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Research on Complexity of China's Manufacturing Networks

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ABSTRACT
In this article, the industry complex network of China's manufacturing is built based on the central input flow matrix data of 2012 Input-Output Tables of China through industry network modeling. This article analyses the complex nature of China's manufacturing network in three aspects, which are feature of industry network in general, community structure and industry nodes, using a series of statistics measuring complex network.

KEY WORDS: China; complex network; industry network; manufacturing

1 INTRODUCTION

FROM the perspective of network and graph, inter-industry linkage is a network graph with industry sectors as its vertex and connections between or inside these sectors as its arc or edge. Inter-industry network refers to the technology and economic connection or linkage between inputs and outputs of different industry sectors, an approach of quantitative static analysis of technology and economic linkage and means of such connection between varies industry sectors of national economy (Hou & Wang, 2014). In this article, inter-industry linkage network equals to industry network. Quantitative analysis of industry network can be used to find out the role certain industry sector plays in the industry network and well as underlying problems of industrial development. It also helps in revealing similarities and differences of industrial structure of different countries and regions, which can be served as scientific reference in adjusting, optimizing and upgrading industrial structure (Wang, Chen, Zhang & Lu, 2015).

At the end of 20th century, two academic articles concerning 'small-world' network (Watts & Strogatz, 1998) and random networks (Barabási & Albert, 1999) have inspired a lot of research on complex network. As its theories continue to develop, complex networks gradually become a new research field in subjects including economics (Li, Liu & Jin, 2017), management (Ballı & Tüker, 2017), sociology (Zhou & Luo, 2017), ecology (Fan, Li, Liu, Mu & Zhao, 2017), statistic physics (Kong, Huang, Gong & Li, 2018) and etc. Experts and scholars adopt theories and methodologies of complex network to work on problems of their own field, expecting complex network to bring some insights (Yang et al, 2010). Against such background, in the field of social science, it's becoming increasingly common to combine the theories of complex network and input-output analysis in the field of economics to conduct researches on inter-industry connections.

The very first article to adopt graph theory into inter-industry linkage research is the one by Campbell (1972), who built directed industry network based on input-output data and used subgraph and degrees to study the inter-industry linkage in Washington state. Then, Schnabl (1995) and Aroche (1996) respectively built their industry complex network modeling by adopting different quantitative methods to determine threshold value in order to find strong correlations. Besides, Ghosh (1981) used significant coefficient analytical method to build industry network to compare India's industry structure of 1983 and that of 1989. From the perspective of complex network, Fang et al. (2008) utilized input-output data by National Bureau of Statistics of the PRC to make a complex network model of input-output correlation of different industry sectors and analyzed major attributes of input-output network including edge weight distribution, strength distribution and clustering coefficient. Kim et al (2009) reviewed the role of information and communication technology industry from the view point of the variation of 'technology linkage structure' density of Korean enterprises. Based on effective association, Wang and Yang (2011) discussed general features of association network which has 67 manufacturing industries in Sichuan Province, such as small-world, free-scale and community structure, and identified some important industries that have a role to play in improving hub

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efficiency, betweenness efficiency and information broker efficiency in this network. Another paper (Aroche & Marquez, 2012) built an input-output model of all industrial sectors of Mexico from 2005 to 2010 and revealed performance variation of different groups of industries categorized by different technical strength. Zhao et al. (2013) found out the algorithm of foundational industry linkage tree based on Kruskal algorithm, the minimum spanning tree of graph theory. Li (2016) used the input-output tables of 144 industry sectors of Shanghai from 2007 to 2014 to calculate the in-degree and out-degree based on input-output complete consumption coefficient. The article also analyzed the correlation of GDP and in-degree and out-degree of varies types of industry sectors and discussed relevance and status of manufacture industry and service industry in the industry network of Shanghai.

From the existing research works, thanks to many scholars, the analytical approach that, based on data from input-output tables, incorporates theories of complex network to analyze the structure and efficiency of industry network through network analysis, has been well developed. However, researches concerning the manufacturing industry network of major manufacturing countries are insufficient. Hopefully this article could help expand the scope and enrich the content of the research field of industry network by analyzing subdivided manufacturing network structures based on the latest input-output table of 135 sectors published in 2012.

