in the total income of residents, which in turn leads to changes in the trade balance, which in turn affects the economic growth of a country or region.

4 EMPIRICAL STUDY ON THE RELATIONSHIP BETWEEN FOREIGN TRADE AND ECONOMIC GROWTH

1) Data Sources

This paper selects the GDP of the PRD region as an indicator to measure economic growth, and uses the two variables of export trade volume and import trade volume as an indicator to measure the foreign trade status. The GDP, export trade volume and import trade volume from 2010 to 2019 are selected. All the original data are from the Guangdong Statistical Yearbook. In order to narrow the quantitative difference between the variables and reduce the impact of data fluctuations, all variables are logarithmically, and the variables are gross domestic product (LnGDP), total imports and exports (LnT), exports (LnEX) and imports (LnIM).

2) Correlation Test

The correlation coefficients between the value of export and import and GDP are calculated based on the data of the PRD region, as shown in Table 3. There is a positive correlation between imports, exports and GDP in the PDR region. Among them, the correlation coefficients between GDP and exports and imports are 0.724 and 0.555, respectively, with a high degree of correlation, which means that the economic growth of the PRD has a strong correlation with import and export trade.

Table 3 Correlation Coefficients between GDP and Import & Export Trade in the PRD Region

Correlation	GDP	Export	Import
GDP	1.000	0.724	0.555
Export	0.724	1.000	0.714
Import	0.555	0.714	1.000

3) Empirical Analysis

a) Unit Root Test (ADF Test)

Most time-series economic variables are not stable, and direct analysis of the variables may lead to "pseudo-regression "and make the conclusion invalid. GDP, total imports and exports, exports and imports are all continuous time series. Therefore, in this paper, the ADF test is used to test the smoothness of LnGDP, LnT, LnEX and LnIM, respectively, while taking the first and second-order differences of these variables for the same operation, and the specific test results can be seen in Table 4.

As shown in Table 4, the critical value at the significant level of 5% is less than the original ADF value of all variables and is a non-stationary time series. In comparison, the critical value at the significant level of 5% is greater than the ADF value of the second-order differential sequence, so the sequence obtained after the second-order differential is smooth.

Table 4 ADF Test Results for the Smoothness of each Variable

variable	ADF value	5% threshold	Inspection results
LnGDP	-1.7154	-4.2465	Unstable
ΔLnGDP	-6.8435	-2.0062	Stable
LnT	-2.1002	-3.2598	Unstable
ΔLnT	-6.2846	-2.0062	Stable
LnEX	-2.8745	-4.1078	Unstable
ΔLnEX	-4.2914	-2.0062	Stable
LnIM	-4.0215	-4.2465	Unstable
ΔLnIM	-2.2159	-2.0211	Stable

b) Cointegration Test

Cointegration test is often used to test the long-term equilibrium relationship between non-stationary time series variables. The prerequisite for its use is that all variables to be tested are single-integer of the same order. From the unit root test results in Table 4, LnGDP, LnT, LnEX and LnIM are second-order single-integer so that the Ordinary Least Square method can be used for cointegration analysis, the LnGDP is regressed as the explanatory variable, LnT, LnEX and LnIM as the explanatory variable, and the smoothness of the residual sequence is tested.

①Regression Analysis

The regression results of the three models are as follows:

$$LnGDP=-10.294+1.9339LnT \qquad R^2=0.570 \qquad (4)$$

(-1.573) (3.254)

$$LnGDP=-14.8344+2.457LnEX \quad R^2=0.891 \quad (5)$$

(-4.643) (8.085)

$$LnGDP=-6.9536+1.7733LnIM \quad R^2=0.307 \quad (6)$$

(-0.723) (1.882)

