The Spatial Economic Interdependence between China and the rest of the World

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Abstract: This paper studies the degree of economic spatial dependence between China and the rest of the world by using multiregional input-output approach. Our study shows that (1) China has integrated into the global value chain but in the downstream location. (2) The total external dependence of China's economy has increased during the analysis period, but its spatial distribution is uneven globally. (3) Specific to the national level, China has increased its dependence on the United States and declined the dependence on Japan.

Keywords: Economic linkage; Spatial interdependence; World input-output tables.

1 Introduction

Over the past two decades, more and more manufacturing value chains are fragmented and distributed globally. For example, in the study of the iPod, Dedrick, Kramer and Linden (2010) discuss how the iPod is assembled in China with hundreds of components from the rest of the world. Although the last assembling and testing activities is distributed in China, the key components and parts are sourced from around the world. This paper aims to examine the spatial economic interdependence between China and the rest of the world by using the multi-regional input-output model.

There have been a large number of studies on the economic interdependence between nations. According to Cooper (1972), international economic interaction is commonly thought of as a dollar value of the transaction of goods and services between nations. Baldwin(1980) suggests that economic interdependence may be conceived as the opportunity costs incurred from potential exit costs that incur as a result of breaking existing economic ties between nations. Unlike the above definition, we think the economic spatial interdependence should be the degree of a country's economic rely on the countries outside its border.

The spatial interdependence is related to the regional economic integration, which has been studied extensively. For instance, Zhang and Hock (1996), Choe (2001) and Sohn (2005) investigates the economic integration through trade and investment. Unlike the above studies, Sato and Zhang (2005) investigates the evidence for a monetary union in East Asia. However, the existing studies listed above has limited their studies by using the microeconomics data, so the indirect effect generated by interactions between countries has not been considered in above papers.

According to Nagendra and Yuichi (2006), on contrast to the analysis with microeconomic data, the analyses under IIO framework has the following advantages: (1) capable of dealing direct and indirect effects, (2) designed for sector level as well as country level analysis, and （3） equipped to involve the production technology in terms of intermediate goods. By using the published IIO table for 2000 with maximum disaggregated sectors, they found the degree of economic integration in East Asian has been improved at both country level and production sector level. However, the

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limitation of their studies is that they only focus on East Asian in 2000 instead of the global production networks.

The current paper is different from previous studies in the following ways. First, we seek to investigate the economic interdependence between China and the rest of world concerning the global fragmentation of production. Second, we use the world input output database which provide time-series of world input output data for forty countries covering the period from 1995 to 2011. Finally, our results are based on the analysis with disaggregated production sectors, so we can study the economic interdependence at sector level.

The reminder of this paper is organized as follows. Section 2 presents the analytical framework. Section 3 describes the data used in this study. Section 4 discussed the results of analysis. Finally, section 5 concludes the paper.

2. Analytical Framework

We measure the economic spatial interdependence with the global input output approach. Figure 1 is a layout of a typical global input output table with n countries. The variables z, f, v, and y represent the intermediate goods, the final demands, the value added and the total input/output respectively. The uppercase and the lowercase letters denote the matrices and scalar values respectively. For the intermediate goods (z) and the final goods (f), the first subscript represents the country of origin and the second is the destination country.

Figure 1 Layout of a typical global input output table

	Intermediate Use			Final Demand			Total
	Country 1	⋯	Country n	Country 1	⋯	Country n	Output
Country 1	z_{11}	⋯	z_{1n}	f_{11}	⋯	f_{1n}	y_1
⋯	⋯	z_{rs}	⋯	⋯	⋯	⋯	⋯
Country n	z_{n1}	⋯	z_{nn}	f_{n1}	⋯	f_{nn}	y_n
Value Added	v_1	⋯	v_n				
Total Input	y_1	⋯	y_n				

The intermediate input coefficients could be defined as $a_{ij} = \frac{z_{ij}}{y_j}(i, j = 1, \cdots, n)$; $A = [a_{ij}]$ is the total intermediate input coefficient matrix which presents the direct requirement of the intermediate goods from both endogenous and exogenous countries for unit production of the goods. According to the balance of horizontal direction in Figure 1, the system could be expressed as the following:

$$AY+F=Y \qquad (1)$$

The solution of above system is:

$$Y=BF=(I-A)^{-1}F \qquad (2)$$

The Leontief inverse matrix B in equation (2) is calculated as (I-A)-1, where I is the identity matrix of suitable size. The meaning of the column in matrix B is the total output of each sector of countries that are produced to fulfill a unit final demand in the corresponding sector. On the contrary, the meaning of the row is the total output of corresponding sector that are produced to fulfill a unit final demand in each sector of countries.

