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The International Influence of China's Equipment Manufacturing Industry: Evidence from the WIOT

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Abstract

Purpose - This study analyzes economic relations and mutual influence in the global equipment manufacturing industry (EMI) and China's influence.
Research design, data, and methodology - Data were collected from the World Input-Output Database (WIOT), looking at 16 countries. The sample time period was 2002-2011. Influence and motivation coefficients were calculated.
Results - 1) China's EMI showed a very strong influence coefficient, even surpassing world industrial powers like Japan, the USA, Germany, and Korea.
2) As for influence on added-value, China's EMI motivation coefficient was ranked third in 2011, which meant it had a negligible effect on added-value.
3) From 2002 to 2011, both the influence and motivation coefficients of China's EMI rose.
Conclusions – China's EMI has strong influence and motivation coefficients. It has a significant impact on the world EMI, especially on the total output of the global EMI. Additionally, during 2002 to 2011, the ranking of China's EMI motivation coefficient improved year over year, and its economic efficiency obviously improved. By 2011, China's EMI's international influence was second only to the US and Japan.

Keywords: World Input-Output Analysis, Equipment Manufacturing Industry, International Influence, Added-Value.

JEL Classifications: F10, F13, F14.

1. Introduction

EMI is a generic terms of various manufacturing industry which provides technology and equipment for the simple reproduction and expanded reproduction of various sectors of the national economy. It is the strategic and pillar industry of a country, involving the lifeline of the national economy and national security and plays an important role in the economy of a country. The development level of the EMI determines the level of industrial competitiveness and industrialization of a country. As the core of modern industrial structure, China EMI has made an important contribution to the economic development of China. According to China statistical yearbook data, the total output value of China EMI in 2010 has been over 2000 billion yuan and its output value accounted for 34% of the total industrial output value.

However, according to DRCNET statistical database, the total finished product for EMI in 2014 is 137,341. 62 billion yuan and it increased 16.1% compared with the same period in 2013. Besides, the total profit is 226399.54 billion yuan which increased 11.3% compared with the same period in 2013. It seems that China EMI is still in the growth stage. However, compared with the same period in 2012' the total finished product increased by 9.8% while the total profit increased by 18.4% in 2013. From the data above, we can see that the annual output in 2014 grew much faster than 2013 whereas the amplification of the total profit were much smaller than 2013. There are a lot of factors behind such a developing situation. Blindly expanding the scale of production has been unable to bring the EMI's healthy development. Is this the common trend for world EMI

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development? Or is it a particular condition for China's EMI? Where does China's EMI locate in the Global EMI Value Chain? How is the international influence of China's EMI? All these questions have arose interests over many scholars who are doing analysis and research on related aspects.

2. Literature Review

With the development of globalization, the global economy is divided into different processes and sections from the vertical integration of the production process. These processes are dispersed in different countries and form a dispersion in space. The whole value chain of the industry is expanded into a global value chain based on the international division of labor. Multinational companies transfer out of the low value-added sections with their core competitiveness so as to firmly grasp the high value-added sections (Fonseca, 2005). In order to reflect the position of a country in international trade accurately, Vertical Specialization index (Hummels et al., 2001), GVC Position index, GVC Participation index were raised gradually. As the downstream industry, EMI provides technology and equipment support for other industries in China. Since 2005, Dependence on imports of intermediate products of China's EMI has been continuously strengthened, but the degree of vertical specialization has not increased (Li, 2013). In the international division of labor system, China's EMI is locked in the low end of the global value chain, which is a number of non-strategic links with low added-value. From the GVC status index and the comparison of import and export products price, China EMI showed a trend of escalation, but the status is still in the low position (Lin & He, 2015). Vicious cycle of production mode of "self-lock" makes China EMI located in the low-end lock state in the global value chain. Introduction of foreign capital on EMI in our country has strengthened the trend of its low-end locking condition, while the innovation of value chain is an important way to break through the lock-in effect (Chen & Liu, 2011).

