Research on Spatial Pattern and Evolution of FDI Based on Social Network Analysis

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Abstract: Absorbing foreign direct investment (FDI) is an important part of China's opening-up and accelerating the construction of market economy and it is also a positive measure for China to conform to the trend of economic globalization and actively participate in the international division of labor. Therefore, in order to explore the change of China's position in global FDI network, this paper adopts the social network analysis method and constructs a trade network model. By using the FDI flow data between 60 countries (regions) from 2002 to 2021, this study empirically analyzes the evolution characteristics of the global FDI network structure, with a view to providing enlightenment and reference for department concerned to introduce investment and formulate relevant policies.
Keywords: FDI; Social Network Analysis; Spatial Pattern

Introduction

FDI is the forms of capital internationalization. FDI introduction has increased capital supply and labor demand. As a big bilateral investment country, China's two-way FDI is about to develop in a balanced stage.

Social network analysis as a new economic analysis tool, uses algebraic model and graph, describes social structure from the perspective of relationship, which can comprehensively reflect the characteristics and status of each node (Serrano et. al , 2003).

In recent years, the international situation is complicated. On the one hand, with the deepening of economic globalization, the economic and trade ties between countries are getting closer. On the other hand, nationalism and trade protectionism are on the rise and many countries have strengthened the management of cross-border investment to prevent domestic capital outflow. The process of global multilateral trade liberalization led by WTO has come to a standstill, while local multilateral trade liberalization such as bilateral or reginal trade agreements has gradually become mainstream (Tie Y. et al., 2021) and global trade liberalization has shown unbalanced development. This paper hopes to explore the spatial pattern of FDI and provide a useful perspective for this field.

1. Model and data

1.1 FDI network model

In this paper, the FDI inflow and outflow matrices are normalized by Ucinet 6, and the network is drawn by Gephi to analyze the spatial characteristics. Due to limited space, 2002, 2012 and 2021 are selected as representative years. (Figure 1)

In the FDI network diagram, the size of nodes is proportional to FDI inflows and outflows stock in countries and line thickness is proportional to the strength of the connection between two countries. It is found that the number of core trading nodes is increasing, showing a multipolar trend.

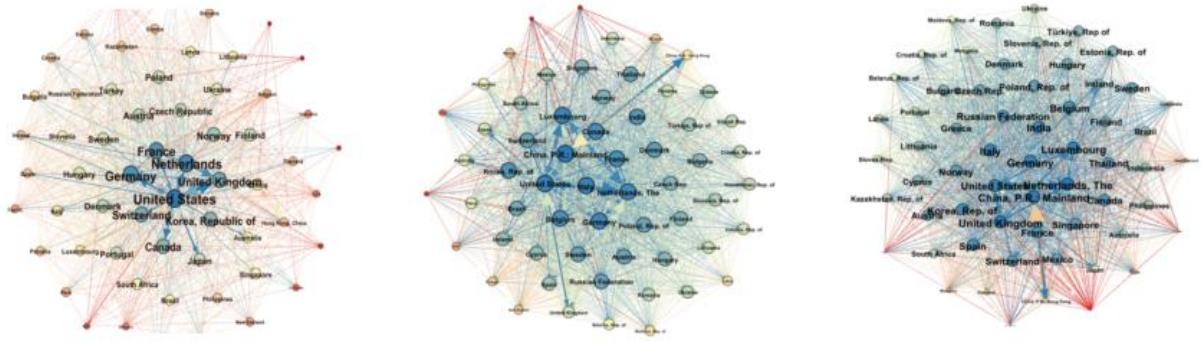
According to Fagiolo et al. (2009), a weighted FDI network matrix W^t is constructed, in which w_{ij}^t is the amount of FDI flows between country i and j, that is, $w_{ij}^t = (fdi_{ij}^t + odi_{ij}^t)$, where fdi_{ij}^t is FDI from country j to i in period t and odi_{ij}^t is ODI from country i to j in period t. Also, all values in weighted matrix are divided by the maximum in matrix to make $w_{ij}^t \in [0, 1]$.

The indicators used mainly include network density, core degree etc. to describe the characteristics of global FDI network and the

evolution of China's position.

1.2 Data sources

In this paper, FDI datas between 60 countries (regions) from 2002-2021 come from UNCTAD and IMF databases. Considering that statistical caliber among countries is different, so this paper uses the maximum method to symmetrically modified the asymmetric matrix W^t . Due to the lack of data in a few countries, the data are processed as follows: if the FDI data from A to B is missing but the ODI data from B to A exists, then, use ODI data.



