

Social Network Analysis of International Trade Among EU Member States(2009-2015)

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Abstract: Since 2009, due to the global economic crisis, European debt crisis and the British falling out Europe and other factors, the internal structure of the European Union has changed. Through the method of social network analysis, this paper discussed the changes of international trade network pattern of EU member states. We find that when the international trade between EU members is more intense, the whole network will shows the discrete trend, and vice versa. For the traditional sense of the outer ring, Finland, Portugal, Greece and Luxembourg centrality continues to decline, indicating that influence on the EU of these peripheral countries are declining. Germany's position in the EU continued to strengthen, at the same time, the influence of EU on Germany exceeds the influence of Germany to the EU, which means Germany's profit from EU exceeds Germany's contribution to EU in the process of integration of EU, that is to say, the integration effect is obvious. The core periphery trend of EU is obvious, while the core periphery trend in the EU continue to strengthen.

1. Introduction

With the deepening of the process of regional economic integration, the international trade in regional economic integration has developed rapidly. The European Union has become the most successful regional economic integration organization after the Euro's test and operation, the unification of monetary policy and the strengthening of police cooperation. From the perspective of internal trade, the development of intra-European trade on the one hand promoted the deep development of EU's economic integration, and at the same time, it also formed the driving force to push forward the integration of European economy. Since 2009, the internal structure of the European Union has changed greatly because of the influence of the global economic crisis, the European debt crisis and the British separation from the European Union. In this context, it is necessary to study the trade pattern of EU member states.

The traditional analysis of EU's internal trade mainly adopts econometric method, but econometrics method is aimed at attribute data, which ignores the analysis of relational data. In this paper, we use the social network analysis method and use UCINET6.0 as an analytical tool to examine the changes of the international trade patterns of EU members from 2009 to 2015, and intends to further explore the characteristics and rules of EU Member States' international trade.

2. Descriptive Statistics of the Trade Network among EU Member Countries

2.1 Introduction of Social Network Analysis

The method of social network analysis is a quantitative analysis method developed on the basis of mathematical method and graph theory. Initially applied in the field of sociology, with the maturity of this method, social network analysis has been widely applied in politics, management, international economics and trade. Traditional econometrics analysis focuses on all kinds of attribute data, and deduces various variables models under the assumption of some exogenous variables. However, in such an analysis, the relationships between subjects are neglected. Social network analysis is a method that focuses on relational analysis. By studying network relationship, we can integrate

individual relationships, micro networks and macro structure of large-scale social system, which helps to understand the structure and evolution of network deeply.

2.2 Data Source and Processing

In this paper, the data of international trade among EU member countries comes from the UNcomtrade and the time span is 2009-2015. Because the export of one country is the import of another country. Therefore, in order to avoid repeated calculation, the data of international trade is counted by the export volume of EU members, and at the same time, the re-export and re-import are ignored.

In order to facilitate the analysis and statistics of data, this paper deals with the standardization of trade data. The goal of the standardization of data is to eliminate the dimension and eventually to get the data into a [0,1] interval. The specific formula model is as follows:

$$X = \frac{X - MIN}{MAX - MIN} \quad (1)$$

The MAX is the maximum of the sample data, and the MIN is the minimum of the sample data. The resulting matrix data is called a weighted network, where A_{ij} represents the export of country i to country j , so diagonal value is meaningless, which is defined as 0. Thus, standardized data represents weight. In addition to the analysis of the weighted network, this paper also analyzes the unweighted network in order to understand the pattern of international trade among the EU members. In order to construct the unweighted network, we carry out binarization processing on the weighted network, after several attempts, all the standard value which less than 0.01 are set to 0, all the standard value which are greater than or equal to the value of 0.01 are set to 1.

3. Descriptive Statistics of Trade Networks

Density is an important index in social network analysis. It is mainly used to measure the degree of closeness between nodes in the network. The size of the value is equal to the ratio of the total number of actual relationships and the total number of theoretical relationships. In this paper, the Ucinet6.0 software is used to calculate the density of the unweighted network and the weighted network matrix. The results are as follows:

Table 1 The Density Table of EU Trade Unweighted and Weighted Network(2009-2015)

matrix	2009	2010	2011	2012	2013	2014	2015
unweighted network	0.416	0.4217	0.4301	0.4245	0.4021	0.4021	0.4127
weighted network	0.0461	0.0455	0.0444	0.0436	0.041	0.0421	0.0437

Data sources: the original data came from the UNcomtrade, measured by UCINET6.0.

As can be seen from table 1, the density of the EU member's unweighted trade network is between 0.40-0.44 from 2009-2015, and reached the highest point in 2011, the lowest point in 2013. For weighted networks, the density of 2009-2015 years is between 0.041-0.047, and is positively correlated with the density of unweighted network, which shows that the weight has no effect on the overall network density. In July 1, 2013, Croatia officially became the twenty-eighth member of the European Union. In order to avoid the error of data, the above network density should be adjusted to average density so as to compare the longitudinal time series. The network density after the UCINET6.0 adjustment is shown as follows.