From a statistical point of view, the fit degree of model (5) and model (4) is high, and the fit degree of model (6) is low. The most obvious of these is that the coefficient of determination of export value and GDP is 0.891, which is close to the value of 1, indicating that the change in export value can explain 89% of the change in GDP value. From the *t*-test value of the slope term, the *t*-value of the three models is greater than the critical value 1.86 of the degree of freedom of n-2 = 8 at the level of significance of 5%, indicating that the effect of the explanatory variable export, import and total foreign trade on the GDP of the explained variable is significant. From an economic point of view, model (4) shows that for every 1% increase in total foreign trade, the region's GDP will increase by 1.9339%. Model (5) indicates that for every 1% increase in exports, GDP increases by 2.457%. Model (6) shows that for every 1% increase in imports, the GDP will increase by 1.7733%. This result reveals that import and export trade in the PRD region can promote economic growth, and export trade has a greater role in promoting economic growth than imports. Since the reform and opening-up, the PDR region has used its position, labor and other advantages to expand the export volume of raw materials and parts to drive GDP growth.

② Residual Sequence Stationarity Test

As can be seen from the co-integration test principle, if the residual term obtained by the two variables after the Engle-Granger test is a smooth sequence, it is considered that there is a long-term equilibrium relationship between the two variables. Table 5 shows that there is a clear long-term equilibrium relationship between LnGDP and LnT as well as LnEX. In contrast, the long-term equilibrium relationship with LnIM is not obvious, which means there is a long-term equilibrium relationship between GDP in the Pearl River Delta region and total foreign trade and total exports, but there is no long-term equilibrium relationship with total imports.

Table 5 Results of Stationarity Test for Residual Items

variable	ADF value	5% threshold	Inspection results
E(T)	-4.6545	-2.986	Stable
E(EX)	-6.1658	-2.986	Stable
E(IM)	-2.5049	-2.986	Unstable

Note: E (T), E (EX), and E (IM) are the residuals of the regression to equation (4) (5) (6) above, respectively.

③Granger Causality Test

The co-integration test shows a co-integration relationship between foreign trade and economic growth, and whether there is a causal relationship between the two is still unknown. In the time series case, the Granger causality test is mainly used to examine whether x affects y, mainly to

see the extent to which the past X can explain the current Y and whether the lag value of X is added to make the degree of explanation significantly improved. If the correlation coefficient between X and Y is statistically significant, it is called Granger causality. The test results are as follows:

Table 6 Granger Causality Test for each Variable

Original hypothesis	**Lag period**	**F statistic**	***p*-value**	***Inspection results***
LnT is not the Granger cause of LnGDP	2	0.2648	0.7836	*Accepted*
LnGDP is not the Granger cause of LnT	2	0.6229	0.5939	*Accepted*
LnEX is not the Granger cause of LnGDP	2	4.0391	0.0409	*Rejected*
LnGDP is not the Granger cause of LnEX	2	1.5243	0.3493	*Accepted*
LnIM is not the Granger cause of LnGDP	2	9.3921	0.0511	*Accepted*
LnGDP is not the Granger cause of LnIM	2	5.4426	0.1004	*Accepted*

The test results indicated that the relationship between foreign trade and economic growth in the PRD region is as follows: when the data lags for two periods and the confidence level is 0.05, the *P*-value of export trade is not the Granger cause of economic growth, which is 0.0409. In the case of a significance level of 5%, the original hypothesis is rejected, that is, export trade is the Granger cause of economic growth in the PRD region, while economic growth is not. Similarly, there is no apparent causal relationship between import and export and import and economic growth.

5 CONCLUSIONS

Taking the PRD region as an example, this paper studies the relationship between foreign trade and economic growth through the co-integration and Granger causality tests. It is found that there is a long-term positive correlation between economic growth and import trade and export trade in the PRD region. Both export trade and import trade in the PRD region have an important and positive effect on the regional economy. Among them, the promotion effect of export trade is more obvious. Export is the Granger cause of economic growth, and in turn, economic growth is not the cause of export.

In the new stage of industrial upgrading and reform, the key to economic growth and foreign trade in the PRD region lies in how to shift from comparative advantage to competitive advantage, adjust the development of foreign trade on time, find new ways of independent innovation and development, seek more international cooperation by itself as well as by the government, promote economic growth and foreign trade and investment integration, and realize effective upgrading of the future development of regional foreign trade.

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