The Relationship Between Foreign Trade and Economic Development in Guangdong Province

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Abstract. This paper investigates the relationship between foreign trade and economic development in Guangdong Province, aiming to explore how Guangdong promotes economic development through foreign trade. Various econometric methods such as stationarity tests (ADF test), cointegration tests, Granger causality tests, and VAR models are employed to empirically analyze the data of Guangdong Province's GDP and total import and export volumes (Export and Import) from 2000 to 2023. The results indicate a significant positive correlation between foreign trade and economic growth in Guangdong Province. Export trade has a positive impact on high-quality economic development, while import trade shows a negative impact. This study provides theoretical references and empirical evidence for the future economic development of Guangdong Province.

Keywords: Trade-Economic Development, Granger Causality Test, VAR Model, Import and Export Trade.

1 Introduction

In the context of globalization, the role of foreign trade in promoting economic development is significant, particularly in advancing the development of advanced manufacturing and modern service industries. This paper studies the relationship between foreign trade and economic development in Guangdong, aiming to explore how Guangdong leverages foreign trade to drive economic development. Using methods such as the ADF test, cointegration test, and VAR model test, the relationship between Guangdong's GDP and total import and export volumes is analyzed to reveal the impact of foreign trade on Guangdong's economic growth, providing references for Guangdong's future economic development.

2 Literature review

Scholars have conducted extensive research on the development status of regional trade and its impact on economic development.

(1) Development of Foreign Trade. The adoption of an "export-oriented" development strategy has significantly influenced foreign trade dynamics, particularly in Guangdong province. Wang Bingke et al.[1] conducted a comprehensive analysis of Guangdong's foreign trade landscape, identifying key factors and proposing strategic measures to enhance trade

MSEA 2024, May 24-26, Jinan, People's Republic of China

DOI 10.4108/eai.24-5-2024.2350112

performance. This research emphasizes the importance of tailored strategies in fostering robust trade growth. Deng Pingyu's empirical analysis[2], leveraging data on Guangdong's total exports and imports, substantiates the positive correlation between foreign trade and regional economic performance. The findings suggest that foreign trade acts as a catalyst for economic development in Guangdong, highlighting its critical role in driving growth.

(2) Application of Economic Models. Regarding the application of economic models, several studies have employed sophisticated econometric techniques to elucidate the interplay between foreign trade and economic growth. Ye Junwei et al.[3] utilized empirical statistical models, notably cointegration tests and Granger causality tests, to establish a long-term equilibrium relationship between foreign trade and GDP growth in Guangdong province. Their research confirms the existence of a cointegrating relationship, providing a robust framework for understanding trade dynamics. Wu Wenwen's research[4] introduced an Autoregressive Distributed Lag (ARDL) model to examine the relationship between import and export trade and high-quality economic growth in Guangdong. The study reveals that while export trade positively influences high-quality economic growth, import trade has a negative impact. This nuanced understanding underscores the differential effects of trade components on economic performance. Liu Jinshan et al.[5] employed a Vector Autoregression (VAR) model to empirically investigate the impact of export and import trade on economic growth in Guangdong province. Their findings contribute to the broader discourse on trade and growth, providing valuable insights into the dynamic interactions within the regional economy. Liu Xiaopeng's application of cointegration econometric analysis and the construction of an error correction model further elucidate the significant role of import growth in national economic development[6]. This research demonstrates the critical importance of imports in sustaining economic growth, expanding the understanding of trade's multifaceted impacts.

(3) Broader Context and Comparative Studies. Expanding the scope beyond Guangdong, other scholars[7-8] have explored the impact of sectoral value addition on international business, capital flows, and economic growth in different contexts. For instance, research on the added value of agriculture, forestry, and fisheries in India has examined both short-term and long-term equilibria, providing insights into sector-specific contributions to economic growth. Utilizing the Environmental Kuznets Curve (EKC) framework, studies have assessed the environmental and economic impacts of trade in environmentally-sensitive products across G20 countries from 1990 to 2019. These investigations highlight the complex interactions between trade, environmental sustainability, and economic development. In the context of Afghanistan, a multiple regression model has been deployed to analyze the effects of imports and exports on economic growth from 2003 to 2021. This research[9] underscores the critical role of trade in shaping economic trajectories in conflict-affected regions. Further, studies on Bangladesh have evaluated the influence of technological innovation, foreign direct investment, trade, and human capital on economic development. By examining the symmetric and asymmetric effects of these factors, the research provides a comprehensive understanding of their collective impact on growth[10].

