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The interaction of clusters between manufacturing and producer services in China

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ABSTRACT

The interactive development of clusters between manufacturing and producer services is important for China to break its comparative economic dilemma. The scientific novelty in this article is embodied by the interaction of various clusters of manufacturing with producer services. Taking the location quotient as the index measuring cluster, it was found that various manufacturing clusters and producer service clusters in the east achieved comparative equilibrium, while the middle and the west were comparatively imbalanced in development. By comparison of influencing factors, it was shown that decline of energy consumption and technology level, acceleration of multinational corporations, strengthening of competition and cooperation and strictness of regulation are beneficial to traditional industrial clusters. However, the effects of these factors on modern industrial clusters were the opposite. Empirical analysis showed that traditional manufacturing clusters had a close relationship with traditional producer service clusters, and were the opposite with modern producer service clusters. Finally, the countermeasures for achieving the interacting development of industrial clusters were proposed from aspects of the gradient development of producer services clusters, the guidance of dominant industries in manufacturing clusters, promotion of industry clusters by centralising high-levelled elements and the diversity of policy guidance.

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1. Introduction

China's economy has been in a state of obvious comparative dilemma in recent years, which has much relevance not only to a comparatively unstable international environment inducing, to some extent, relatively blocked development of the export-oriented economy, but also comparatively scattered development within industry and comparatively uncoordinated development among different industries, which is important to elevate economic development. Therefore, clustering development of industries should be important. For example, various types of industrial zones and industrial clustering zones have become normal in

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different regions in China. Per-capita G.D.P. reached US\$ 8016 in 2015 in China; according to the view of the theory of developing economics, in this stage of economic development there exist upwards or downwards possibilities, which reflect economic development, so co-cultivation of industries should be important to reverse the developing trend. As for industrial characteristics, development of manufacturing would bring enormous demand for producer services, while business form's elevation of producer services would promote upgrading of manufacturing; thus it is important to detect the internal relationship of clusters between manufacturing and producer services.

There exist internal relationships between producer services and manufacturing (Abdulrahman, Subramanian, Chang, & Shu, 2015; Juleff-Tranter, 1996; Liu, Wan, & Zhou, 2014; Peter & Celine, 2009; Sue & Paul, 1994), e.g., logistics services contribute greatly to the development of manufacturing (Liu & Cui, 2009; Prem, Tim, & Brian, 2014), and economic transformation and upgrading require interactive development between them (Kumar, Kar, & Sanjay, 2007; Yang, Liang, & Cai, 2014). Many scholars have examined their interaction through national-level data. For example, Philip (2008) made the comparison of Japan and US to detect differences of interaction. Nikezic, Bataveljic, and Matic (2012) discussed initiative development of manufacturing and service clusters in the Republic of Serbia. Eri and Kawakami (2015) evaluated dynamic externalities of producer services clustering on the motor metropolis in Japan. Klaus, Ejaz, Stephen, and Esteban (2015) considered that spatial development in India contributed much to the mixed development between producer services and manufacturing clusters. Santamaría, Nieto, and Miles (2012) analysed service innovation in manufacturing firms in Spain. Alan (1997, 2008) detected the influence of producer services on manufacturing firms from the aspect of innovation in New York State. Bowen and Leinbach (2003) analysed the relationship between electronics manufacturers and the strategic use of advanced producer services using data from industrialising Asian economies. Oleksandr and Volodymyr (2015) analysed the impact of Ukraine's services on productivity of manufacturing firms. In addition, scholars have examined the relationship between producer services and manufacturing clusters in Japan (Matsumoto & Umeda, 2011), the U.S.A (Giutini & Gaudette, 2003), India (Rathore, Kota, & Chakrabarti, 2011) and Italy (Rosanna & Filippo, 2015).

Regarding producer services and manufacturing in China, an effect of synergy and co-agglomeration exists (Jiao & Jiang, 2014; Ke, He, & Yuan, 2014). There has been much research concerning the status quo and influencing factors of manufacturing clusters or producer services clusters in China. The research on manufacturing clusters includes Wang (2006), Chen and Tong (2006), Li, Li, and Liu (2011), Zhang, Xu, and Liu (2011), while the research on producer services clusters includes Shen, Qiu, and Ren (2009), Ji and Yang (2012), and Wang (2014). Some scholars have investigated the internal relationships between manufacturing and producer services clusters; however, manufacturing and producer services were not divided into different types. For example, Zhang and Li (2011) showed that producer services clusters were highly positive for manufacturing clusters, based on China's provincial data, by taking the Location Quotient Index; Ji, Li, and Su (2012) found that producer services clusters contributed to the relationship with manufacturing clusters in China and showed a balanced development trend by taking the Herfindahl-Hirschman Index and the EG Index; Han, Sun, and Zhang (2012) analysed the effects of producer services clusters and manufacturing clusters on returning to education and salary level by examining industrial panel data.

