Spatial-Temporal Characteristics of UK—Commonwealth of Nations’ Trade and its Impact on the UK’s Economic Growth

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Abstract. This paper analyzes the trade between the UK and Commonwealth of nations from the perspective of time and space. We use a detailed trade data to analyze the volume and structural change of trade in the 21st century, the findings show that the trade volume of goods between the UK and the Commonwealth is only 8.27% of the UK's total foreign trade of goods, the degree of closeness and dependence of trade show a decreasing trend, and the bilateral trade shows significant spatial differences. Then we use vector auto-regressive model to analyze the impact of the UK's trade with the Commonwealth on its economy and there exists a long-term stable trend. Trade shock has a positive effect on the UK's economic growth.

1. Introduction

International trade promotes the formation of the world market and provides conditions for a country to actively participate in the international division of labor and develop its own economy. During the Great Geographic Discovery, the UK's rapid economic growth is closely related to the establishment of the global trading system. The British Commonwealth as the imperial heritage assumes the role of the UK’s main trade partner. In the 1970s, the European Community replaced the Commonwealth as the UK’s largest trading partner, and the "visibility" of the Commonwealth in international trade has declined year by year. However, the occurrence of the black swan event in the 2016 Brexit referendum has brought renewed attention to the trade relationship between the UK and the Commonwealth. The UK is the world's fifth largest economy, and the Commonwealth is the world's second largest international organization after the United Nations. In 2018, the total merchandise trade of the Commonwealth was 5.48 trillion U.S. dollars, accounting for 14.06% of the total world merchandise trade. The UK and the Commonwealth play an important role in the international trade structure. Scientifically explore the dynamic relationship between Commonwealth trade and British economic growth is a prerequisite for a deep understanding of the evolution of the world economy and trade pattern.

The issue of trade and economic growth is an important topic and many scholars have explored the ways of trade to promote economic growth. Smith once pointed out that foreign trade effectively expanded the scope of the market, and the deepening of the international division of labor promoted the improvement of production efficiency[1]. Free trade with the colonies should be actively developed to promote the economic growth of the UK. North studied from the perspective of economic history the reasons why Spain went from prosperity to end and Netherlands and the UK eventually became maritime hegemons, and pointed out that trade was the main driving force for institutional changes and economic growth[2]. Romer believes that international trade promotes the exchange of knowledge and technological progress among countries, improves factor productivity and
thus promotes the economic growth of a country[3]. The empirical literature on trade between the UK and the Commonwealth is relatively abundant. The paper mainly discussed the trade origin and division of labor of the Commonwealth countries[4], analyzed the trade transmission effect between the economic growth of the UK and the commonwealth[5], the trade preference between the UK and the commonwealth[6], discussed the feasibility of the commonwealth replacing the EU as the main trade object of the UK[7].

Based on the existing research findings, it is rare to comprehensively explain the economic growth of the UK and the trade of the Commonwealth in the 21st century. So we analyze the spatial-temporal characteristic of trade between the UK and the Commonwealth of nations in the 21st century and the impact of trade on the British economy. It trying to provide reference for in-depth discussion of the trade trend between the UK and the Commonwealth countries and the evolution of its role in the economic growth of the UK.

2. Research Methods and Data Sources

2.1. Trade Intensity Index

In 1947, Brown proposed the trade closeness index, which was revised and improved by Kojima. It uses the ratio of the economy’s exports to the economy’s total exports to the economy’s imports to the world’s total imports to reflect the closeness of trade relations between the economies. The trade intensity index can be calculated as:

\[
I_{ab} = \frac{X_{ab}/X_a}{Y_b/Y_W}
\]  

(1)

Where \(I_{ab}\) represents the trade closeness index between economy a and b, \(X_{ab}\) represents the export value of economy a to economy b, \(X_a\) is the total export value of economy a, \(Y_b\) is the total import value of economy b, and \(Y_W\) is the total world import value. If \(I_{ab}\) is less than 1, it means that the trade relations between the economies are relatively loose; if \(I_{ab}\) is greater than 1, it means that the trade relations between the economies are relatively close.