In summary, scholars have examined the development of foreign trade in Guangdong province and its impact on economic growth from various angles, enriching our understanding of the province's and the nation's foreign trade development model, and providing theoretical guidance for the future development of foreign trade.

3 Methods

Step 1: as shown in Figure 1, to determine the relationship between GDP and import and export trade, the ADF test is first conducted for stationarity, with appropriate logarithmic or differencing operations applied to reduce the non-stationarity of the data, according to equations (1), (2) ,(3) .

$$\Delta X_t = \sigma X_{t-1} + \sum_{i=1}^{m} \beta_i \Delta X_{t-i} + \epsilon_t \quad (1)$$

$$\Delta X_t = \alpha + \sigma X_{t-1} + \sum_{i=1}^{m} \beta_i \Delta X_{t-i} + \epsilon_t \quad (2)$$

$$\Delta X_t = \alpha + \beta_t + \sigma X_{t-1} + \sum_{i=1}^{m} \beta_i \Delta X_{t-i} + \epsilon_t \quad (3)$$

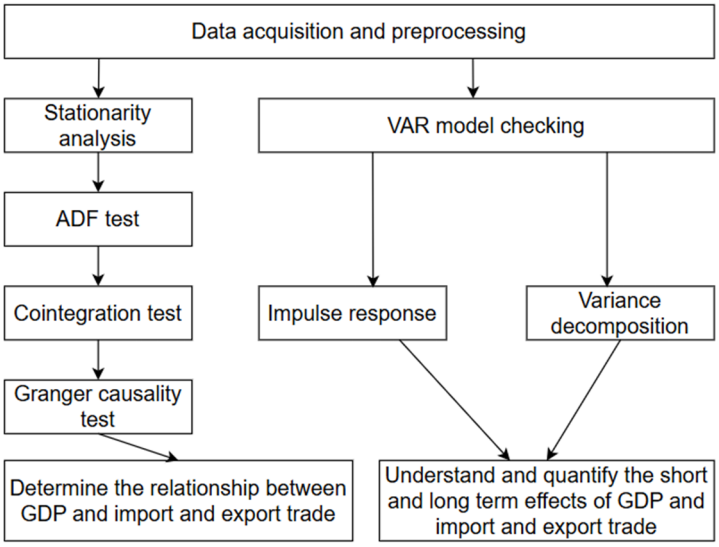

Figure 1 Flow chart of research methods

Step 2: the cointegration test is conducted for non-stationary series to determine the long-term stable relationship between these variables. The Engle-Granger two-step method used to test for cointegration between two non-stationary time series, y_t and x_t can be outlined as follows. First, perform a linear regression of y_t on x_t to obtain the residuals (u_t) which represent the deviation from the long-run equilibrium relationship:

$$y_t = \alpha + \beta x_t + u_t \quad (4)$$

Second, ADF-type regression on the differenced residuals can be represented:

$$\Delta u_t = \gamma u_{t-1} + \sum_{i-1}^{p} \emptyset_i \Delta u_{t-i} + \epsilon_t \quad (5)$$

In this equation: Δu_t represents the first difference of the residual at time t, γ is the coefficient on the first lag of the differenced residual, indicating the strength of serial correlation, $\emptyset_i$ are coefficients for additional lagged differences of the residuals, capturing higher-order serial dependencies, ϵ_t is the error term assumed to be white noise.