From the above, we know that there have been many studies on manufacturing clusters and producer services clusters, few studies on the relationship between these two clusters, and no study was found from the aspect of dividing manufacturing into different types, which is the key point of this article. In fact, different types of producer services cluster may have different influences on various types of manufacturing cluster, and this is essential for China's efficient transformation and upgrading. The purpose of this article was to detect the interaction between different types of manufacturing clusters and producer services clusters; this was expected to provide a comparatively new angle on industrial cluster research. This article analyses common influencing factors on various types of industrial clusters based on calculating degrees of manufacturing clusters and producer services clusters, and detects effects of various types of producer services cluster on various types of manufacturing cluster, from the national and regional perspectives, then proposes some measures for achieving effective cooperative development of clusters between manufacturing and producer services.

2. Status quo of manufacturing cluster and producer services cluster

2.1. Calculation method

Methods for calculating the degree of industrial cluster included the Herfindahl–Hirschman Index, the Gini Coefficient, the EG Index, the Krugman Specialisation Index, the Location Quotient Index and the CR Index. Considering the available data, we took only the Location Quotient Index (abbreviated, β value) to measure the degree of industrial cluster for the consequent analysis (ignoring the other five methods); this is described in the following equation:

$$\beta_{ij} = \frac{\theta_{ij} / \sum_{i=1}^n \theta_{ij}}{\sum_{j=1}^n \theta_{ij} / \sum_i \sum_j \theta_{ij}} \quad (1)$$

In Equation (1), i and j represent industry 1, 2, 3... n and region 1, 2, 3... n , respectively. θ_{ij} and $\sum_{i=1}^n \theta_{ij}$ represent the value of industry i in region j and value of regional manufacturing in region j respectively, and $\sum_i \sum_j \theta_{ij}$ represent the national value of industry i and national value of manufacturing. The same method of calculation was implemented for producer services.

2.2. Data description

Relevant data were obtained from the *China Industrial Economy Statistical Yearbook*, *China Statistical Yearbook of Tertiary Industry* and *China Statistical Yearbook*. For detecting the state of China's manufacturing clusters in detail, we divided 21 industries into labour-intensive, resource-intensive, capital-intensive and technology-intensive categories, with data obtained from the *China Industrial Economy Statistical Yearbook*, with 5, 7, 5, 4 industries, respectively; the whole nation was separated into the eastern region, the middle region and the western region. Considering the *China Statistical Yearbook* and the difficulty of achieving product values of various producer services, producer services were considered to include

transportation, storage, postal industry, wholesale, retail industry and the financial industry. Here, we defined the transportation industry, storage and postal industry, the wholesale and retail industry as traditional producer services, and the financial industry as modern producer services.

We took relevant data for the period 2006–2011 for the following analysis. The statistical criterion of the manufacturing sector has changed since China's *Industrial Economy Statistical Yearbook* was renamed *China Industrial Statistical Yearbook* after 2013. Therefore, to maintain consistency of the data, data after 2012 were not considered. With no G.D.P. data for various manufacturing industries in the *China Industrial Economy Statistical Yearbook*, we took the industrial total value to replace it. The total value of manufacturing and producer services of China and various regions were summarised by the above types of manufacturing and producer services using the simple-weighted calculation method. Here, the simple-weighted method is a way to obtain the weighted arithmetic average with the certain observation value and time sequence number as the weight. As producer services included only three industries, there was no need to make them into different types. It should be noted that the simple-weighted calculation method might make much difference to the average value of β being 1, which implies that traditional criteria on value judgement did not fit this analysis. For example, regarding capital-intensive manufacturing in 2006–2011, the eastern value was about 1, but the whole nation and the other regions were less than 1, therefore, the β value achieved could be used for comparative analysis, which implied that comparison was feasible among one region or different regions. Putting relevant data into the above equation, we achieved a relevant β value, shown in Table 1 and Table 2. For convenience of the following analysis, we made *LD*, *ZY*, *ZB*, *JS*, *JY*, *PL*, *JR* represent labour-intensive manufacturing, resource-intensive manufacturing, capital-intensive manufacturing, technology-intensive manufacturing, transportation, storage and postal industry, the wholesale and retail industry and the financial industry, respectively.

Table 1. Definition of Types of Manufacturing and Regions.