There are 4 parts in the remaining content of this article: the first part is about source of the data that is used to build China's manufacturing industry network and data processing; the second part contains varies statistics for industry network analysis; the third part is the analysis of the complexity of China's manufacturing network structure from three different perspectives, namely general network structural features, network cohesive subgroup structural features and industry node; the last part is the conclusion and summary of the complex nature of China's manufacturing industry network.

2 DATA COLLECTION AND INDUSTRY NETWORK MODELING

2.1 Data Collection

CHINESE authority publishes national and provincial input-output statistics every five year and the latest input-output table is the one published in 2012. This 2012 version contains two input-output tables due to different standards (GB/T 4754-2011) of industry sector classification, one of 42 industry sectors and the other of 135 sectors. However, in the table of 42 industry sectors, difference of subsectors within one industry sector are too obvious that it hampers us from digging in the pattern of complex inter-industry linkage. At the same time, considering that China is the top manufacturing nation, choosing a table with more detailed classification is more helpful for a better understanding of China's manufacturing industry network. In the 2012 input-output table with 135 industry sectors, there are 84 manufacturing sectors. Three of these sectors, namely, Other Manufactures, Comprehensive Utilization of Waste Resources and Repair of Fabricated Metal Products, Machinery and Equipment, are excluded from following discuss and there are 81 subdivided manufacturing industry sectors left. Notably, deletion of the three sector is because their industrial attributes are not very clear that Comprehensive Utilization of Waste Resources is more of recycling industry while Repair of Fabricated Metal Products, Machinery and Equipment is manufacturing industry with service industry attribute. Exclusion of these sectors can to some extent avoid distraction of research analysis.

2.2 Industry Network Modelling

Industry network modeling normally refers to how to define inter-industry linkage base on input-output relationships, which means to define the rules of vertex and edge in the industry network based on inter-industry linkage. Some scholars have already explored this industry network modeling method. The research of Campbell (1972) neglected possible influence of different volume of inter-industry inflow have on the model. It was believed that as long as there was inter-sector inflow, the relevant industry sectors were considered connected or linked. Later, another research of Campbell (1975) took the mean of input-output flow matrix of intermediate goods as threshold value to build models of significant inter-industry linkage. Schnabl (1995) adopted Minimal Flow Analysis (MFA) to build industry network model. The mean of three threshold values, calculated according to three different principles, was used as the final threshold value. Aroche-Reyes (1996) believed that MFA model was too tedious and Important Coefficient Analysis (ICA) was used to differentiate inter-industry linkage. However, the choice of threshold value in this research was somehow empirical. On the basis of Weaver-Thomas Index (W-T Index), Zhao (1996) assigned a threshold value to each of the industry sectors through sensitivity trial calculation. Thus, sectors with different industrial attributes got a different threshold value. Yet it lacked a single standard to differentiate threshold values of different sectors since each of these sectors were given different threshold value according to W-T Index. Considering the fact that different manufacturing industry sectors have different attributes, this research article assigns different threshold values to every sectors by reference to Zhao's research model method of determining threshold value. What's different from Zhao's research is that, in this research article, the network model is built on the average mean of coefficient of each column of the input-output matrix plus 1.5 times the standard deviation. This poses stricter identification conditions of inter-industry linkage but it's more convenient and effective to discern the basic structure of China's manufacturing industry network.

3 METHODOLOGY

THIS article will break down the complex nature of China's manufacturing industry network structure from three different dimensions, general network structure, community network structure and industry node. Several commonly used statistics.

3.1 Measurement of General Features

Network Density: Network density is an essential criterion for measuring general industry network density. The denser general network is, the closer connections of industry sectors in the network are, the stronger effect of division and collaboration of manufacturing industry is as well, vice versa. It is measured by the ratio of the actual quantity of industry linkage to the theoretical maximum quantity of industry linkage in the network:

$$DS = m/(N(N-1)) \tag{1}$$

In the formula, DS represents network density. N is the number of all sectors in the network. m is the number of actual inter sector linkage in the industry network.