Step 3: the Granger causality test is performed to determine whether one or a group of time series can effectively predict the future values of another time series. The mathematical formulation for conducting a Granger causality test involves a regression models and using an F-test to determine statistical significance, according to equations (6).

$$Y_t = \sum_{i-1}^{s} \alpha_i Y_{t-1} + \sum_{i-1}^{m} \beta_i X_{t-1} + u_{2t} \quad (6)$$

Step 4: to understand and quantify the short-term and long-term effects between GDP and import and export trade, a VAR model is established for impulse response and variance decomposition analysis, with python program Project1.

```
program Project1;
begin
import pandas as pd
import numpy as np
from statsmodels.tsa.vector_ar.var_model import VAR
import matplotlib.pyplot as plt
lag_order = 1
model = VAR(data)
results = model.fit(maxlags=lag_order)
print(results.summary())
results.plot_acorr()
plt.show()
irf = results.irf(periods=10)
irf.plot_cum_effects()
plt.show()
end.
```

4 Empirical Analysis

4.1 Data Collection and Processing

Utilizes Eviews 12 for data analysis. We conduct an empirical analysis on the relationship between foreign trade and economic development using data spanning 24 years, from 2000 to 2023, from Guangdong province. The selected variables include the Gross Regional Product (GDP), Export volume, and Import volume of Guangdong province. As observed from Figure 2, the growth of imports and exports in Guangdong is largely synchronous with GDP growth, indicating a positive correlation between them. Influenced by the financial crisis in 2008, China experienced a decline in total import and export volume. However, following the implementation of emergency measures to stabilize the financial system and stimulate

economic growth, China's economy showed rapid growth after 2008. Despite various countermeasures enacted by the government to combat the financial crisis, the economic downturn ensued globally for a certain period, leading to a slowing of China's GDP growth rate. Yet, as the crisis management policies began to take effect, China gradually emerged from the economic downturn, exports and imports gradually rebounded, and signs of economic recovery appeared. Before executing the empirical research, it is necessary to preprocess the sample data. To meet the requirement of stationarity in the time series as much as possible, the data is log-transformed, and the variables following the transformation are denoted as lnGDP, lnEX, and lnIM.

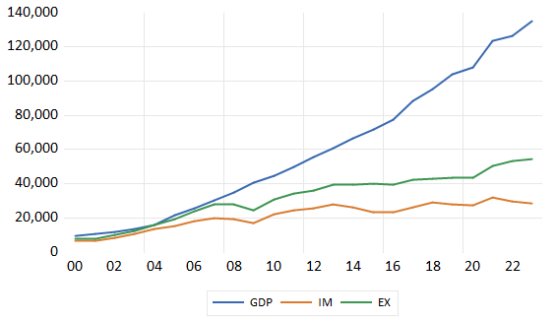

Figure 2 Trends of GDP, Export Volume, and Import Volume

4.2 Stationarity Test

As depicted in Figure 3, the three variables under investigation exhibit a substantial similarity in time trends, all incrementing as time progresses. Initially, it is inferred that the presence of a unit root persists even following the logarithmic transformation of the raw variables.

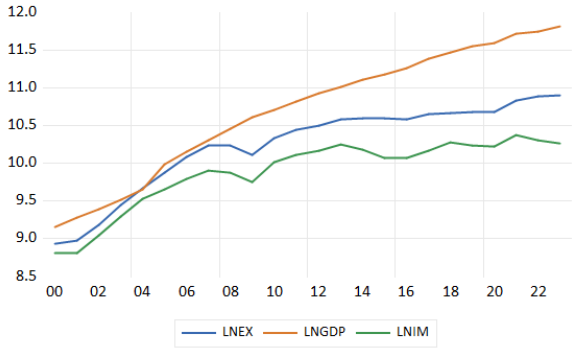

Figure 3 Time Trend Graph of lnGDP, lnEX, lnIM

The present study employs the ADF test to conduct a stationarity analysis of the data. As derived from Figure 3's time trend graph, all three variables under examination demonstrate a pronounced upward trend over time, deducing the presence of a defined trend in this process, with the temporal trend being dominant.

The determination of the lag order in the ADF model is addressed here. The information criterion is chosen to discern the optimal order for the model (as demonstrated in Table 1).