Content	Type	Definition
Manufacturing	Labour-intensive	Clothing, shoes, hat manufacturing, textile manufacturing, the agricultural and sideline food processing industry, food manufacturing, the beverage processing industry
	Resource-intensive	The non-ferrous metal product industry, the ferrous metal smelting and rolling processing industry, the metal product industry, the tobacco product industry, the papermaking and paper product industry, the petroleum processing, coking and nuclear fuel processing industry, the non-ferrous metal smelting and rolling processing industry
	Capital-intensive	The electrical machinery and equipment industry, the transportation equipment industry, the chemical fibre industry, the general equipment industry, the specific equipment industry
	Technology-intensive	The pharmaceutical industry, the instrument and culture, office machinery industry, the chemical raw materials and chemical products industry, the communications equipment, computers and other electronic equipment industry
Regions	Eastern region	Beijing, Tianjin, Liaoning, Hebei, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, Hainan
	Middle region	Shanxi, Neimenggu, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, Hunan, Guangxi
	Western region	Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang

Source: The data is from China's *Industrial Economy Statistical Yearbook*.

Table 2. β Value of Various Types of Manufacturing in 2006–2011.

β	Time						β	Time					
	2006	2007	2008	2009	2010	2011		2006	2007	2008	2009	2010	2011
LD_n	1.06	1.07	1.04	1.08	1.10	1.09	LD_e	0.96	0.91	0.89	0.91	0.90	0.90
ZY_n	1.30	1.28	1.27	1.30	1.29	1.26	ZY_e	0.95	0.98	0.99	1.00	1.00	1.00
ZB_n	0.80	0.79	0.78	0.79	0.78	0.77	ZB_e	0.98	0.97	0.99	0.99	0.99	1.02
JS_n	0.97	0.96	0.96	0.93	0.91	0.89	JS_e	1.04	1.03	1.05	1.03	1.05	1.04
LD_m	1.18	1.17	1.11	1.14	1.16	1.16	LD_w	1.04	1.14	1.14	1.19	1.24	1.23
ZY_m	1.26	1.24	1.19	1.21	1.18	1.15	ZY_w	1.73	1.67	1.66	1.71	1.71	1.66
ZB_m	0.85	0.84	0.78	0.80	0.78	0.77	ZB_w	0.54	0.53	0.54	0.56	0.54	0.49
JS_m	0.76	0.74	0.73	0.74	0.74	0.73	JS_w	1.10	1.11	1.10	1.00	0.93	0.89

Note: subscript $_n$ represents the whole country, $_m$ for the middle region, $_e$ for the eastern region and $_w$ for the western region. Source: The data is from China's *Industrial Economy Statistical Yearbook*.

2.3. Analysis of β value

β values of various types of manufacturing in 2006–2011 are analysed in Table 2. The whole country's β values of resource-intensive and labour-intensive categories were larger than 1, while those of the technology-intensive and capital-intensive categories were less than 1; in particular, those of the capital-intensive category were less than 0.8, which indicated that the clustering degree of the resource-intensive category was the largest and that of the capital-intensive category was smallest. However, there was much difference among different types of manufacturing in certain regions. Except for those of the labour-intensive manufacturing (about 0.9), the β values of other types of manufacturing in the eastern region were about 1, meaning that the clustering degree of various types of manufacturing in the eastern region was similar, reflecting a comparatively balanced state of clustering development; there was little difference in the β values of the labour-intensive and resource-intensive categories in the middle region, similarly for those of the capital-intensive and the technology-intensive categories; therefore we learn that the clustering degrees of the labour-intensive and resource-intensive categories were obviously larger than those of the capital-intensive and the technology-intensive categories in the middle region. The western region's β values of for the resource-intensive category were over 1.6, while those of the capital-intensive category were about 0.5; therefore, we learn that there existed a large difference among clustering degrees of various types of manufacturing, which might mean that the western region needs more resources to induce the development of resource-intensive manufacturing to achieve comparative concentration and clustering.

In Table 3, the β values of various types of producer services in 2006–2011 are analysed. From a producer services perspective, the whole nation's β values for the transportation, storage and postal industry were the highest in 2006–2011; β values for the wholesale and retail industry and those of the financial industry were basically equal, with the characteristic of being comparatively low. The β values of three types of producer services in the eastern region were about 1, which indicates a comparatively balanced state of producer services, and this was basically similar to the changing trend of those of various types of manufacturing. β values of the transportation, storage and postal industry were obviously higher than the other two in the middle region, and that of the financial industry was the least, with the characteristic of the clustering degree of each type of producer services being gapped at about 0.2. There were comparative differences among those three types of producer services in the western region, and those of the wholesale and retail industry were the smallest.

Table 3. β Value of Various Types of Producer Services in 2006–2011.