Average Shortcut Distance: in the industry network the shortest shortcut distance describes the number of linkages that connect any two sectors with the smallest amount of linkage of all industry connections. The average shortcut distance is the average value of shortest shortcut distance of any two sectors in the network, measuring the connectedness of the whole industry network. The formula is:

$$L = \frac{2}{N(N-1)} \sum_{i \geq j} d_{ij} \tag{2}$$

In the formula, L is average shortcut distance. N is the number of sectors in the whole network. d_{ij} is the number of linkages between sector i to sector j.

Clustering Coefficient: Clustering coefficient in the network refers to the ratio that two sectors have industry linkage between one another when they are both connected to another sector, similar to the ratio of two people, who are friends of another person, are also friends themselves. The formula goes as follows:

$$C = \sum 2E_i /(k_i(k_i-1))) \tag{3}$$

In the formula, C is average clustering coefficient. N is the number of all sectors in the network. k_i is the number of linkage sector i has between other sectors in the network. E_i is the number of valid industry linkage among k_i sectors. Average clustering coefficient in the network is the mean value of clustering coefficient of all sectors.

3.2 GN Algorithm Based Community Division Method

Community structure is shared attribute among various complex networks, which also exists in the industry network due to different degree of connectedness between sectors. To identify community structure, GN algorithm is utilized used to divide the network into several communities by constantly removing the edge with the largest betweenness from the network. Modular Q index is adopted as measurement of criteria of quality to identify various communities (Newman & Girvan, 2002, 2004):

$$Q = \sum_i (e_{ii} - a_i^2) = Tre - \| \mathbf{e}^2 \| \tag{4}$$

If the whole network is divided into k communities, $\mathbf{e} = (e_{ij})$ is defined as a $k \times k$ dimensional symmetry matrix in which e_{ij} represents the proportion of the edges connecting two community nodes to all edges, and these two community nodes are community node no. i and no. j . $Tre = \sum_i e_{ii}$ is the sum of elements on the diagonals of the matrix. $a_i = \sum_j e_{ij}$ refers to the sum of elements on each row (or column). $\| \mathbf{x} \|$ means the sum of all elements in the matrix $\mathbf{x}$.

3.3 Industry Node Complexity Measurement

Degree: Degree describes some sort of importance of nodes in complex network, while in the field of industry network it represents the number of valid industry linkages between all industry nodes. In directed networks, degree of industrial sectors can be categorized into in-degree and out-degree based on whether it is the raw material supplier or the recipient. Total degree value can be defined in symmetric undirected network. At the same time, node industry, defined in this article based on degree value, means industry sectors that have connections with more than one different industry sectors in industry network. Due to its particular feature, flow of raw materials can occur between node sector and multiple other sectors. In complex network algorithm, node industry sectors are also industry nodes of high degree values in the industry network.

Betweenness: Betweenness, also known as betweenness centrality, measures the ability of a sector to control resources in the entire network, that is, the length of the shortest path through this sector connecting any other two sectors. The formula is:

$$B_i = \frac{1}{(N-1)(N-2)} \sum_{j \neq k} \frac{b_{ijk}}{b_{jk}} \quad (6)$$

In the formula, B_i is the betweenness. b_{jk} describes the length of the shortest path between sector j and node k. b_{ijk} means the length of the shortest path that connects sector j and sector k through node i. N is the number of industry sectors of the entire network.

Meanwhile, intermediary or betweenness industry sector is also defined according to the definition of betweenness, meaning industry sectors that, passed by other edges, connect two different industry sectors with shortest path or edges in the industry network. Intermediary industry sectors can have control and influence on other sectors through indirect ways, thus have effect on the connection of a much larger scale of industries.

4 RESULT AND ANALYSIS

4.1 Industry Network General Features

ACCORDING to network building method, coefficients that are above the threshold value are retained and regarded as strong inter-sector linkages. The asymmetric valid connection matrix of the 81 sectors of China's manufacturing industry is obtained. For research purpose, the asymmetric matrix corresponding to directed network is converted into symmetric matrix corresponding to an undirected network.