A.2002 B.2012 C.2021

Figure 1 Global FDI Network.

2. Spatial structure characteristics of FDI network

2.1 Network Density

Network density is usually used to measure the closeness and strength of members. Social networks with high density often have dense overall structure and complex node association. The calculation formula is:

$$\text{Network denisty}=\frac{2m}{n(n-1)}$$

“m” is network relationships numbers and “n” is total nodes number.

This study uses Ucinet 6 to calculate the density of unweighted FDI networks from 2002 to 2021. The result shows that the network density of FDI in major countries fluctuates between 0.4-0.8 and increases steadily, indicating the FDI among countries is in a mature and stable state. (Figure 2)

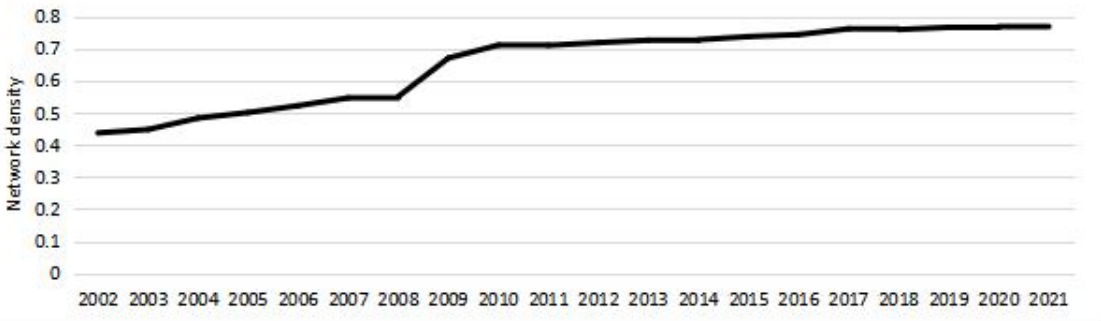


Figure 2 FDI network density.

2.2 Network Core Degree

To identify the countries located in core position in global FDI network, the core-edge structure analysis is conducted to measure the participation of each country. The higher the core degree, the more important the country's status is. To distinguish different levels, this paper classifies the top 95% of whole sample as core countries, 75% to 95% as sub-core countries, 5% to 75% as semi-periphery countries and the last 5% as periphery countries. As shown in Figure 3, the core countries' average core degree has decreased steadily but remained above 0.15, the sub-core countries' has remained around 0.14, the semi-periphery countries' has increased steadily and

basically stabilized at 0.05-0.1, the periphery countries' fluctuatingly rise and remained at 0.01-0.06, while the overall average of 60 countries has remained stably at 0.11-0.11, indicating that the global FDI network has gradually tended to be decentralized and polycentric since 2002.

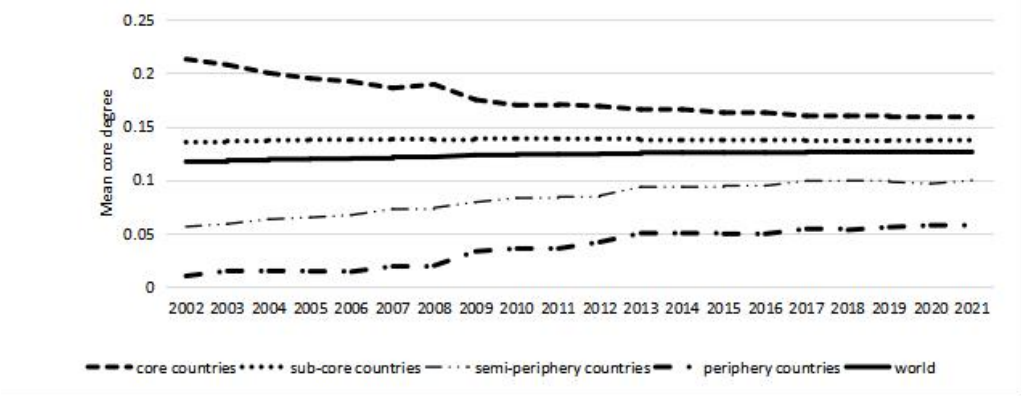


Figure 3 Mean core degree.

2.3 Network Centrality

Network centrality mainly analyzes the status of each country and this study uses degree centrality, betweenness centrality and closeness centrality.