2.2. HM Index

In 2003, Baldwin proposed the Hubness Measurement Index (HM index) to measure the axis degree of economies in a trade network, thereby reflecting the degree of trade interdependence between economies[8]. The HM index can be calculated as:

\[
HM_{ab} = \frac{X_{ab}/X_a}{\left(1 - \frac{Y_{ab}}{Y_a}\right) \times 100%}
\]  

(2)

Where \(HM_{ab}\) represents the dependence of the export of economy a on the market of economy b, \(Y_{ab}\) is the import value of economy a to economy b, \(Y_a\) is the total import value of economy a, and \(X_{ab}\) and \(X_a\) have the same meaning as mentioned above. The value range of the HM index is \([0, 1]\). The value range of the HM index is \([0, 1]\]. The larger the calculation result indicates that the export of economy a is more dependent on economy b. The smaller the calculation result indicates that the export of economy a is less dependent on economy b.

2.3. Vector Autoregressive Model

VAR model or vector autoregressive model, is mainly used to analyze the multivariate measurement and statistical relationship. Due to the complex dynamic relationship between economic growth and foreign trade volume, this paper uses the VAR model to study the trade relationship between British economic growth and the Commonwealth, and establishes the following model:
3. Analysis of the Status Quo of Trade Between the Uk and the Commonwealth of Nations

3.1. Analysis of Total Trade Volume

From 2001 to 2018, the total trade in goods between the UK and the Commonwealth of Nations showed a slow and tortuous upward trend. The total trade volume increased from 60.267 billion to 94.545 billion dollars, with an annual growth rate of 2.68%, and its share in the total trade between the UK and the world decreased from 9.44% to 8.17%. The total trade volume between the UK and the Commonwealth is smaller than that of the UK and the EU, and the rate of increase is also significantly lower than that of the UK-US and UK-China trade. All economies except China have shown a downward trend of trade share to varying degrees.

![Figure 1. UK's trade volume with the world's major economies from 2001 to 2018](image)

We use the Commonwealth countries as the trade network nodes and the total bilateral trade in goods as the weights to construct an trade network map. Then we select the trade network snapshots in 2001 and 2018 to analyze the evolution characteristics of the trade network of the Commonwealth countries by using ArcGIS10.5. In order to clearly show the network relationship, the following figure selects countries with bilateral trade flows greater than 1,000 dollars for research. The density of the trade network in 2018 was slightly stronger than that in 2001. The main trade nodal countries were the UK, Canada, India, South Africa, Australia and Singapore. The trade ties between the Commonwealth countries in Asia and Africa are relatively close, but the ties between the Commonwealth countries in the Americas and Oceania are relatively loose. The main reasons are that countries in Asia, India, Africa and South Africa are relatively big, while Oceania and the Commonwealth of America are mostly small island countries, similar industrial structures lead to mutual exclusion of trade products and hinder the development of bilateral trade. Because Canada has a large economic aggregate and...
shares a common cultural basis and trade agreement with the UK, the bilateral trade volume is the largest, accounting for 22.58% of the total trade volume between the UK and the Commonwealth, while the trade volume of the UK and Tuvalu is the least.

**Figure 2.** Commonwealth of nations’ trade networks in 2001 and 2018

3.2. Analysis of Trade Closeness and Dependence

From 2001 to 2018, the average value of the trade closeness index between the UK and the Commonwealth was only 1.03, with an average annual change rate of -1.79%, indicating that the overall trade relationship was relatively loose and the degree of trade closeness showed a downward trend. International trade has accelerated the process of economic globalization. The rapid economic growth of developing countries such as China and Brazil has diversified the trading partners of the Commonwealth, impacting the trade links between the UK and the Commonwealth. Among them, the trade closeness index between Nauru and the UK has fallen the fastest. Nauru is the smallest island country in the world, with a small geographical area and single resources, making it difficult to carry out international trade. Moreover, its economic income gradually declines with the depletion of phosphate resources, hindering the development of trade between the two countries.

The bilateral trade between the UK and the Commonwealth countries presents a significant
one-way dependence feature. The Commonwealth countries’ trade dependence on the UK is much higher than that of the UK on Commonwealth countries, but this dependence has shown a rapid downward trend over time. As the world’s fifth largest economy and tenth largest exporter, the UK is the country with the strongest economic and trade strength among the Commonwealth countries so far. It has developed financial and manufacturing industries, but its trading partners are developing countries, their mechanical and electrical products, transportation equipment rely on British exports. With the trend of economic globalization, the export market of the Commonwealth countries is expanding, and the growth rate of exports to the United States, India and other countries is much higher than that of the UK. Among them, Botswana is not only the country with the highest dependence on the UK, but also the country with the fastest decline in dependence on the UK. Botswana has excellent government management and stable economic development. Its trading partners have gradually diversified, which has changed the situation of importing a large amount of precious metals and meat from the UK, and its dependence on UK trade has gradually decreased.