β	Time						β	Time					
	2006	2007	2008	2009	2010	2011		2006	2007	2008	2009	2010	2011
JY_n	1.10	1.15	1.11	1.12	1.12	1.12	JY_e	0.94	1.03	0.95	0.95	0.96	0.95
PL_n	0.96	0.99	1.00	0.96	0.96	0.95	PL_e	1.01	0.99	1.00	1.00	1.00	1.00
JR_n	0.93	0.86	0.87	0.95	0.96	0.98	JR_e	1.08	1.06	1.07	1.05	1.04	1.04
JY_m	1.24	1.26	1.27	1.22	1.22	1.23	JY_w	1.12	1.16	1.13	1.20	1.20	1.18
PL_m	0.99	1.03	1.04	1.01	1.00	1.00	PL_w	0.89	0.94	0.95	0.86	0.86	0.85
JR_m	0.61	0.61	0.60	0.75	0.77	0.79	JR_w	1.08	0.90	0.93	1.04	1.06	1.10

Note: subscript $_n$ represents 'the whole country'; $_m$ for middle region; $_e$ for eastern region and $_w$ for western region.
Source: The data is from China's *Industrial Economy Statistical Yearbook*.

From the above analysis, we learn that clustering degrees of various types of manufacturing and producer services in the eastern region were about 1, which implies that manufacturing and producer services achieved comparatively balanced development in the eastern region, while various industries in the middle region or the western region appeared to be unbalanced in development to some extent.

3. Comparison of influencing factors on manufacturing cluster and producer services cluster

3.1. Influencing factors and theoretical model

As an important driving force for regional development, the technical level influenced not only economic development, but also brought a comparatively strong impetus on achieving clustering development among manufacturing and producer services. The regional differences in economic development were obvious in China, reflected on both the level of development and the quality of development, and various types of industrial cluster affected energy consumption obviously at the same time; hence, energy consumption is an important aspect influencing industrial clustering. Under the background of China's gradual and in-depth reform and opening up, industrial clustering development cannot ignore the support of foreign direct investment (FDI); this might be an important point of entry for the multinational corporation. The greater the number of the same industry in one region, the worse the effect of clustering usually was, and large-sized firms tended to make upstream and downstream industry chain integration to achieve clustering development; thus the degree of the firm's cooperation and competition would directly affect industrial clustering development. China's economic development is generally policy driven, therefore, adjustment of the relevant national policies would have a significant impact on industrial clustering development. For the convenience of measuring the factors, abbreviations and meanings are listed in Table 4.

Supposing that various types of industrial cluster were influenced by the above factors, we established the following model to make an empirical analysis:

$$JJ = f(NH, RD, FDI, JZ, SO) \quad (2)$$

In the model, JJ represents the industrial clustering degree. Supposing the influence was obedient to the Cobb–Douglas function, we made two sides of Equation 2 logarithmic and carried panel data model; then Equation 2 could be rewritten as:

$$\ln JJ_{ij} = c + \alpha \ln NH_{ij} + \eta \ln RD_{ij} + \delta \ln FDI_{ij} + \varphi \ln JZ_{ij} + \gamma \ln SO_{ij} + \varepsilon_{ij} \quad (3)$$

Table 4. Description of the Influencing Factors.

Symbol	Factor	Measurement
RD	Technical level	R&D of the above scaled enterprise (with unit being ten thousand Yuan) divided by the certain region's GDP (with unit being 0.1 billion Yuan)
NH	Energy consumption	Per unit GDP energy consumption coefficient multiplied by 100
FDI	Multinational corporation	Foreign direct investment (with unit being 0.1million US\$) divided by the Certain region's GDP (with unit being 0.1billion Yuan)
JZ	Cooperation & competition degree	Ten times of the quantity of private enterprises divided the quantity of state and state-owned enterprises
SO	Policy influence	The quantity of sulphur dioxide emissions (with unit being ton) divided the certain region's GDP (with unit being 0.1billion Yuan)

Source: The data is from China's *Industrial Economy Statistical Yearbook*.

In Equation (3), i and j represent the year and the region respectively. JJ could be replaced by clustering degree of LD , ZY , ZB , JS , JY , PL , JR , respectively, under different conditions, as Equation (3) is a standard model to detect the effect of factors influencing various industrial clusters.

3.2. Empirical analysis

As for the panel data model, this includes three models: fixed effect model, random effect model, and pooled data model. For the period 2006–2011 and five variables in the above model, the random effect model did not fit for econometric analysis. At the same time, econometric results obtained from the fixed effect model were similar to those of pooled data model. Therefore, we only report econometric results obtained from the pooled data model for analysis, with results detailed in Table 5. Meanwhile, for convenience, in the following econometric analysis we made 100 times of various calculated clustering degrees, either for manufacturing or for producer services, as there were not sufficient values. In general, each equation was comparatively good, which implied a p -value of zero and an adjusted coefficient of over 0.2 (except for that of the financial industry). However, the coefficient was not an important index for judging a certain econometric model as to panel data model, while the variable passing the significance test was the most important aspect. According to the econometric results, for the seven equations, only one factor in one model (here, called the JY model) did not pass the 10 percent significance test, so the above seven factors could be used to detect relevant economic meaning for making a parallel analysis.