In terms of international influence and competitiveness, research on the EMI is relatively few. Most of existing research results is about the high technology industry and manufacturing industry as a whole. Overall, the conclusion is relatively consistent. Whether the manufacturing industry or high-tech industries, China still has a big difference with the developed countries. Labor intensive industry has a better international status and influence than technology intensive industries (Zhou, Lan, & Fu, 2014).

<Table 1> Studies Related to International Status and Influence

Author	Context	Main Methods	Findings
Li (2013)	Study on Influencing Factors of Vertical Specialization Position of Chinese Equipment Manufacturing Industry	HIY, O-ring theory,	The increasing of FDI, perfecting of infrastructure construction, increasing of port efficiency and perfecting of transaction environment, are all good for participating in vertical specialization of China EMI
Chen & Liu (2011).	Determinants of Chinese Machinery Industries' Position in GVCs: Based on Input-output Empirical Analysis of Divided Industries	Input-output analysis,	The degree of vertical specialization also rises but big foreign leakage battles the stretch of national value chains.
Lin & He (2015)	Position and Upgrading of China's Equipment Manufacturing Industry in Global Value Chain	Kaplinsky upgrading index, GVC position index	China still remained at the relative low-end in term of the position in the global value Chains. However, it should be noted that China's equipm ent manufacturing industry had significantly improved
Zhou, Lan, & Fu (2014)	Division Status of China's Manufacturing Industry in Global Value Chains: A Study Based on Koopman's GVC Position Indices.	GVC position index	The division status of China's manufacturing industry and its sectors in GVC are presently at low levels, and labor intensive manufacturing sectors are apparently at higher levels than those of China's technology, capital and natural resource intensive manufacturing sectors

To sum up, the EMI is a unique concept in China, and few foreign researches on it can be found. There are some researches in China, but most of them are on Manufacturing industry and high-tech industry. However, as China EMI is deeply embedded in global value chain, its development is certainly influenced by the global developing environment, and it will inevitably affect the development of the world EMI. Blindly expand the scale of production has been unable to bring the sound development of China's EMI. How to guide China EMI to develop in an improve way, and how is its international influence and status? These problems become the focus of attention from all circles of scholars.

In this paper, we pay attention to one main question. After all these years developing, is China's EMI still be located in the low level like most scholars pointed out? With the data from WIOD Database, the real and effective industrial influence of China's EMI is analyzed from the perspective of global value chain by the means of world input-output table.

3. Methods and Indications

3.1. World input-output model

Input-output model has a long history, in the fifties of the 20th century, Isard (1951), Chenery (1953) and Moses (1955) put forward the inter regional input-output model based on the input output model. In1961, Wonnacott first applied the input-output model to the analysis of inter country.

There are a variety of forms of the International Input-Output table, which can be divided into the national input-output tables and interstate input-output tables. In this paper, we will use the WIOT which is under the structure of SNA-08, which is based on the supply table and application table of various countries. Interstate input-output table can be used to compare the dependence degree and influence degree of import input of various sectors of different countries (regions), and then analyze the international status of one country's industrial sector. Different from the national input-output table, the global input-output tables do not include imports and exports. The global economy is regarded as a closed economy, every industry of every country is seen as different sector. A country's exports transform to inputs to other country's industry sector, while imports transform to input from other countries.

Based on the World Input-Output table, we can get the Intermediate input of each department to produce a certain department. With all these data, we can know the economic and technical relationship between all the sections from all countries. Also, the origin country of all the added-value can be distinguished.

3.2. Industrial influence measure index

Industry influence refers to the impact that caused by a sector's changing its final use. In the input-output model, it is usually quantitatively studied by the influence coefficient and the sensitivity coefficient. For the measurement of the influence coefficient, many scholars in China have questioned the traditional formula, and give the correction and adjustment. This paper adopts the viewpoint of Lisheng Shen. Traditional influence coefficient reflects the changing of the total output of various departments caused by a certain sector changing its final use while the motivate coefficient is calculated based on added-value and reflects the changing of the added-value.