The industry network is built based on two connection matrices. Directed network density is 0.041. Undirected network density is 0.081. There are 268 edges in the directed network, 524 in the undirected, indicating that there are 7 pairs of industry sectors that have two direction connections with one another. At the same time, clustering coefficient and average shortcut distance of undirected network are 0.388 and 2.906, which show strong internal connection and clustering tendency. Also, inter-industry connections cause relatively fluid and smooth flow between sectors in the entire industry network. Sectors need just three linkages to get connected with one another on average.

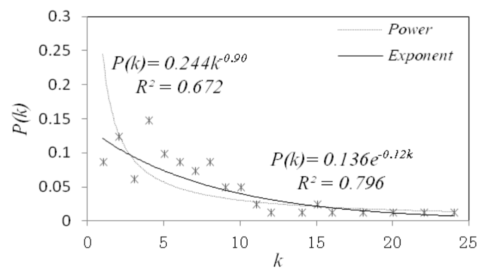

Figure 1. Degree distribution of China's manufacturing network.

Degree distribution is another essential component of complex network study. Degree distribution of nodes in the network can be described by distribution function $P(k)$. $P(k)$ shows the proportion of nodes with degree k in the entire network. According to random graph theory, degree distribution of complex network follows Poisson distribution, which has a distinguished feature that most of degree values of nodes in the network are close to the mean value. In this sense, complex network is homogeneous network. However, a large number of research outcomes about degree distribution of large real networks show that complex network is not homogeneous but heterogeneous. Degree distribution of complex network does not follow Poisson distribution but power law distribution. Power law fitting of degree distribution of manufacturing industry network of 2012 shows that goodness of fit R^2 is only 0.673. Yet the goodness of fit R^2 of exponential fitting reaches 0.796 (shown in Figure 1). Such results suggest that degree distribution of China's manufacturing network is inclined to follow exponential distribution, that meaning only few industrial sectors have a large amount of backward linkage with other industrial sectors and most brunches of industry have very few backward linkages.

4.2 Community Structural Features

GN algorithm is adopted to divide China's manufacturing network into different communities. Q index is taken to judge the quality of community classification. Q index is calculated respectively assuming the network is divided to 2 to 20 ($k \in [2, 20]$) different communities. When $k = 6$, meaning to divide the network into 6 communities, Q reaches its peak at 0.457. Thus it is decided to have 6 communities in the network, and directed network of community division is shown in Figure 3 as below:

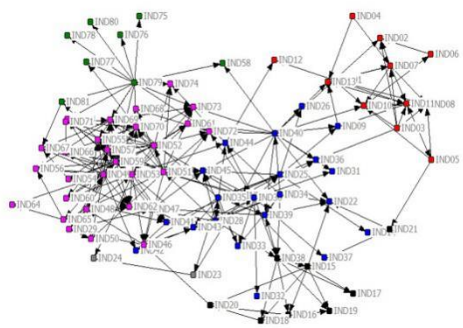

Figure 3. Community structure of China's manufacturing network.

Table 1 shows the number of sectors or members of each community, what sectors are within each community, number of all connections of the community and internal and external connections of each community. Members of Community I are mainly from food manufacturing industry. Members of Community II are subsectors of Papermaking, Printing and Manufacture of Articles for Culture, Education and Sports Activities, Manufacture of Refined Petroleum, Coke Products and Processing of Nuclear Fuel, Manufacture of Chemicals and Chemical Products and Manufacture of Nonmetallic Mineral Products. Subsectors under Community III are all from Manufacture of Textiles and Manufacture of Textile Wearing Apparel, Footwear, Leather, Fur, Feather and Its Products. The only 2 members of Community IV are from Processing of Timers and Manufacture of Furniture, exactly the only two subsectors within this category in the table. Community V has members mainly from Manufacture and Processing of Metal, Manufacture of Fabricated Metal Products, Except Machinery and Equipment and all manufacture sectors of equipment except Manufacture of Communication Equipment, Computer and Other Electronic Equipment. Community VI has members mainly under Manufacture of Communication Equipment, Computer and Other Electronic Equipment. Communities with the top 2 largest number of members are Community V and Community II , 29 and 22 respectively. The number of connections of these two communities are 251 and 143. Community with the least number of members are Community IV, with only 2 subsectors, Processing of Timbers and Manufacture of Products of Wood, Bamboo, Rattan, Palm and Straw and Manufacture of Furniture.