Various factors had significantly different impact on different types of manufacturing cluster. The econometric result showed that energy consumption decline, decreased technology level, FDI reduction, cooperation and competition being tighter, and stricter regulation were beneficial to the labour-intensive manufacturing cluster; therefore, we could consider that this type of manufacturing was in a state of low-level trap, external capital being hard to achieve for efficient adjustment, scale of the firm being comparatively small; economic transformation and upgrading and developing quality being higher were useful to maintain the cluster. Compared with the influence of the labour-intensive manufacturing, FDI degree and cooperation and competition's degree of influence were opposite to those seen in resource-intensive manufacturing, which implied that FDI being larger and the firm being more unified were beneficial to the resource-intensive manufacturing cluster. The difficulty for a small firm in efficiently achieving resource, and the technology level being

Table 5. Empirical Result of Factors Influencing Manufacturing Cluster and Producer Services Cluster.

Econometric result	Manufacturing				Producer services		
	LD	ZY	ZB	JS	JY	PL	JR
c	7.170	5.243	5.659	4.778	4.102	5.462	3.572
α	-0.042**	-0.044	-1.193	0.133	0.150	-0.193	0.149
η	-0.364	-0.110	0.215	-0.020	-0.029	-0.047	0.137
δ	-0.208	0.176	0.519	-0.257	0.060	0.023	-0.102
ϕ	0.210	-0.093	0.197	-0.027	0.005*	0.015	-0.024
γ	-0.260	-0.056	0.132	0.079	-0.083	0.018	0.042
A-R ²	0.434	0.384	0.734	0.316	0.413	0.244	0.087

Note: *indicated not passing 10 percent significance test; **indicated passing 10 percent significance test but not 5 percent significance test, the other indicated passing 5 percent significance test, p -value of each model was 0.000. The following carried the same treatment.

Source: The data is from China's *Industrial Economy Statistical Yearbook*.

comparatively low would be obstacles for attracting FDI. Compared with the influence of these factors on the capital-intensive manufacturing cluster and the technology-intensive manufacturing cluster, we learn that governmental regulation being looser was beneficial to these two clusters, while the other four factors have an opposite influence. For example, FDI was beneficial to the capital-intensive manufacturing cluster but not the technology-intensive manufacturing cluster, which might be reason for the multinational corporation having a comparatively low-level technology mixed with a large quantity of capital, making it difficult for China's clustering development of technology-intensive manufacturing to rely on external support. In addition, looser governmental regulation was beneficial to clustering development of capital-intensive manufacturing and technology-intensive manufacturing, which indicated that China's advanced manufacturing (here, including the capital-intensive and the technology-intensive) was at an infant stage to some extent, and the government should implement a biased protection policy to stimulate sustainable development.

Now, we turn to analyse the factors influencing the producer services cluster. The influence of the cooperation and competition degree index on the transportation, storage and postal industry did not pass the 10 percent significance test, while other factors passed the 10 percent significance test; the effects of factors were basically equal to those in the resource-intensive manufacturing cluster but not the energy consumption index, which may mean that producer services is a traditional industry, mainly with the characteristic of development, and a cluster needing much energy consumption. The effects of factors on the wholesale and retail industry cluster were opposite to those for the financial industry cluster; econometric results showed that the energy consumption index and technology level index were negative for the wholesale and retail industry cluster, while the multinational corporation index and the cooperation and competition index were positive; the above four factors' influence on the financial industry cluster were opposite. At the same time, the regulation index's influence was positive, either for the wholesale and retail industry or the financial industry.

We regarded labour-intensive manufacturing, resource-intensive manufacturing, the transportation, storage and postal industry, and the wholesale and retail industry as traditional industries, and regarded capital-intensive manufacturing, technology-intensive manufacturing, and the financial industry as modern industries, and made a comparison of factors influencing relevant clusters based on the econometric results. We found that energy consumption decline (except the transportation, storage and postal industry), low technology level, multinational corporations' entry acceleration (except the labour-intensive

manufacturing), cooperation and competition being tighter (except in resource-intensive manufacturing and the transportation, storage and postal industry) and regulation being stricter (except the wholesale and retail industry) were beneficial for the traditional industry achieving clustering development. At the same time, energy consumption increase (except in capital-intensive manufacturing), high technology level (except in technology-intensive manufacturing), multinational corporations' entry slow down (except the capital-intensive manufacturing), cooperation and competition being looser (except the capital-intensive manufacturing) and regulation being looser were beneficial to the traditional industry achieving clustering development. Therefore, we learned that there were some 'common sense' influencing factors in manufacturing and producer services, and influencing performance was basically equal to those developing levels being similar in both manufacturing and producer services. In fact, manufacturing and producer services were products of economic development to some extent, which implied that manufacturing development was coupled with producer services, so it was necessary to empirically detect the influence of producer services clusters on manufacturing clusters.