Under the “n-countries and m-sectors” framework in this paper, B is the $(n \times m, n \times m)$ matrix

and could be expressed as $\left[b_{rs}^{ij} \right]$, where b_{rs}^{ij} means the total output of i sector in r country that is produced to fulfill the unit demand of j sector in s country. To measure the economic linkage between a country and the rest of the world (not including itself), the following two indexes could be defined:

$$Back_s = \sum_{j}^{m}(\sum_{r=1}^{n}\sum_{i=1}^{m} b_{rs}^{ij}), \qquad Forw_r = \sum_{i}^{m}(\sum_{s=1}^{n}\sum_{j=1}^{m} b_{rs}^{ij}) \qquad r \neq s \qquad (3)$$

The above equation includes two indexes, which are often be used to investigate the backward linkage and forward linkage. The results based on the Leontief inverse matrix fails to measure the interdependence as the matrix does not count the size effect.

After considering the value-added, the global economic system could be expressed as:

$$\mathrm{Val}=\mathrm{A_v BF} \qquad (4)$$

In above equation, the variables Val and $\mathrm{A_v}$ denote the vectors of GDP and matrix of value-added coefficient. So the value-added under the global input output framework could be formulated in the following forms:

$$val = \begin{pmatrix} v_1, \cdots, 0 \\ \cdots, v_i, \cdots \\ 0, \cdots, v_n \end{pmatrix} \begin{pmatrix} b_{1,1}, \cdots, b_{1,n} \\ b_{i,1}, \cdots, b_{i,n} \\ b_{n,1}, \cdots, b_{n,n} \end{pmatrix} \begin{pmatrix} f_1 \\ \cdots \\ f_n \end{pmatrix} = \begin{pmatrix} \sum_{j=1}^{n} v_i b_{i,j} f_j \end{pmatrix} \quad (5)$$

Equation (5) means that with globalization of world economy, the value-added of a country depends on not only itself, but also the other countries. So the economic interdependence between country i and country j could be defined as following:

$$Ind_{ij} = \frac{v_i b_{i,j} f_j}{Val_i} \qquad (6)$$

In above equation, $v_i b_{i,j} f_j$ represents the real GDP in country i induced by final demand of goods produced in country j. So the above ratio denotes the relative economic interdependence between country i and country j. If i=j, the coefficient means the self-dependence of country i. The large coefficient means the low degree of the dependence for the country to the outside world.

3. Data

To measure the economic spatial interdependence among countries, we need to track the flow of products across countries. The world input output tables provide input-output data from 1995 to 2011 covering 40 countries (Timmer et al. 2014; Dietzenbacher et al 2013). The 40 countries include all 27 countries of the European Union and 13 other countries: Australia, Brazil, Canada, China, India, Indonesia, Japan, Mexico, Russia, South Korea, Taiwan, Turkey and the United States. In addition, the data of remaining uncovered countries is provided as a whole. Moreover, to investigate the economic interdependence between China and the rest of the world in depth, 27 countries of the European Union are aggregated as a whole.

4. Results

The aim in this paper is to measure the interdependence between China and the rest of the world. Figure 1 is the graph of the economic linkage of the world and China from 1995 to 2011.For the world as a whole, the average economic linkage has increased from 1.06 in 1995 to

1.47 in 2011, which means that the linkage among countries has been improved with the establishment of international division of labor. For China, the forward linkage and backward linkage are 0.74 and 0.65 respectively, which was much lower than the average world level at that time. But in 2011, the forward linkage in China has increased to 5.99 while the backward linkage has almost not changed. The above analysis denotes that China has integrated into the global value chain but in the downstream location.

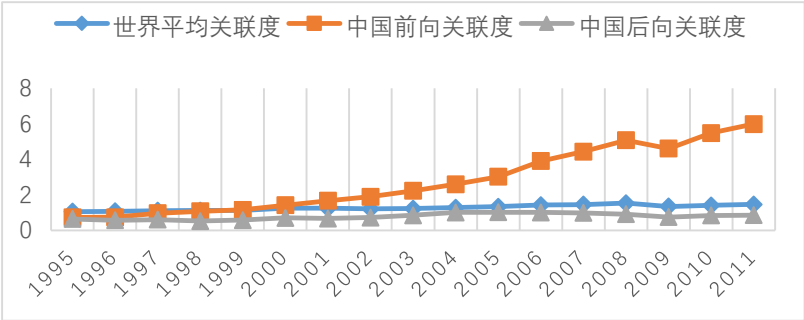

Figure 1: The changing trend of economic linkage for the world and China between 1995 and 2011

Table 1 provides the changing trend of economic linkage from 1995 to 2011 in China at industry level. It could be found that for agriculture, both the value of forward and backward linkage are very low. On the contrary, the forward linkage of secondary industry in China has increased from 0.48 in 1995 to 4.47 in 2011, while the backward linkage changed from 0.33 to 0.48 at the same period. Compared with the second industry, both the forward and backward linkage of the third industry in China is in a low level. The above analysis implies that the secondary industry is the main reason to explain the change of China during the analysis period.