For a better understanding of internal structure of each community as well as inter-community connectedness, a connectedness index is created to show internal and external connectedness of communities by dividing the number of external connections and the number of internal connections by the number of sector nodes respectively. Among all the communities, the one with the best internal connectedness is Community V, the connectedness index of which reaches 7.31. This is mainly because subsectors of metal manufacturing industry and equipment manufacturing industry often needs products of other subsectors under this category as components or production materials. Thus, this community has close internal connections. Community I and Community II have also relatively good internal connectedness, with their internal connectedness index above 4. Community with best external connection is Community II, the external connectedness index of which goes as high as 1.95. Members of this community are generally within the following four sectors, papermaking and printing and stationary manufacturing, refined petroleum and coke product and nuclear fuel processing industry, chemicals and chemical products making and nonmetallic mineral products industry. A common ground shared by these four sectors are that they all provide production materials for all other manufacturing industries. That's why it is rated the highest in terms of external connectedness.

4.3 Nodular Features

According to formula (5) and (6), the mean value of degree value and betweenness plus 1.5 times standard deviation taken as selection threshold in order to identify hub industries and betweenness industries in China's manufacturing network, the results are shown in Table 2. Hub industries of the entire network are the top 8 in degree value ranking, which are Manufacture of Fabricated Metal Products, Except Machinery and Equipment, Processing of Steel Rolling Processing, Manufacture of Other General-Purpose Machinery, Manufacture and Casting of Non-Ferrous Metals and Related Alloys, Manufacture of Plastic Products, Manufacture of Basic Chemicals, Manufacture of Electronic Components and Parts and Processing of Non-Ferrous Metals Rolling. They are in the center of the whole industry network. Betweenness industries are the top 7 in betweenness ranking. From top to bottom they are Manufacture of Refractory Products, Manufacture and Casting of Basic Iron and Steel, Manufacture of Textile Wearing Apparel, Manufacture of Fabricated Metal Products Except Machinery and Equipment, Processing of Steel Rolling Processing, Manufacture of Other General-Purpose Equipment and Manufacture of Coke Products. These subsectors have strong control over connections between other sectors. Notably, all three subsectors, Manufacture of Fabricated Metal Products Except Machinery and Equipment, Processing of Steel Rolling Processing and Manufacture of Other General-Purpose Equipment, are both hub industries or sector nodes and betweenness industries.

Table.1 Communities structure of 81 manufacturing association network in China

Communities	No. of sectors	No. of total connections	No. of internal connections	No. of external connections	Members
Community I	12	60 (5.00)	52 (4.33)	8 (0.67)	IND01, IND02, IND03, IND04, IND05, IND06, IND07, IND08,IND10,IND11,IND12,IND13
Community II	22	143 (6.50)	100 (4.55)	43 (1.95)	IND09,IND14,IND22,IND25,IND26,IND27,IND28,IND30,IND31,IND32,IND33,IND34,IND35,IND36,IND37,IND39,IND40,IND41,IND42,IND43,IND44,IND45
Community III	8	39 (4.88)	30 (3.75)	9 (1.13)	IND15,IND16,IND17,IND18,IND19,IND20,IND21,IND38
Community IV	2	5 (2.50)	2 (1.00)	3 (1.50)	IND23,IND24
Community V	29	251 (8.66)	212 (7.31)	39 (1.34)	IND29,IND46,IND47,IND48,IND49,IND50,IND51,IND52,IND53,IND54,IND55,IND56,IND57,IND59,IND60,IND61,IND62,IND63,IND64,IND65,IND66,IND67,IND68,IND69,IND70,IND71,IND72,IND73,IND74
Community VI	8	26 (3.25)	14 (1.75)	12 (1.50)	IND58,IND75,IND76,IND77,IND78,IND79,IND80,IND81

Note: numbers in the brackets indicate the number of internal connections and the number of external connections divided by the number of corresponding community nodes respectively.