2.3.1 Degree Centrality

It refers to the number of other units connected to the unit. The more connected units, the larger the centrality, indicating the greater status and influence. The calculation formula is:

$$DC_i = \frac{k_i}{N-1}$$

"k_i" represents the number of existing edges connected with node"i", "N-1" represents number of edges that node"i"connected to all other nodes.

Because the different number of core nodes in each year will lead to different results, this paper takes 2002 as base period, the ratio of core nodes number in reporting period to that in base period as adjustment coefficient. The adjusted degree centrality in reporting period is the product of that before adjustment in reporting period and coefficient. After adjustment, the mean degree centrality in each year has shown that a fluctuating trend, but it is on rise as a whole. (Figure 4)

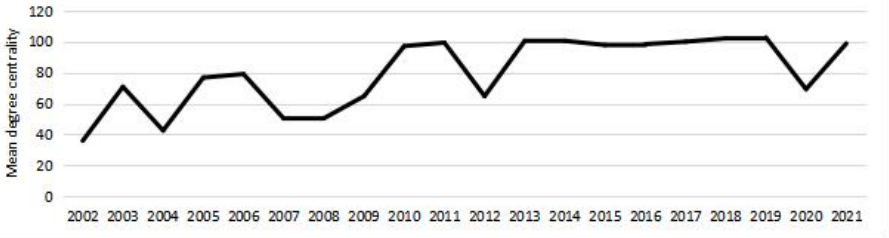


Figure 4 Mean degree centrality from 2002 to 2021.

2.3.2 Betweenness Centrality

It refers to the number of times a node acts as a bridge between the other two nodes. The more times a node acts as a bridge, the higher the betweenness centrality, the more it occupies the key position of resources and information circulation. The calculation formula is:

$$BC_i = \sum_{s \neq i \neq t} \frac{n_{st}^i}{g_{st}}$$

"nsti" represents the number of shortest paths passing through node "i" and "gst" represents the number of shortest paths connecting "s" and "t"..

However, the different number of core nodes in each year will lead to different results, to eliminate the influence of the number of

core nodes, this paper takes 2002 as base period, the ratio of the betweenness centrality of all core nodes in reporting period to that in base period as adjustment coefficient, and the adjusted betweenness centrality in reporting period is the product of that before adjustment in reporting period and coefficient. The average adjusted betweenness centrality of global FDI network from 2002 to 2021 has shown a downward trend. (Figure 5)

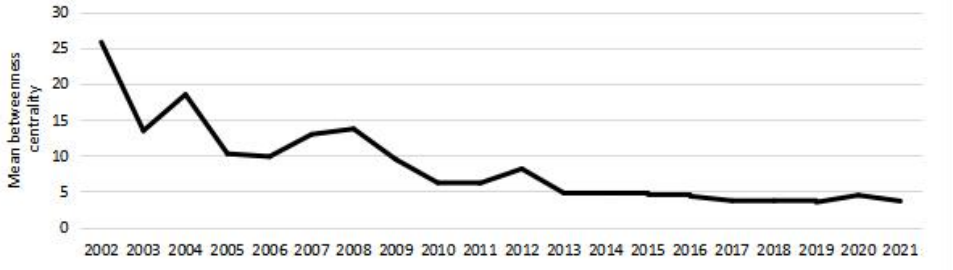


Figure 5 Mean betweenness centrality.

2.3.3 Closeness Centrality

It reflects the closeness of a node to other nodes and the smaller the closeness centrality, indicating the node is more centrally located. The calculation formula is:

$$d_i = \frac{1}{N-1}\sum_{j=1}^{N} d_{ij} \qquad CC_i = \frac{1}{d_i}$$

"di" represents the average distance from node "i" to other nodes.

After the normalized matrix is symmetrized, the closeness centrality is calculated. Because the number of nodes in each year will affect results, the adjustment coefficient is constructed to eliminate the influence of nodes number. Taking 2002 as base period, the ratio of overall mean closeness centrality in reporting period to the overall mean closeness centrality in base period is taken as adjustment coefficient, and the closeness centrality in reporting period is the product of that before adjustment and adjustment coefficient. From which the adjusted mean closeness centrality of major countries from 2002 to 2021 is calculated and its trend shows that the mean closeness centrality of global FDI network in major countries has fluctuatingly risen. (Figure 6)