3.2.1. The Influence Coefficient

The Influence coefficient reflects the demand impact to other national economic sectors caused by a unit final use increase of a certain sector.

We denote the direct consumption coefficient as A. Then the Leontief inverse matrix can be denoted as $(I-A)^{-1}$ (I is unit matrix). To simplify the formula below, we denote the Leontief inverse matrix as $(I-A)^{-1}=L=\begin{bmatrix} l_{11} & \cdots & l_{1n} \\ \vdots & \ddots & \vdots \\ l_{n1} & \cdots & l_{nn} \end{bmatrix}$. The calculation formula for influence coefficient F_j can be:

$$F_j=\frac{\sum_{i=1}^{n} l_{ij}}{\frac{1}{n}\sum_{j=1}^{n}\sum_{i=1}^{n} l_{ij}}(j=1,2,...,n) \quad (1)$$

Of these, $\sum_{i=1}^{n} l_{ij}$ is the sum of the j column of The Leontief inverse matrix $\frac{1}{n}\sum_{j=1}^{n}\sum_{i=1}^{n} l_{ij}$ is the average of the j column of the Leontief inverse matrix.

The greater the influence coefficient is, the greater the pull of the Department to other international sectors is. When $F_j>1$, the impact of the Department's production to other sectors is more than the average of the society. When $F_j=1$, the impact of the Department's production to other sectors is equal to the average of the society. When $F_j<1$, the impact of the Department's production to other sectors is lower than the average of the society.

3.2.2. The Motivate Coefficient

The traditional influence coefficient is the ratio of the sum of the Leontief inverse matrix's each column value and its average. It reflects the demand change of various economy sectors in other countries generated by a certain country's department changing its final use. However, if one sector of a certain country do has a high influence coefficient, does that mean it really do good impact to other sectors and to the world economy? Total output = intermediate input + added-value. The increase in total output is probably the result of the increase of intermediate input and added-value. It also can be caused by a single increase in the value of an intermediate input or an added-value. It even can be explained by one is increased while the other is declined. But either way, it gives a distinct answer to the question, that the traditional influence coefficient can not give a perfect explanation to the impact of a certain country's industrial sector to the overall economic benefits.

The Leontief inverse matrix reflects the comprehensive output changes in each industrial sector caused by the sector changing its production. Each of its columns indicates the sum number of the sum of intermediate products provided by all departments for a department need to consume to earn one unit final product. Its economic meaning is the direct and indirect output change of the

other departments which are caused by the change of the unit product of a certain industrial sector. Therefore, the influence coefficient which is calculated based on the matrix means the impact degree on all sectors made by one sector changing its final use.

In input output table, Added-value rate (R) = Added-value / Total input, Total input = Total output. So that Added-value rate (R) = Added-value / Total output. Therefore, When the total output is multiplied by the Added- value rate (R), we get the added-value. When multiplied by the Added-value rate matrix, the economic meaning of the Leontief inverse matrix becomes the change of added-value and thus the meaning of the motivate coefficient which is calculated by the Leontief inverse matrix is that when a certain sector changes its final use, it would affect the added-value of all other sectors around the world.

As mentioned above, the Leontief inverse matrix is denoted as L. The weight is the rate of increase of each sector $R(r_1, r_2, ..., r_n)$. The calculation formula for motivate matrix (P) is:

$$P = R \cdot (I - A)^{-1} = R \cdot L = (r_1, r_2, ..., r_n) \begin{bmatrix} l_{11} & \cdots & l_{1n} \\ \vdots & \ddots & \vdots \\ l_{n1} & \cdots & l_{nn} \end{bmatrix} = (p_1, p_2, .., p_3) \quad (2)$$

Accordingly, The calculation formula for the motivate coefficient ($F_j^{'}$) is:

$$F_j^{'} = \frac{p_j}{\frac{1}{n}\sum_{i=1}^{n} p_i} (i = 1,2,..., n) \quad (3)$$

Of these, $\frac{1}{n}\sum_{i=1}^{n} p_i$ is the average of the column of the motivate matrix.