Table 2. Hub industries and betweenness industries of effective association network in China

Type		Hub industries (degree value)	Betweenness industries (betweenness)
Entire network		IND53,IND49,IND59,IND51,IND40,IND30,IND79,IND52	IND46,IND48,IND20,IND53,IND49,IND59,IND29,
Communities	Community I	IND07	IND07,IND01
	Community II	IND30	IND30,IND25
	Community III	IND15	IND15
	Community IV	None	None
	Community V	IND49,IND53,IND59	IND49,IND51,IND53,IND59
	Community VI	IND79	IND79

Also, hub subsectors and betweenness subsectors within each community are identified as follows. Community I, II, III and VI are all single-hub industry communities. Community V has more than one hub subsectors. Community III and VI are both single-betweenness subsector communities. Community I and II have two betweenness subsectors. Community V has multiple members that are betweenness subsectors. Since Community IV has only two members, there is no hub industry or betweenness industry within Community IV. Besides, hub industry subsectors within each community are mostly betweenness industry subsectors as well. Subsectors that are both hub industry and betweenness industry are: Processing of Other Food of Community I, Manufacture of Basic Chemicals from Community II; Spinning, Weaving and Finishing of Cotton and Chemical Fibers from Community III, Manufacture of Fabricated Metal Products Except Machinery and Equipment, Processing of Steel Rolling Processing and Manufacture of Other General-Purpose Equipment from Community V; Manufacture of Electronic Components and Parts from Community VI. The above findings show that these sectors not only have direct control over connections of other sectors, they are also essential parts of connections of other sectors in the network.

5 CONCLUSION

THIS article utilizes central input flow matrix data of input-output table of 2012 to build complex network of China's manufacturing industry through industrial network modeling. The complex nature of China's manufacturing network is analyzed in three perspectives, namely, general features of industry network, community structural features and industry nodular features. Our major conclusions are listed as follows.

Regarding the general feature of manufacturing industry network, based on power law fitting of degree distribution, it is found that degree distribution of China's manufacturing network is inclined to follow exponential distribution rather than power law distribution. Concerning community structural features, Community with most internal connections is composed of subsectors of metal manufacturing industry and equipment manufacturing industry. The internal connection index of this community goes as high as 7.31. Community that are best externally connected is made up of four subsectors, papermaking and printing and stationary manufacturing, refined petroleum and coke product and nuclear fuel processing industry, chemicals and chemical products making and nonmetallic mineral products industry.

As for the nodular feature of manufacturing industry network, sector of fabricated metal, sector of steel rolling processing and sector of general-purpose machinery are both hub and betweenness industries. These sectors not only have direct control over connections of other sectors, they are also the essential parts of connections of other sectors in the network.