Table 1: The changing trend of economic linkage of three industries in China from 1995 to 2011

	forward linkage				backward linkage			
	Primary	Secondary	Tertiary	total	Primary	Secondary	Tertiary	total
1995	0.07	0.48	0.18	0.73	0.13	0.33	0.19	0.65
1999	0.09	0.76	0.31	1.16	0.12	0.30	0.17	0.59
2003	0.14	1.58	0.51	2.23	0.18	0.45	0.23	0.86
2007	0.21	3.34	0.89	4.44	0.20	0.54	0.25	0.99
2011	0.26	4.47	1.26	5.99	0.18	0.48	0.21	0.87

Table 2 divides the countries in the world into four groups according to their average values of self-dependence. There are six countries whose value of self-dependence is larger than 0.9, including The U.S., Japan and so on, while only two countries' self-dependence is less than 0.7. In general, the greater the economic scale, the lower the degree of its dependence on foreign countries. The average value of China's self-dependence is 88.48%, which rank the 10th among all the countries in the world.

Table 2: The distribution of average self-dependence for countries in the world between 1995 and 2011

self-dependence(δ)	country
δ⩾0.9	The United States, Greece, India, Japan, Brazil, Turkey
0.8⩽δ<0.9	Cyprus, Germany, Denmark, Spain, France, England, Italy, Poland,, Portugal, Luo Maria, Canada, Mexico, Australia, China, Indonesia, Korea, South Korea

0.7≤δ<0.8	Austria, Belgium, Bulgaria, Czech, Estonia, Finland, Hungary, Lithuania, Latvia, Malta,, Portugal, Slovakia, Slovenia, Sweden, Russia, Taiwan
δ<0.7	Luxemburg, Ireland

Figure 2 provides the changing trend of economic self-dependence of China between 1995 and 2011. It could be found that the economic self-dependence of China has decreased from 91.04% in 1995 to 84.7% in 2007 which is the lowest during the analysis period. After receiving the impact of the financial crisis in 2008, it has bounce back to 88.99% in 2009 then continue to decline to 87.97% in 2011.However, the changing trend are different for three industries in China. The self-dependence of secondary industry is the lowest among three industries and decline from 89.46% in 1995 to 85.67% in 2011which is the most significant too. On contrast, the self-dependence of the primary industry is the highest and declined from 93.56% in 1995 to 90.69% in 2011. The self-dependence of tertiary industry is between primary industry and secondary industry but its decline range is the slightest of the three.

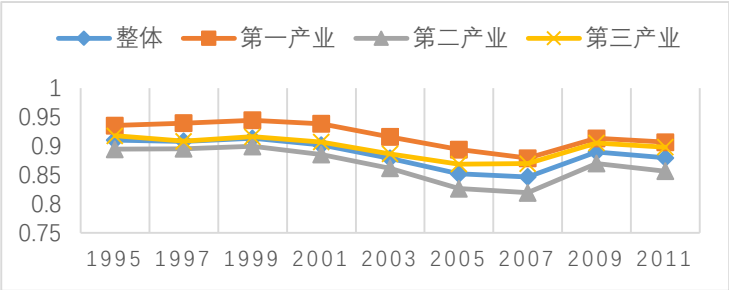

Figure 2：The changing trend of economic self-dependence of China between 1995 and 2011

Table 3 provides the spatial distribution of China's economic external dependence on the rest of the world. The total dependence has increased about 3.08 percent during the analysis period, from 8.96% in 1995 to 12.03% in 2011. The dependence on North America has increased from 1.78% in 1995 to 2.92% in 2011, which is the most significant in the world. At the same time, the dependence of China on other Asia countries has increased only 0.15 per cent during the related period, from 2.88% in 1995 to 3.03% in 2011. In the three industry, the dependence structures of every industry are different. For primary industry, its dependence on other developing countries has been improved. On the contrary, secondary industry has increased its dependence on North America and other developing countries. Unlike the primary and secondary industry, the external dependence of the tertiary industry is more evenly distributed among the different regions.