The motivate coefficient reflects the added-value change of various economy sectors in other countries generated by a certain country's department changing its final use. It pays more attention to the economic benefits of the production process and reflects the economic benefits of the industrial sector. The greater the motivate coefficient is, the bigger the pulling effect on other sectors is. When the sector enlarges its investment, it can stimulate more output of the world's economic sectors.

World input output table has two types: the competitive input output table and the non-competitive input output table. In Shen's paper, it was pointed out that the Leontief inverse matrix itself is not reasonable so that the influence coefficient which is calculated based on the matrix is not reasonable either in the competitive input output table. Only in the non-competitive input output table, the Leontief inverse matrix would be meaningful. In this paper, the world input output table we chose takes the global economy as a closed economy and each sector in each country is considered to be an industrial sector different from each other. The export of one country is transformed into the input of the industrial sectors in other countries while the import is transformed into the input from other sectors. Therefore, there is no import and export, which is a non-competitive input output table, so that we can calculate the traditional influence coefficient and the motivate coefficient based on this table.

4. Empirical Analysis

4.1. Data Sources and Processing

The data used in this paper are the 2011 world input output table data from WIOT database. The world input-output table contains 40 countries and regions and other regions of the world input-output data, the data are numerous. The group of 20 cover a wide range of leading economies, which is very representative. And the group of 20 GDP accounted for 90% of the global economy, world trade accounted for 80% of the whole world. It has therefore replaced the G8 as the main forum for global economic cooperation. GNP (gross national product) of its member countries accounted for about 85% of the whole world, and the population was almost 2/3 of the world's total population. This character makes economic behavior of G20 really representative. So, this paper select the data of G20. The G20 members including the United States, Japan, Germany, France, Britain, Italy, Canada, Russia, the European Union, Australia, China, South Africa, Argentina, Brazil, India, Indonesia, Mexico, Saudi Arabia, Turkey, South Korea. However, the world input-output table did not separate the data from South Africa, Argentina, Saudi Arabia and the EU, so this paper uses the data of other sixteen countries other than the four countries. In addition, the sixteen countries including Asia (China, India, Indonesia, Japan, South Korea, Turkey)' North America (Canada and the United States), Latin America (Brazil and Mexico), Europe (Britain, Germany, France, Italy, Russia) and Oceania (Australia), covering all continents of the world. They are also representative, so this paper uses the data of the 16 countries.

World input output table includes 35 industrial sectors in total, in order to understand the international status of China EMI more clearly, during data processing, according to the international classification standards of the EMI, we will take, Machinery, Nec (Not Elsewhere Classified devices), Electrical and optical equipment, and transport equipment as "the EMI", the rest of the industrial sector is merged into the "others" category.

The following data are all calculated in accordance with the formula mentioned in 3.2.

4.2. Industrial Influence Analysis

4.2.1. The Influence Coefficient and the Motivate Coefficient analysis

By calculating of the 2011 world input-output table and we get the influence coefficient and motivate coefficient for all the 16 countries. After sorting the results, we come to the following results.

<Table 2> The Influence Coefficient and Motivate Coefficient for China EMI in 2011

Rank	Influence coefficient (F)		Motivate coefficient(F')	
	Country	value	Country	value
1	China	1.55104	Japan	1.04401
2	Korea	1.34682	USA	1.03562
3	Canada	1.17331	China	1.03299
4	Japan	1.16990	Indonesia	1.02857
5	Mexico	1.14936	Australia	1.00635
6	France	1.12990	Korea	0.98496
7	Russia	1.12616	Canada	0.98473
8	Australia	1.10159	Mexico	0.98272
9	Italy	1.08069	Italy	0.98263
10	India	1.08050	Germany	0.97635
11	Indonesia	1.05839	Britain	0.97348
12	Brazil	1.04601	Russia	0.96554
13	Turkey	1.04006	France	0.96273
14	Germany	1.02678	Turkey	0.95691
15	Britain	1.00524	India	0.95575
16	USA	0.97201	Brazil	0.89736