5.1 Appendix

Appendix 1. Number and full name of subsectors

No.	Full name
IND01	Manufacture of Grain Mill Products
IND02	Manufacture of Prepared Animal Feeds
IND03	Manufacture of Crude and Refined Oils from Vegetable
IND04	Manufacture of Sugar
IND05	Slaughtering and Processing of Meat
IND06	Processing of Aquatic Products
IND07	Processing of Other Foods
IND08	Manufacture of Convenience Food Products
IND09	Manufacture of Milk and Dairy Products
IND10	Manufacture of Flavoring and Ferment Products
IND11	Manufacture of Other Food Products n.e.c
IND12	Manufacture of Alcohol and Alcoholic Beverages
IND13	Manufacture of Soft Drinks and Refined Tea Products
IND14	Manufacture of Tobacco Products
IND15	Spinning, Weaving and Finishing of Cotton and Chemical Fibers
IND16	Spinning, Weaving and Finishing of Wool
IND17	Spinning, Weaving and Finishing of Bast and Silk Fibers
IND18	Manufacture of Knitted and Crocheted Fabrics and Articles, Except Apparel
IND19	Manufacture of Made-up Textile Articles, Except Apparel
IND20	Manufacture of Textile Wearing Apparel
IND21	Manufacture of Leather, Fur, Feather and Its Products
IND22	Manufacture of Footwear
IND23	Processing of Timbers and Manufacture of Products of Wood, Bamboo, Rattan, Palm and Straw
IND24	Manufacture of Furniture
IND25	Manufacture of Paper and Paper Products
IND26	Printing and Reproduction of Recording Media
IND27	Manufacture of Stationeries, Musical Instruments, Products of Arts and Crafts, Sports Goods, Games and Toys
IND28	Manufacture of Refined Petroleum Products, Processing of Nuclear Fuel
IND29	Manufacture of Coke Products
IND30	Manufacture of Basic Chemicals
IND31	Manufacture of Fertilizers
IND32	Manufacture of Pesticides
IND33	Manufacture of Paints, Printing Inks, Pigments and Similar Products
IND34	Manufacture of Synthetic Materials
IND35	Manufacture of Special Chemical Products
IND36	Manufacture of Daily-use Chemical Products
IND37	Manufacture of Pharmaceutical Products
IND38	Manufacture of Chemical Fibers
IND39	Manufacture of Rubber Products
IND40	Manufacture of Plastic Products
IND41	Manufacture of Cement, Lime and Plaster
IND42	Manufacture of Products of Plaster and Cement and Similar Products
IND43	Manufacture of Brick, Stone and Other Building Materials
IND44	Manufacture of Glass and Glass Products
IND45	Manufacture of Cematic and Porcelain Products
IND46	Manufacture of Refractory Products
IND47	Manufacture of Products of Graphite and Other Nonmetallic Minerals
IND48	Manufacture and Casting of Basic Iron and Steel
IND49	Processing of Steel Rolling Processing
IND50	Manufacture of Ferroalloy
IND51	Manufacture and Casting of Non-Ferrous Metals and Related Alloys
IND52	Processing of Non-Ferrous Metals Rolling
IND53	Manufacture of Fabricated Metal Products, Except Machinery and Equipment
IND54	Manufacture of Boiler and Prime Mover
IND55	Manufacture of Metal working Machinery
IND56	Manufacture of Lifting and Handling Equipment
IND57	Manufacture of Pump, Valve, Compressor and Similar Machinery
IND58	Manufacture of Movie, Office Machinery and Equipment, of Projector and Camera
IND59	Manufacture of Other General-Purpose Machinery
IND60	Manufacture of Machinery for Mining, Metallurgy and Construction
IND61	Manufacture of Machinery for Chemical Industry, Timber and Nonmetal Processing
IND62	Manufacture of Machinery for Agriculture, Forestry, Animal Production and Fishery
IND63	Manufacture of Other Special-Purpose Machinery
IND64	Manufacture of Motor Vehicles, Except Parts and Accessories for Motor Vehicles
IND65	Manufacture of Parts and Accessories for Motor Vehicles
IND66	Manufacture of Railway Transport Equipment
IND67	Manufacture of Boats and Ships and Floating Devices
IND68	Manufacture of Other Transport Equipment
IND69	Manufacture of Generators and Electic Motors
IND70	Manufacture of Equipments for Power Transmission and Distribution and Control

IND71	Manufacture of Wire, Cable, Optical Cable and Electrical Goods
IND72	Manufacture of Batteries
IND73	Manufacture of Household Appliances
IND74	Manufacture of Other Electrical Machinery and Equipment
IND75	Manufacture of Computer
IND76	Manufacture of Communication Equipment
IND77	Manufacture of Broadcasting, Television Equipment, of Radar and Related Equipment
IND78	Manufacture of Audiovisual Apparatus
IND79	Manufacture of Electronic Components and Parts
IND80	Manufacture of Other Electronic Equipment
IND81	Manufacture of Measuring Instruments and Meters

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7 DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

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