Table 3: The spatial distribution of Chinese economic external dependence during 1995-2011

		Europe	North America	Asia	Other	Total
National	1995	2.09%	1.78%	2.88%	2.20%	8.96%
	2011	2.79%	2.92%	3.03%	3.30%	12.03%
Primary	1995	1.37%	1.29%	2.23%	1.55%	6.44%
	2011	2.10%	2.26%	2.32%	2.63%	9.31%
Secondary	1995	2.15%	2.30%	3.38%	2.71%	10.54%
	2011	3.20%	3.51%	3.51%	4.10%	14.33%
Tertiary	1995	2.43%	1.34%	2.56%	1.88%	8.21%
	2011	2.50%	2.43%	2.66%	2.58%	10.18%

Specific to the national level, China's economy is dependent on the United States and Japan

greatly. The average dependence of China's economy on the two countries are 2.26% and 1.19% respectively, which means that about 2.26% and 1.19% GDP of China are induced by United States and Japan during the analysis period. Figure 3 shows the changing trend of China's dependence on the two countries. At the beginning of the analysis period, the dependence level of China on the two countries are almost the same, about 1.5 percent. But at the end of the analysis period, the dependence level of China on the United States has increased to 2.32% in 2011. However, at the same time, its dependence on Japan has declined to 0.99% in 2011. The above analysis denotes that during the construction of the global specialization system, China has increased its dependence on the United States and declined the dependence on Japan.

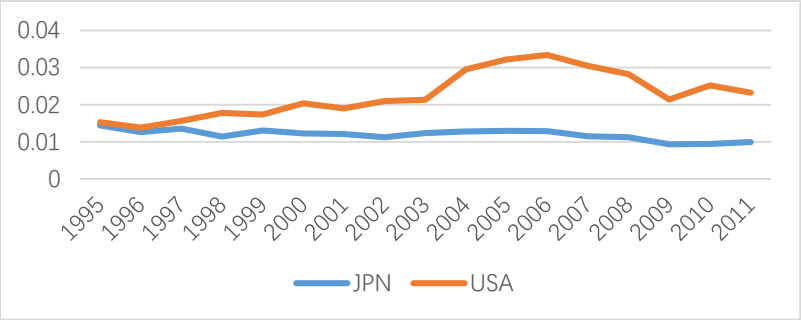

图 3： 1995-2011 年期间中国经济对于美国和日本依存度变化趋势

5. Conclusion

This paper studies the degree of economic spatial dependence between China and the rest of the world by using multiregional input-output approach. Our study shows that the economic linkage among countries is improved during the process of global specialization. For China, the forward linkage and backward linkage was much lower than the average world level in 1995. But in 2011, the forward linkage in China has increased greatly while the backward linkage has almost not changed, which denotes that China has integrated into the global value chain but in the downstream location. Specific to the industry level, secondary industry is the main reason to explain the China's changing structure during the analysis period.

The total external dependence of China's economy has increased during the analysis period, but its spatial distribution is uneven globally. The increase of dependence on North America is the most significant while its dependence on other Asia countries has almost not changed. In the three industry, the dependence structures of every industry are different. Specific to the national level, China's economy is dependent on the United States and Japan greatly. However, during the construction of the global specialization system, China has increased its dependence on the United States and declined the dependence on Japan.

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References

Dedrick, Jason, Kenneth L. Kraemer, and Greg Linden, 2010. "Who Profits from Innovation in Global Value Chains? A Study of the iPod and Notebook PCs." *Industrial and Corporate Change*

19 (1): 81-116.
Cooper, Richard N.,1972. “Economic Interdependence and Foreign Policy in the Seventies”. *World Politics 24 (02): 159–181.*
Baldwin, David A. 1980. “Interdependence and power: a conceptual analysis”. *International Organization 34 (04): 471–506.*
Dietzenbacher, Erik, Bart Los, Robert Stehrer, Marcel P. Timmer and Gaaitzen de Vries, 2013. “The Construction of World Input-Output Tables in the WIOD Project” Economic Systems Research 25 (1): 71-98.
Zhang, Z.Y., and Hock, O.C. 1996. “Trade Independence and Direct Investment between ASEAN and China” *World Development,* Vol. 24, No.1 pp. 155-170.
Choe, J.I., 2001. “An Impact of Economic Integration through Trade: On Business Cycles for 10 East Asian Countries”. *Journal of Asian Economies*, Vol. 12, No. 4, pp. 569-586.
Sato, K. and Zhang, Z.Y. 2005. “Real Output Co-movements in East Asia: Any Evidence for a Monetary Union?” CITS Working Paper 2005-08, Center for International Trade Studies, Faculty of Economics, Yokohama National University.
Sohn,C.H. 2005. “Does the Gravity Model Explain South Korea’s Trade Flows?” Japanese Economic Review, Vol. 56, No. 4 pp.417-430.
Nagendra Shrestha and Yuichi Hasebe. 2006. “An Input-Output Analysis of Economic Integration in East Asia”, Working Paper.
Timmer, Marcel P. Dietzenbacher, Erik, Bart Los, Robert Stehrer and Gaaitzen de Vries, 2014. “The World Input Output Database (WIOD): Contents, Concepts and Applications.” GGDC Research Memorandum 144, Groningen Growth and Development Centre.