*The data is calculated by data from WIOD Database

It is evident from table 2 that there are large gaps the influence coefficient and the motivate coefficient of China EMI. China's influence coefficient ranks the first with the number 1.55104, which infects that the change of China EMI's final use has the greatest impact on total output of other sectors. However, as for the motivate coefficient which calculated on added-value, China EMI ranks the third place and the value is 1.03299. It ranks behind Japan and USA, and before Indonesia with a very small disparity.

In the input-output table, the greater the traditional influence coefficient is, the greater the impact on world EMI's total output is. But due to that the total output = intermediate input + value-added, the effect of the total output is influenced by the two aspects which are the intermediate input and the added value. If the impact on the middle of the input occupy is bigger, then the property of its intermediate products is more obvious, and its economic benefits is worse. The motivate coefficient describes the impact on added-value and it can reflect the true international influence of the sector. The greater the motivate coefficient is, the better economic benefit it has. Through table1, we can say that China's EMI has a strong influence on the global EMI output and a relatively high influence on the added-value too. Compared with China, American has a low influence coefficient but a high motivate coefficient, which makes American EMI an industry with a high effective and real international influence and a high international status. In contrast, China EMI's international influence and status is worse than American, as well as Japan, but obviously better than other countries.

4.2.2. The changes analysis of the influence coefficient and the motivate coefficient

Since China joined WTO in 2002, China EMI gradually open to the outside world and get into the big international stage of economy, technology and trade. China EMI has been facing the challenge and seizing the opportunity. Based on the calculation of world input-output table from 2002 to 2011, the influence coefficient and the motivate coefficient during the decade are as follows:

<Table 3> Analysis on China EMI's Change on F&F'

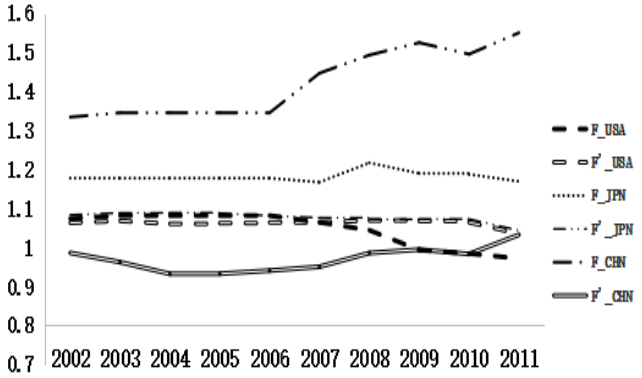
Time	Influence coefficient (F)	Motivate coefficient (F')	Rank (F')
2002	1.33480	0.98648	6
2003	1.34581	0.96280	8
2004	1.34581	0.93271	11
2005	1.34581	0.93303	11
2006	1.34581	0.94110	10
2007	1.44738	0.95097	8
2008	1.49387	0.98619	5
2009	1.52560	0.99503	4
2010	1.49620	0.98369	5
2011	1.55104	1.03299	3

*The data is calculated by data from WIOD Database

As shown in table 3, since 2002, influence coefficient of China EMI present a rising trend, while the motivate coefficient has declined before 2006 with a twist after 2006. Till year 2011, China EMI's motivate coefficient has been up to the third place with a value higher than 2002. On one hand, the continuously growing influence coefficient reflects the expanding international influence of China EMI in the international market. On the other hand, the rising motivate coefficient shows the rising influence on world EMI's added-value. Regardless of the impact on total output or on added-value, the international influence of China EMI has

been obviously risen, especially the impact on added-value. From the ranking point of view, since 2006, the international influence of China EMI has risen rapidly.