4. Empirical analysis of producer services cluster's effect on manufacturing cluster

4.1. Establishment of theoretical model

In order to analyse the influence of the producer services cluster on the manufacturing cluster, we established the following equation:

$$M = f(JY, PL, JR) \quad (4)$$

Equation (4) demonstrates the effect of different producer services clusters on various types of manufacturing cluster.

Similar to Equation (3), we supposed Equation (4) obeyed the Cobb–Douglas function, and made two sides logarithmic and carried panel data model, then Equation 4 could be rewritten:

$$\ln M_{ij} = c + \chi \ln JY_{ij} + \lambda \ln PL_{ij} + \sigma \ln JR_{ij} + \varepsilon_{ij} \quad (5)$$

Equation (5) was the econometric equation of the effect of the producer services cluster on the manufacturing cluster. We used the pooled data model to make an econometric analysis from aspects of the whole nation and various regions in the following analysis. Here, i and j represent the year and the region, respectively.

4.2. Producer services cluster's effect on manufacturing cluster in the whole nation

Table 4 shows the whole nation's producer services cluster's effect on the manufacturing cluster. From the econometric results, we know that the financial industry cluster in model 2 and model 4 did not pass the 10 percent significance test, while all variables in model 3 and model 5 passed the 10 percent significance test. Therefore, we used model 1, model 3, model 5 and model 6 to analyse influence of performance. Here, model 2 and model 3 were econometric models for ZY, and model 4 and model 5 were econometric models for ZB.

Table 6. Empirical Result of Producer Services Cluster's Influence on Various Types of Manufacturing Cluster.

Econometric result	LD		ZY		ZB		JS
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	
c	2.821	3.485	3.129	2.803	3.133	10.422	
χ	0.264	0.477	0.500	-0.606	-0.627	-0.883	
λ	0.282	-0.189	-0.155	0.901	0.869	-0.299	
σ	-0.178	-0.020*		0.019*		-0.107	
A-R ²	0.072	0.130	0.130	0.110	0.110	0.221	

Note: *indicated not passing 10 percent significance test; **indicated passing 10 percent significance test but not 5 percent significance test, the other indicated passing 5 percent significance test, p -value of each model was 0.000. The following carried the same treatment.

Source: The data is from China's *Industrial Economy Statistical Yearbook*.

Some conclusions are shown in Table 6: (1) As to the transportation, storage and postal industry cluster, this was positive to the labour-intensive manufacturing cluster and the resource-intensive manufacturing cluster, and negative to the capital-intensive manufacturing cluster and the technology-intensive manufacturing cluster; this might be a result of traditional manufacturing being similar to traditional producer services. At the same time, the transportation, storage and postal industry might be the major producer service stimulating traditional manufacturing's development. (2) The effect of the wholesale and retail industry cluster on various types of manufacturing clusters had a relationship with residual consumption; it should be positive if some types of manufacturing were fitter for residual consumption, otherwise it would be negative. Compared with resource-intensive manufacturing and technology-intensive manufacturing, labour-intensive manufacturing and capital-intensive manufacturing were major industrial items for residual consumption in China, which made the above two clusters positive to the wholesale and retail industry cluster. (3) China's financial industry was mainly state-owned and the market proportion of private finance was comparatively small, which meant that the financial industry cluster was much influenced by the government but not the market. Therefore, the financial industry cluster's effect would not have a strong relationship to manufacturing clusters, and the econometric results agreed with this opinion; the effect of the financial industry cluster on the resource-intensive manufacturing cluster and the capital-intensive manufacturing cluster did not pass the 10 percent significance test, while that for the labour-intensive manufacturing cluster and the technology-intensive manufacturing cluster was only -0.178 and -0.107, respectively. But, the coefficients in Table 6 were comparatively small, which implies that various types of producer services cluster do not have a strong relationship with various types of manufacturing cluster.

4.3. Producer services cluster's effect on manufacturing cluster in various regions

There were 12 equations for three types of producer services' effect on various types of manufacturing cluster in various regions, and some equations did not pass the 10 percent significance test. For convenience of comparison, we did not assess those equations with variable (or, variables) not passing the significance test. Table 7 shows the econometric results.

Various types of producer services cluster's effect on various types of manufacturing cluster were not good in the western region generally, adjusting coefficients being about or less than 0.1. According to the theory of economic developing stages, nurturing each other

Table 7. Empirical Result of Producer Services Cluster's Influence on Various Types of Manufacturing Cluster in Various Regions.