4. Analysis of the Status Quo of the Impact of Trade on Economic Growth

4.1. Stability of Variables and Co-Integration Test

ADF unit root test is usually used to determine the stationarity of time series in order to avoid false regression of macroeconomic series. The test results of this paper show that all sequences present non-stationarity at the significance level of 5%. After the first-order difference, dlngdpuk, dlncom, dlneu, dlnchina reject the null hypothesis at the significance level of 5%, and dlnusa reject the null hypothesis at the significance level of 1%. In other words, the variables are integration of the same order after the first-order difference, which can further test the co-integration between variables.

Cointegration is a statistical description of the long-term equilibrium relationship of non-stationary variables. Johansen test is usually used to judge the cointegration relationship between multiple variables. Due to the lag of the causal relationship between variables, it is necessary to select the lag order after constructing the VAR model. According to the AIC and SBIC criteria, the optimal lag order is judged to be the second order. The Johansen test results show that there are three cointegration equations for the variables. That is, there exists a long-term stable relationship between variables.

AR characteristic roots are used to test the stability of the VAR model. When the modulus of all unit roots is less than 1, that is, they are within the unit circle, the model is considered stable. The test results show that the set model is stable and meets the requirements of impulse response analysis.

4.2. Impulse Response Analysis

The impulse response function is used to measure the current and future trajectories of a standard deviation shock of a random disturbance item on the current and future values of other variables. This paper use it to analyze the shock response relationship between the economic growth of the UK and the trade volume of various economies. In figure 5, the horizontal axis represents the retrospective period, and the vertical axis represents the response size of the dependent variable to the impact of the independent variable.

After the impact of trade between the UK and the Commonwealth on a unit of the British economy, lngdpu reacted negatively in the current period, then it began to rise in the second period, and gradually decreased after reaching the maximum value (0.02) in the third period and tended to be stable. The cumulative response value (0.04) during the entire analysis period is positive, indicating that with the increase in trade between the UK and the Commonwealth, the overall British economy is showing an upward trend. After the impact of the trade between the UK and the EU on the UK economy, lngdpuk reacted positively in the current period, then began to decline, rebounded after reaching the minimum in the third period and gradually stabilized. The UK-US and UK-China trade had relatively consistent responses to the impact of the UK economy. After the current reaction was negative, it rose to the maximum in the 5th period and then gradually declined and stabilized. In terms of volatility, the UK and Commonwealth trade shocks reacted relatively smoothly, and the overall
volatility was smaller than that of the EU and the US.

Figure 3. Impulse response of lncom, lneu, lnusa and lnchina to lngdpuk

4.3. Variance Decomposition Analysis

Variance decomposition measures the importance of different structural shocks by analyzing the contribution of each structural shock to the change of endogenous variables. In this paper, the lag period of variance decomposition is selected as 15 periods. Lngdpuk’s variance decomposition analysis is performed based on the VAR(2) model.

The findings show that the contribution rate of the British economy reached 100% in the first period, showing a decreasing trend as a whole. The contribution rate of the 15th period was 39.71%. Although its own disturbances have gradually changed, it has always been in a dominant position. The contribution rate of the first phase of the UK-Commonwealth trade is 0, and gradually tends to balance after the seventh phase, and the contribution rate of the 15th phase is stable at 11.67%. The contribution rate of trade between the UK and EU showed a trend of increasing first and then decreasing. The contribution rate of the second period was the highest, and the contribution rate of the 15th period fell to 17.39%. The contribution rate of the UK-US and UK-China trade volume to the British economy showed an overall upward trend and the rates of 15th period were 30.52% and 0.70%.

5. Conclusions and Discussion

The trade volume between Britain and the Commonwealth accounted for 8.27% of the total foreign trade of the UK, and the growth rate of trade was slow. Britain’s main trading partners are the EU, the United States, and China, and the trade volume with China has increased significantly. The trade volume between the UK and the Commonwealth countries shows significant spatial differences, with Asian and African Commonwealth countries as the main trading partner, while trade volume with small island countries in the Pacific and the Caribbean is relatively small. The trade relationship between the UK and the Commonwealth is relatively loose, and the closeness of bilateral trade and the
dependence of Commonwealth countries on British trade show a downward trend. There exists a long-term stable trend in trade between the UK and the Commonwealth and the growth of the British economy. Trade shocks have a positive effect on the economy, but the magnitude of shock fluctuations is relatively small, and the contribution rate to the UK's economic growth is also less than that of the EU and the US. UK-China trade has a relatively small positive effect on the British economy, but it shows an upward trend.

6. References
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