No doubt that only pay attention to change of the influence coefficient and the motivate coefficient of China EMI can not fully explain its international influence and change of its situation. To this end, we also calculate the changes of some other representative countries development for ten years, and the results are as follow.



<Figure 1> The influence coefficient and the motivate coefficient of USA, Japan, and China

Figure 1 respectively describe the process of change of the influence coefficient and the motivate coefficient for the United States, Japan, and China EMI from 2002 to 2011. From the figure, we can see that in this decade, the US EMI's influence coefficient showed a downward trend, while the motivate coefficient is relatively stable and even higher than the influence coefficient after 2007. Japan, another developed country, EMI has a stable influence and motivate coefficient, and the motivate coefficient was all the first rank over the decade. All these data can exclude the overall global economic factors from all the factors that may cause the change of influence coefficient and the motivate coefficient of China EMI.

Unlike these countries, influence coefficient of EMI in China is on the up, and the motivate coefficient eventually increased compared to 2002 after several ups and downs. Although from value angle, the change is very small, China EMI still has secured marked achievement from the rank of motivate coefficient. In fact, China EMI have a negligible progress on some high-end equipment manufacturing in recent years. There are many thriving industries, such as high-speed rail, unclear power, UHV equipment, and so on. China also cultivate a series of excellent large enterprises focusing on technological innovation, like Sany, ZOOMLION, XCMG etc. There are still some problems during the development period. Overheated investment in industries with low entrance barrier, the cheap and intensive labor resources and expanding productivity blindly contribute to the overcapacity of China EMI directly. But with the guidance of national policy, backward production capacity accelerates to be eliminated and key industry production capacity is increasing rapidly. According to the first half of 2015 data from the Chinese report hall, China's high-end EMI output value has exceeded 10% of the total EMI output value.

5. Conclusions

EMI is an important industry to every country. All developed countries with high influence to world economy are countries with a powerful EMI. In this paper, global economy is seen as a whole. The real international influence of China EMI is analyzed by analyzing the influence coefficient and motivate coefficient and the following conclusions are drawn through the analysis of the World Input-Output Model.

First, as for the influence to total output, although China EMI has a very high influence coefficient and it even has surpassed world industrial powers like Japan, the USA, Germany and Korea, this influence is mainly reflected in the influence of intermediate inputs but not the added-value. As for the influence to added-value, the motivate coefficient of EMI in our country has been ranked third in 2011, just after the United States and Japan. China EMI belongs to the forefront of the world no matter the traditional influence coefficient or motivate coefficient with high influence on both total output and added-value, and it plays an important role for world EMI development.

Second, from 2002 to 2011, both influence coefficient and motivate coefficient of China EMI has been risen up, and the influence coefficient is all on the way up during this decade while the motivate coefficient has declined before 2006. Compared with the USA and Japan, although China EMI's motivate coefficient is still lower than USA and Japan, China EMI is on the way up since 2006 while Japan and USA has been relatively stable for over ten years. China's EMI has a high international influence and an important international status, and the development trend of this rise is very obvious.

So, after all these years developing, is China's EMI still be located in the low level like most scholars pointed out? The answer is obvious. In general, China EMI is in a quite important position with high international share, and with high international influence, including the influence on the total output and the added-value. However, it is also a department of which the motivate coefficient can be improved further. With labor cost advantage gradually disappearing, some foreign manufacturing enterprises choose to move to Thailand, Vietnam and other countries and regions with more advantage of labor costs. As a result, it will be no longer a conductive long-term sustainable development mode for China EMI to develop to rely on traditional EMI. China EMI still needs to be upgraded for

further, and the proportion of high-end EMI still needs to be further improved. Sharp tools make good work and EMI is the sharp tool for national economy. It should strive to achieve coordinated development between quality and quantity and cultivate local EMI chain with independent innovation ability to break through its current position at the low end and so that it can achieve the promotion of the position in the global value chain.

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