Region		LD	ZY	ZB	JS
The eastern region	c	1.214	9.964	-1.331	1.214
	χ	0.322	-0.079*	-0.058*	0.322
	λ	0.450	-0.411	0.739	0.450
	σ	-0.064*	-0.692	0.594	-0.064*
	A-R ²	0.127	0.582	0.366	0.127
The middle region	c	-8.224	0.408	22.25	0.705
	χ	0.754	1.022	-2.643	-0.149*
	λ	2.073	-0.324*	-0.775	1.014
	σ	-0.067*	0.219	-0.390	-0.090**
	A-R ²	0.246	0.330	0.542	0.446
The western region	c	7.737	33.58	-46.16	13.52
	χ	-0.045*	-2.156	3.319	-0.756
	λ	-0.531*	-2.618	4.724	-0.645*
	σ	-0.132*	-1.443	2.805	-0.565
	A-R ²	0.010	0.122	0.066	0.018

Note: *indicated not passing 10 percent significance test; **indicated passing 10 percent significance test but not 5 percent significance test, the other indicated passing 5 percent significance test, p -value of each model was 0.000. The following carried the same treatment.

Source: The data is from China's *Industrial Economy Statistical Yearbook*.

among different industries is the result of the economy achieving a certain stage; thus the western region's economic level being comparatively low might induce segmented development between manufacturing and producer services, which would make the clusters' relationship between manufacturing and the tertiary industry comparatively low.

Seen from the eastern region, the transportation, storage and postal industry cluster was positive to the labour-intensive manufacturing cluster but negative to the technology-intensive manufacturing cluster, and did not pass the 10 percent significance test as to the resource-intensive manufacturing cluster and the capital-intensive manufacturing cluster, so we could induce that this type of producer services cluster was intimate to industrial characteristics as to the effect on manufacturing cluster. The wholesale and retail industry cluster was negative to the resource-intensive manufacturing cluster, and positive to the labour-intensive manufacturing cluster, the capital-intensive manufacturing cluster and the technology-intensive manufacturing cluster; this implied that a comparatively high developing level would bring an enormous demand of labour-intensive, capital-intensive and technology-intensive items, and these would result in a positive performance in the industrial cluster. The financial industry cluster was beneficial to the development of advanced manufacturing; this was seen from the econometric results. For example, the financial industry clusters were positive to the capital-intensive manufacturing cluster and the technology-intensive manufacturing cluster, and the effect on the capital-intensive manufacturing cluster was larger than that on the technology-intensive manufacturing cluster. In addition, various types of producer services clusters were negative to the resource-intensive manufacturing cluster, which indicated that scattered development of producer services might be favourable to this type of manufacturing achieving clustering development in the eastern region, and this might be reason for the resource-intensive manufacturing's geophysical-dependent characteristic, needing to provide a match for relevant producer services clusters.

In the middle region, the effect of various types of producer services clusters on the labour-intensive manufacturing cluster was similar to that in the eastern region, but the wholesale and retail industry cluster's effect was much larger, with the elasticity coefficient being

2.073. Regarding the other three types of manufacturing clusters, there was a great difference in various types of producer services' effect compared with those in the eastern region; the effects were fundamentally opposite regarding the resource-intensive manufacturing cluster, the capital-intensive manufacturing cluster and the technology-intensive manufacturing cluster. In general, the transportation, storage and postal industry cluster and the wholesale and retail industry cluster had obvious impact on various types of manufacturing clusters, while the effect of the financial industry cluster was relatively weaker. At the same time, regarding the effect on the technology-intensive manufacturing cluster, the transportation, storage and postal industry cluster did not pass the 10 percent significance test, and the wholesale and retail industry cluster passed the 5 percent significance test but the financial industry cluster did not.

Considering that the panel data model says much about the relationship among variables, and the estimated coefficient was just for reference, it was necessary to detect the influencing performance of various variables in the western region even though the coefficient was comparatively small. Each type of producer services' cluster's effect on the labour-intensive manufacturing cluster did not pass the 10 percent significance test, which implied that the producer services cluster did not have much influence on this type of manufacturing cluster. The econometric results showed that all types of producer services clusters were negative to the resource-intensive manufacturing cluster and the technology-intensive manufacturing cluster, were positive to the capital-intensive manufacturing cluster, and each passed the 5 percent significance test; this implied that various types of producer services cluster's effect on various types of manufacturing cluster appeared to be scattered in the western region. To achieve clustering development, producer services should be mixed with the capital-intensive manufacturing cluster so as to achieve cooperative development.

From the above analysis, we know that there were many differences in various types of producer services clusters' effect on various types of manufacturing clusters in different regions. Compared with various types of manufacturing clusters' effects on various types of producer services clusters, $A-R^2$ of those of various types of producer services clusters' on various types of manufacturing clusters were much larger; this indicated that there was a strong relationship as to producer services clusters' effects on manufacturing clusters, and lesser relationship as to manufacturing clusters' effects on producer services clusters. In general, the effect of various types of producer services cluster was that the transportation, storage and postal industry cluster was larger than that of the wholesale and retail industry cluster, and that of the financial industry cluster was the least; this was coincided with the econometric results in Table 6.