Table 1 Results of ADF stationarity test 1

Variable name	Constanterm	Time trend term	Order of lag	Test value	5% critical value	Stationarity
lnEX	Yes	Yes	1	-3.281441	-3.622033	No
lnIM	Yes	Yes	1	-1.581244	-3.622033	No
lnGDP	Yes	Yes	1	-0.749904	-3.622033	No

As depicted in Figure 4, the time trends of each variable have been substantially diminished. In the ADF test applied to the differentiated variables, lnGDP maintained both the constant term and time trend term, lnEX eliminated both the constant and time trend terms, and lnIM preserved only the constant term, removing the time trend term. The ADF test was repeated for these three new variables, with results displayed in Table 2. As demonstrated in Table 2, the time series data, once differentiated, passed the ADF test under a 5% level of significance, displaying a state of stationarity. This verifies that lnGDP, lnEX, and lnIM all conform to I (1).

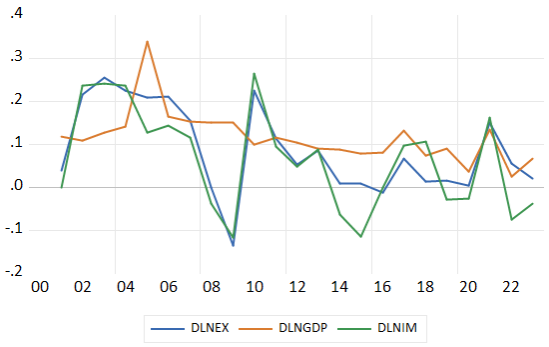

Figure 4 Time trend diagram of dlnGDP, dlnTL, dlnEX and dlnIM

Table 2 ADF test results 2

Variable name	Constan term	Time trend term	Order of lag	Test value	5% critical value	Stationarity
dLnGDP	Yes	Yes	0	-4.439740	-3.004861	Yes
dlnEX	No	No	0	-2.101063	-1.957204	Yes
dLnIM	Yes	No	0	-3.358750	-3.004861	Yes

4.3 Cointegration Test

To examine whether a long-term equilibrium relationship exists amongst the variables within non-stationary sequences, this paper will employ the Engle-Granger two-step process to investigate the relationship between import-export trade and economic development. The initial step involves estimating the regression equation and establishing the following cointegration model:

$$LNGDP=-3.455453+1.382786LNEX+U\_1 \quad (7)$$

$$LNGDP=-6.085805+1.698693LNEIM+U\_2 \quad (8)$$

The residual series of the above two regression equations (7) and (8) are tested for stationarity separately. The hypothesis H0 is proposed: the residual series is stationary. An ADF test is conducted on the residual series (as shown in Table 3). The AEG statistics of both U1 cointegration models and U2 cointegration models can pass the test at a 10% significance level, reject the null hypothesis, and believe that the above regression models are established. The two foreign trade-related indicators studied all have a cointegration relationship with the GDP.

Table 3 AEG test results

Residual sequence	AEG statistics	10% critical value	Stationarity	Co-integration or not
U1	-1.626760	-1.608495	Yes	Yes
U2	-1.612157	-1.608495	Yes	Yes

4.4 Granger Causality Test

To study the economic predictability between variables, it is required to execute a Granger causality test on LNGDP, LNEX, and LNIM. This further probes into whether import and export trade is a primary impetus for the economic growth of Guangdong Province. Table 4 shows the test results when the lag order is at five. It is derived from these results that both the combined and separate entities of import and export indeed serve as the Granger causes for economic growth in Guangdong Province.

Table 4 Results of Granger causality test

Null hypothesis	p-value	Test result	Conclusion
LnEX is not the cause of lnGDP	0.0216	Reject null hypothesis	Exports are responsible for GDP growth
LnGDP is not the cause of lnEX	0.2542	Accept null hypothesis	
LnIM is not the cause of lnGDP	0.0050	Reject null hypothesis	Imports are the cause of economic growth
LnGDP is not the cause of lnIM	0.8286	Accept null hypothesis	

4.5 VAR Model Test

Model Identification and Construction

The most suitable lag order is discerned via the LR statistic, final prediction error (FPE), as well as the AIC, SC, and HQ information criteria. As illustrated in Figure 5, the optimal lag order is identified as one, hence the formulation of the VAR (1) model:

Lag	LogL	LR	FPE	AIC	SC	HQ
0	34.54268	NA	8.57e-06	-3.154268	-3.004908	-3.125111
1	96.13969	98.55522*	4.52e-08*	-8.413969*	-7.816530*	-8.297343*
2	101.5697	7.058997	6.98e-08	-8.056969	-7.011450	-7.852873
3	109.5797	8.010017	9.44e-08	-7.957971	-6.464372	-7.666405
4	119.9427	7.254071	1.30e-07	-8.094267	-6.152589	-7.715231

Figure 5 Optimal Lag Order p Test

Establish Model Equation:

$$LNGDP_t = 0.8586LNGDP_{t-1} + 0.0515LNIM_{t-1} - 0.1060LNEX_{t-1} + 0.0318 \quad (9)$$

$$LNGEX_t = 0.0977LNGDP_{t-1} + 0.4742LNIM_{t-1} + 0.3890LNEX_{t-1} + 0.6035 \quad (10)$$

$$LNIM_t = 0.0747LNGDP_{t-1} + 1.0268LNIM_{t-1} - 0.2334LNEX_{t-1} + 1.3857 \quad (11)$$

The F-statistics of regression equations (9), (10) and (11) are far greater than the critical values, indicating that the fitted equations overall have good statistical significance. Meanwhile, the adjusted R-squared values of the regression equations are 0.996457, 0.974379, and 0.937151 respectively, indicating a very good fit to the original series.

The stationarity test of the model

Figure 6 demonstrates that the reciprocals of the roots of the AR characteristic polynomial are all contained within the unit circle. This suggests the established VAR (1) model complies with the conditions of stationarity, enabling model prediction and impulse response analysis. Concurrently, this signifies the existence of a long-term equilibrium relationship between economic growth in Guangdong Province and overseas trade.

Impulse response analysis of economic growth of Guangdong Province to foreign trade

The Granger causality test deduces that export trade (LNEX) and import trade (LNIM) serve as Granger reasons for economic growth (LNGDP). Primarily, an impulse response analysis of economic growth (LNGDP) is conducted concerning export trade (LNEX) and import trade (LNIM). The horizontal axes in Figures 7, 8, and 9 represent impulse responses, whereas the vertical axes signify the magnitude of the shock (expressed in logarithmic terms). The solid black lines in Figures 7, 8, and 9 denote the effect of a standard deviation innovation of LNGDP, LNEX, LNIM in relation to an increment in the forecast period, while the dashed lines indicate the confidence interval encompassing two standard deviations.

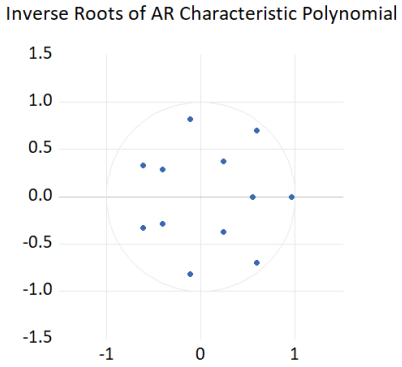

Figure 6 VAR (1) Stationarity test results (Graph)

Figure 7 illustrates that the reaction of the actual GDP (LNGDP) to the standard deviation innovation of GDP (LNGDP) is positive but recedes gradually, signifying the inertia and sustainability of economic growth in Guangdong. Figure 8 suggests the actual GDP's (LNGDP) response to a shock in export trade (LNEX) is positive and rising, peaking in the 6th period. Meanwhile, Figure 9 depicts the actual GDP's (LNGDP) reaction to the shock of import trade

(LNIM) as being positive and increasing, reaching a peak in the 8th period. This implies a one-year lag in the influence of import trade on Guangdong's economic growth.