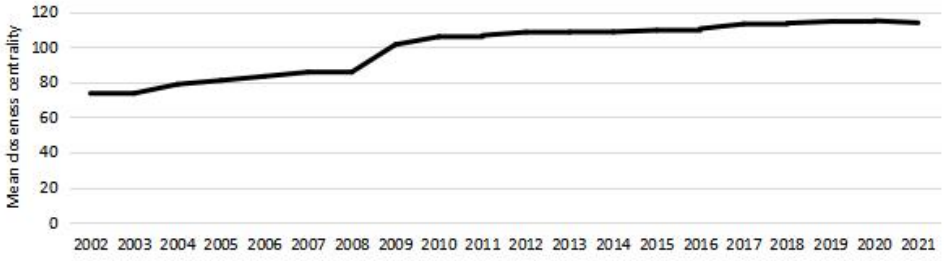


Figure 6 Mean closeness centrality.

3. China's status changes in global FDI network

Comparing indicators of China with the average values of all countries in global FDI network, we can obtain the status changes of China. The results are shown in Figure 7 and conclusions are as follows.

Firstly, comparing the core degree, it is found that the core degree of China has always been higher than the average level of all countries, but the core degree of all countries is relatively stable, while in China it fluctuates.

Secondly,comparing the degree centrality, it shows that China's degree centrality is relatively stable while that in all countries changes greatly. And China's is generally lower than the world average, it only exceeds the world average in a few years, such as 2002, 2007 and 2008.

Thirdly, comparing the betweenness centrality, it indicates that China's fluctuates greatly, but it is basically higher than the average level of world, and only fell below in 2002. Generally, China's betweenness centrality shows a trend of rising first and then declining, while the world's is in a steady decline.

Fourthly, comparing the closeness centrality, the change between China and world is basically consistent, but it is firstly lower than average in 2009, which shows China's central position is higher than average after 2009.

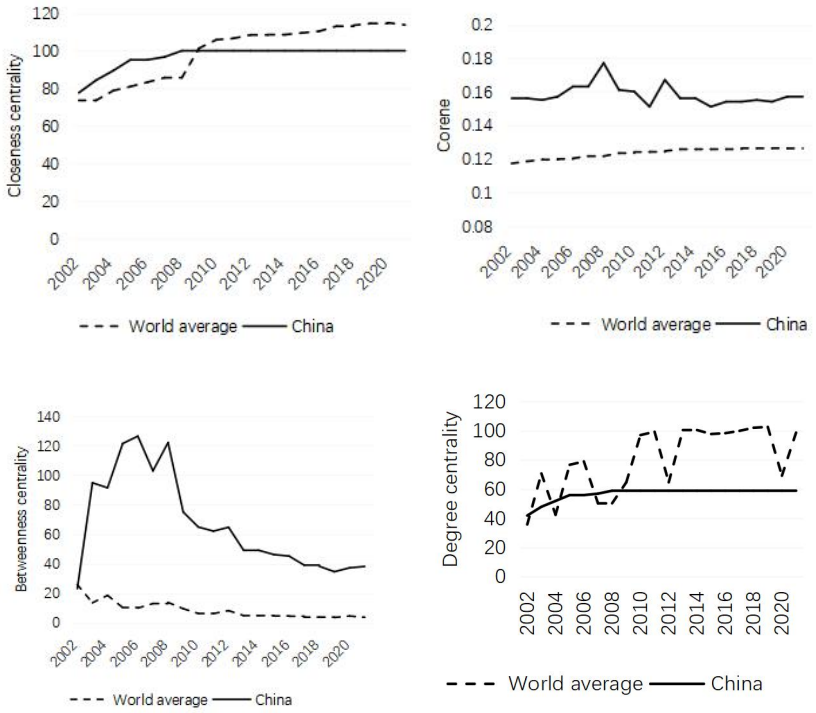


Figure 7 Comparison between China's centrality indicators and world average.

4. Suggestions

After empirical analysis, suggestions are as follows.

(1) Actively and reasonably introduce foreign capital. The local department concerned should encourage relevant multinational companies and R&D centers to settle in and strengthen the construction of intellectual property protection system. It is necessary to creating a good market environment to improve the quality of foreign capital.

(2) Consolidate the talent base. Local department concerneds should implement the talent introduction policy according to local conditions and satisfy the reasonable demands of outstanding talents. Meanwhile, increase the training of technical and skilled talents.

(3) Perfect the institutional environment. Accelerate the transformation of department concerned functions and promote efficiency. The department concerned should implement the national treatment and give preferential policies to foreign-invested enterprises, improve trade, investment facilitation and relevant laws and regulations.

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