5. Conclusions and countermeasures

5.1. Conclusions

Based on the detection of clustering degrees of various types of manufacturing and producer services in China by taking the index of location quotient, a theoretical model was used for the empirical analysis of factors influencing manufacturing clusters and producer services' clusters, and for the empirical analysis of the influence of producer services clusters' on manufacturing clusters. Among these, we found manufacturing to be labour-intensive, resource-intensive, capital-intensive and technology-intensive, and regarded capital-intensive manufacturing and technology-intensive manufacturing as modern manufacturing. At the same time, we regarded the transportation, storage and postal industry, and the

wholesale and retail industry as traditional producer services, and the financial industry as modern producer services. We present the following conclusions.

Clustering effects of labour-intensive manufacturing and resource-intensive manufacturing were obvious, and the effect of capital-intensive manufacturing and technology-intensive manufacturing were not obvious, and those of the three types of producer services were comparatively weak in general. Comparatively balanced development of manufacturing and producer services existed in the eastern region, while we found comparatively imbalanced development in the middle and western regions.

A theoretical model was developed to analyse the factors influencing various types of manufacturing and producer services, from aspects of the technical level, the energy consumption level, the degree of multinational corporation, the degree of cooperation and competition, and policy diversity. Empirical results showed that energy consumption decline, low technology level, accelerated multinational corporation entry, stronger competition and cooperation and stricter regulation were beneficial to traditional industry's clusters, while those for modern industry's clusters were the opposite, which implied a similar degree of industrial development having similar influence in general as the impact of single influencing factors.

Traditional producer services' clusters achieved a positive influence on traditional manufacturing clusters, as also found by Rosanna and Filippo (2015). Meanwhile, they had a negative influence on modern manufacturing clusters. At the same time, modern producer services had the opposite effect compared with those of traditional producer services. In general, effects of the transportation, storage and postal industry cluster on various types of manufacturing were larger than those of the wholesale and retail industry cluster, and those of the financial industry cluster were less than those of the wholesale and retail industry cluster.

5.2. Countermeasures

The effects of various types of producer services clusters on manufacturing clusters were comparatively weak. We propose some countermeasures for achieving interactive development of clusters between manufacturing and producer services to enhance industrial competition.

Gradient development of producer services clusters should be encouraged. The dual economic structure in China implied that the level of development of producer services in the eastern region was higher than that of the middle or the western region, as was the structural level of manufacturing. Therefore, the eastern region should attach more importance to modern producer services clusters (e.g., the financial industry, the consulting industry, and the management industry), and the middle and western regions should focus more on traditional producer services clusters (e.g., the transportation, storage and postal industry, the wholesale and retail industry) to make producer services clusters more efficient, which does not depend upon the region's economic development level, and also the region's manufacturing development level.

Manufacturing clusters should be guided by dominant industries. Based on accelerating the development of dominant industries to achieve adjustment and elevation of the industrial and value chain, each region should amplify the spillover effect fully, and enhance the pooling effect of the influence of industrial clusters on economic development

at the same time. Regarding manufacturing, the eastern region should focus more upon the capital-intensive manufacturing cluster and the technology-intensive manufacturing cluster; the middle region should focus on the labour-intensive manufacturing cluster and the resource-intensive manufacturing cluster; and the western region should focus on the resource-intensive manufacturing cluster. Differentiated development of dominant industries in different regions could not only take comparative advantage of resources and factors, but also achieve an integrated domestic market by industrial transfer, so as to maintain cross-regional extension of the industrial chain.

High-level elements should be pooled to promote industry clusters. High-level elements were important to industrial clusters. Some measures should be made to transfer innovative factors into industrial cluster areas, e.g., bringing in more professional and technical talent, enlarging the degree of R&D input, and attracting the input of high-quality FDI. Each region should focus on the economic development level when inducing the inflow of high-level elements, and should focus on the layout of new national strategic industries and the elevation of advanced manufacturing; this means that the region should care about both applicability and advancement in the course of operation, so as to activate clustering development of the region's economy by the catfish effect brought by high-level elements.

Diversity policy guidance should be implemented to encourage industry clusters. China's overall strategy has inclined to the east since the foundation of P.R.C. achieved the goal of 'let some people become prosperous firstly', which meant that industrial quality in the east was evidently higher than that of the middle and western regions, e.g. industrial pollution and energy consumption in the eastern region were evidently higher; so a differentiated development policy should be carried out to achieve industrial clustering development efficiently. For example, the government should implement a policy of inclining to the middle and western regions for industrial clustering development from aspects of regulation on energy conservation and emission reduction, layout of the headquarters economy, and external elevation influencing undertaking of industrial transfer.

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