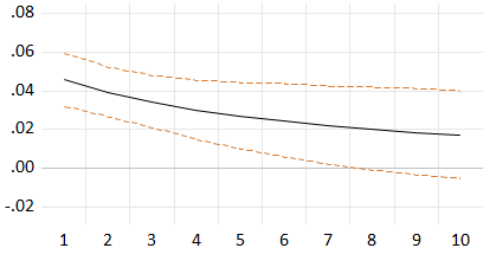

Figure 7 Impulse response of LNGDP to LNGDP

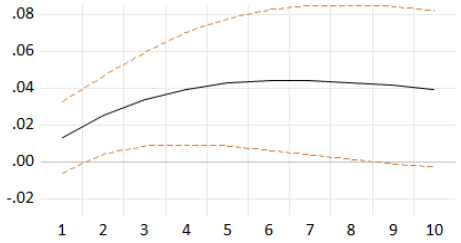

Figure 8 Impulse response of LNGDP to LNEX

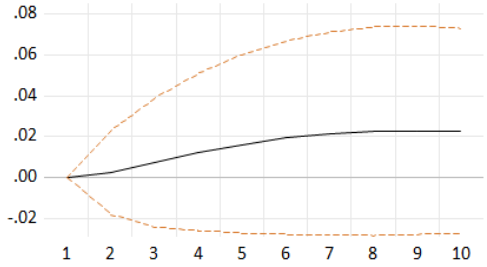

Figure 9 Impulse response of LNGDP to LNIM

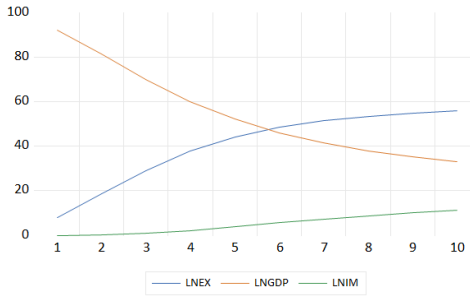

Figure 10 Variance decomposition diagram

In essence, export trade, alongside import trade, in Guangdong fosters its economic growth, and this stimulatory effect typically peaks within 6 to 8 years. Among foreign trade factors, export trade exerts a more conspicuous propulsive effect on Guangdong's economy, exhibiting stronger intensity. Nonetheless, the contributions of import and export trade to Guangdong's economic growth mandate further variance decomposition.

Variance decomposition

To investigate the contributions of export and import trade towards the economic growth of Guangdong Province, a variance decomposition was conducted on variables - the actual gross domestic product (LNGDP), export trade (LNEX), and import trade (LNIM) - causing shocks to the actual gross domestic product (LNGDP). As Figure 10 illustrates, the most significant contributor to the shifts in actual gross domestic product (LNGDP) before the 6th period is itself. The contribution of export trade (LNEX) rapidly escalates, and by the 6th period, considerably impacts the actual gross domestic product (LNGDP), while import trade (LNIM) essentially exerts no influence. Following the 6th period, the contribution of the actual gross domestic product (LNGDP) swiftly decelerates, whereas, the contribution of import trade (LNIM) increases promptly. The two gradually stabilize at approximately 20% after the 10th period. Meanwhile, the contribution of export trade (LNEX) sharply ascends following the 6th period, surpassing the actual gross domestic product (LNGDP), and eventually settles at about 60%.

In the long run, the contribution of export trade to Guangdong Province's economic growth conspicuously surpasses that of import trade.

5 Conclusion

Through empirical research on the relationship between foreign trade and economic development in Guangdong Province from 2000 to 2023, it was found that: (1) Guangdong Province's GDP, total import and export volume, export volume and import volume have maintained a synchronized growth trend in the long term. This indicates that foreign trade plays an important role in promoting the economic growth of Guangdong Province, and there is a consistent growth trajectory between the variables in the short and long term. (2) Total import and export volume, export volume and import volume are Granger causes of GDP growth in Guangdong Province. This shows that historical import and export data can effectively predict future GDP growth. The increase in export trade implies a rise in demand for Guangdong's manufacturing and service industries, thus promoting economic growth; import trade brings in technology and resources, enhancing production efficiency and economic competitiveness. (3) The foreign trade dependence of Guangdong Province shows a downward trend. This reflects the optimization and upgrading of Guangdong's economic structure. It has transformed from an economic model driven by foreign trade to a diversified model driven by domestic demand.

Acknowledgments. This study was supported by Guangdong Provincial Undergraduate Student In-novation and Entrepreneurship Projects (No. S202313675021), Guangdong Province Key Research Base of Humanities and Social Sciences (Grant No. 2022WZJD012).