Table 2 Average Density Table of EU Trade Unweighted Network (2009-2015)

	2009	2010	2011	2012	2013	2014	2015
Average density	0.037	0.037	0.038	0.036	0.034	0.036	0.037
Std Dev	0.102	0.106	0.103	0.1	0.097	0.1	0.105
Sum	25.853	26.801	26.253	25.266	25.682	27.035	28.674
Variance	0.01	0.011	0.011	0.01	0.009	0.01	0.011
SSQ	8.265	8.857	8.383	7.934	8	8.551	9.405
MCSSQ	2.875	2.976	2.895	2.817	2.828	2.942	3.067
Observation number	702	702	702	703	756	756	756

Data sources: the original data came from the UNcomtrade, measured by UCINET6.0.

4. Analysis of the Pattern of International Trade Networks among EU Member States

4.1 Centrality Analysis

Within the European Union, what kind of power the member states have in the whole import trade network, or what kind of central position they are, is the first problem that should be faced when analyzing the import trade pattern within the EU. Social network analysis usually uses the centrality to represent the degree of the individual in the center, called centrality index. Centrality consists of degree centrality, betweenness centrality, and closeness centrality. This study uses relative degree centrality to measure the centrality of a country. The degree centrality is a portrait of the local center node index, strong ties between the nodes and the network measure actors in their own ability to integrate resources, trading ability and communication ability, without considering whether to control others. A point of the center and the degree is directly connected to the other points. Because this paper relates to network as a weighted network, so the degree of center of point A is aggregated of out-degree and in-degree, and the weight is the standard value of trade.

From the centrality analysis, we can see that:

1) as the center of the European Union, the centrality of Germany has been in a long way ahead and, in 2009-2015 years, began to rise gradually after falling to the lowest point in 2011, and reached 7.228 in 2015.

2) Apart from Belgium and Italy, the centrality of France, Holland and the UK has been increasing slowly, as the inner ring of the European Union in the traditional sense.

3) The so-called traditional outer ring, the centrality of Finland, Portugal, Greece and Luxemburg, is declining, indicating that the influence of these peripheral countries on the European Union is declining.

4) From the outliers, Greece's centrality fell off in 2012 and remained low for 2012-2015 years because of the debt crisis in 2009. In May 2012, there was a serious banking run in Greece, and the unemployment rate rose to 20.9%.

4.2 Analysis of Influence Index

The study of social influence has a long history. Usually, people use "get others' attention" to measure "influence", which is the index of influence in common sense. In this paper, we use the Katz index method of Professor Freeman of University of California-Irvine to calculate the influence of EU Member States. The results of the calculation are divided into two groups: one is Row S value, the size of which represents the country's influence on the EU as a whole; the other is the value of Col S, which represents the influence of the EU as a whole to the country.

According to the data, we can see that:

1) as the core of the EU, the influence of Germany on the EU increased from 0.099 to 0.105 from 2009 to 2015, while the European Union's influence on Germany increased from 0.116 to 0.121. It shows that Germany's position in the EU is constantly strengthened, and the influence of the EU on Germany exceeds the influence of Germany on the EU. It shows that in the process of EU integration,

Germany's profit is more than Germany's contribution to the EU, and the effect of integration to Germany is obvious.

2) In addition to Germany, the number of Row S ranked the top six countries, with the exception of a slight rise in Britain and Finland, and the rest declined.

3) From the comparison of the Row S value and the Col S value, the Row S value of most countries is very close to the Col S value, which means that the country's influence on the EU is basically equivalent to the European Union's influence on the country.

4) From the extreme data, the Row S values and the Col S values of Cyprus and Malta are respectively 0.001 and 0, indicating that the economic effects of the two countries' accession to the EU are not obvious.

4.3 Cohesive Subgroup Analysis

This article is analyzed from the network structure, although there are many studies on the network structure, for example, in the field of social theory, anthropology, economics and other fields, most of the studies are qualitative explanations in theory, lack of quantitative research and operationalized indicators, and this is the task of social network analysis. One of the main areas of social networking is to reveal social structure through group research.

In sociological theoretical research, we often use network cohesion as an explanatory variable. According to this idea, we can think that the more frequent contacts, the stronger homogeneity between people. On the contrary, heterogeneity is stronger among people who have few interactions with each other.

According to Professor Freeman's cohesive subgroup analysis, we used the unweighted network in 2015 to analyze cohesive subgroups and found that 6 cohesive subgroups are as follows:

- 1) France Germany Italy Netherlands Spain United Kingdom
- 2) Belgium France Germany Italy Netherlands United Kingdom
- 3) Germany Italy Poland United Kingdom
- 4) Czechia Germany Poland
- 5) Czechia Germany Slovakia
- 6) Belgium Ireland United Kingdom

From the classification of aggregation subgroups, it can be seen that the core periphery trend of the EU is more obvious. At the same time, it can be seen that the core periphery trend of EU is continuously strengthened in combination with the cluster index of 2009.

5. Conclusion

Through the analysis of this paper, the following conclusions are drawn:

1) The stronger the ties of international trade among the EU members, the overall network of the EU shows a trend of discretization. On the other hand, the weaker the international trade relations among the EU members, the overall network of the EU presents a centrality trend.

2) In the process of EU integration, Germany's profit is more than Germany's contribution to the EU, and the effect of integration to Germany is obvious.

3) Apart from Belgium and Italy, the centrality of France, Holland and the UK has been increasing slowly, as the inner ring of the European Union in the traditional sense.

4) In the process of EU integration, Germany's profit is more than Germany's contribution to the EU, and the effect of integration to Germany is obvious.

5) The core periphery trend of the EU is more obvious, meanwhile, the core periphery trend of EU is continuously strengthened.

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