References

[1] Wang Bingke, Xiao Shan, Liu Cui. Analysis on the Development Status of Guangdong Province's Foreign Trade — Oriented by Export [J]. Northern Economy and Trade, 2021, (01): 28-31. https://kns.cnki.net/kcms2/article/abstract?v=mjz80qGfPOWbXPtCmoJ14fJFwtGrkIe7IgEksioDsPUGE0XT8G5E2gzsNv_bAI6LyzW63R5cLvGQrhK3HxrC9Dho2rl2gSkK75dEHff8gvOPrho9nhr_yQzgAio66uvkrmUbXJcVsvw=&uniplatform=NZKPT&language=CHS

[2] Deng Pingyu. The Impact of Guangdong's Foreign Trade on Economic Development [J]. Journal of Huizhou University (Social Science Edition), 2006, (02): 13-18. DOI: 10.16778/j.cnki.1671-5934.2006.02.002.

[3] Ye Junwei, Xie Changqing, Shao Jingyuan, et al. Research on the Relationship between Foreign Trade and Economic Development in Guangdong Province [J]. Northern Economy and Trade, 2023, (01): 118-123. https://kns.cnki.net/kcms2/article/abstract?v=mjz80qGfPOWw_Z-8Yw_dl-P1SqUybq015xepgOyAWpjOpfa_zHHNNtIU-B0Qso4pF4UiWVHFNO-dsnZaZw0nKvwAU1BFytws3GgKL-0HWJz8Mnn5jml8Ud_fR0M7ydANPgA0L1hJaTw=&uniplatform=NZKPT&language=CHS

[4] Wu Wenwen. Research on the Impact of Guangdong Province's Foreign Trade on High-Quality Economic Development — Test Based on the ARDL Model [J]. Special Zone Economy, 2021, (12): 81-89. https://kns.cnki.net/kcms2/article/abstract?v=mjz80qGfPOU4vJnh9-JgWlehn9Pqbwes05uebhjk6pWDuwDErJIfiOFwTYA8B6Ic68IXRXNx1GvHYo26MWhy7sKwc7tD

bBX0QWfd-
ySzK_470FrersS9yzzYE_h8RZ5qJkXAfG_YH4k=&uniplatform=NZKPT&language=CHS
[5] Liu Jinshan, Hu Wengang. Research on the Relationship between Guangdong Province's Foreign Trade and Economic Growth Based on the VAR Model [J]. National Circulation Economy, 2022, (24): 45-50. DOI: 10.16834/j.cnki.issn1009-5292.2022.24.006.
[6] Liu Xiaopeng. Cointegration Analysis and Error Correction Model —— An Empirical Study on China's Foreign Trade and Economic Growth [J]. Nankai Economic Research, 2001(05): 53-56. https://kns.cnki.net/kcms2/article/abstract?v=mjz80qGfPOVOWpaLA2sHZ83iEfxywL4z5WfHmodnCf183F3g0PGKJaB0ur_nD8J1783RsEUdSCdRBabjPu8NaF8XCBpZyXLLTPYrKxhxxcntGHAv9KIbu25s54ZwHza3&uniplatform=NZKPT&language=CHS
[7]J.C S .Impact study of agricultural value added on foreign direct investment, economic development, trade openness for India following ARDL approach[J].Cogent Economics Finance,2023,11(2): DOI:10.1080/23322039.2023.2270595
[8]Alisha M ,Kakali M .Toxic trade and environmental stringency: Exploring the impact on economic growth in the G20[J].Journal of Cleaner Production,2023,422 DOI:10.1016/J.JCLEPRO.2023.138516
[9]Majidi A .Studying the Impact of Foreign Trade on Economic Growth of Afghanistan during 2003-2021[J].Journal of Economics, Finance and Accounting Studies,2023,5(1):148-158. DOI:10.32996/JEFAS.2023.5.1.11
[10]Preethu R ,Zhihe Z ,Mohammad M .Do technological innovation, foreign investment, trade and human capital have a symmetric effect on economic growth? Novel dynamic ARDL simulation study on Bangladesh[J].Economic Change and Restructuring,2023,56(2):1327-1366. DOI:10.1007/S10644-022-09478-1