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Regional growth of pharmaceutical industry in China

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ABSTRACT

The pharmaceutical industry is an integral part of high technology industry. Over the past decade, the average growth of sales revenue of China's pharmaceutical industry has been the fastest among various hi-tech industries. However, there are great regional differences between 31 provincial regions in this country. On the basis of the 2002-2012 statistic data and computation methods of location Gini coefficient, this paper discovers that the location distribution of China's pharmaceutical industry has evolved from the medium concentration to a dispersed state. Using the Shift-share Analysis, it analyzes the factors influencing the growth of pharmaceutical industries in various regions. According to the results, there are 7 regions that have brought about growth due to industry structure advantage, 6 regions that have realized growth due to competitive edge, and 5 regions that have garnered growth due to both.

Key words: Pharmaceutical industry; Regional growth, Industrial structure; Regional competitiveness; Location agglomeration

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INTRODUCTION

In terms of industrial technology intensity, pharmaceutical industry is one of the hi-tech industries. In recent years, the global pharmaceutical industry has grown rapidly with the increasingly active transnational investment in it and the academic community conducted lots of related research into this sector. Generally, there are three main aspects, including the following:

First is the study in terms of industry clustering. Similar to many other hi-tech industries, the pharmaceutical industry is of relatively high industry correlative effect. The external economic effect brought from the location agglomeration is of value to developing the pharmaceutical industry. Wu Xiaojun et al. [1] analyzed the forming process and features of the U.S. bio-pharmaceutical industry clustering and came up with its 3 development modes, i.e. traditional pharmaceutical manufacturing centers, R&D focused biotech clustering, and bio-pharmaceutical with the concentration of venture capital and start-up enterprises. Wu Xiaojun et al. [2] also conducted research into typical cases on several European bio-pharmaceutical industry clusters, including the bioscience industry cluster in London, UK, Denmark-Sweden Bio Valley, and the bio-pharmaceutical cluster in Lombady, Italy, and they analyzed factors of success and failure of these clusters. Gu Hai and Wei Chen [3] made the quantitative analysis of factors influencing China's pharmaceutical industry, based on the theory of industry concentration. They used mathematical methods, such as, MLR and correlation analysis to ascertain the factors and degree of influence of China's pharmaceutical industry concentration. Chu Shuzhen et al. [4], on the basis of calculating indicators like, the Gini coefficient and concentration ratio, argued that the level of China's pharmaceutical industry concentration is very low, which are mainly distributed in a few provinces in the east of China. Lian Guiyu et al. [5] discussed the status quo of China's bio-pharmaceutical industry clustering and its major problems.

Second is the study in terms of economic growth. The pharmaceutical industry has been receiving relatively much attention in respect of its contribution to regional economy, industry development and international trade. Corley and Godley [6] studied the features of development and evolution of veterinary medicine industry in UK's pharmaceutical industry during the 20th century. Beyer et al. [7] studied the contribution of veterinary medicine industry to the economic growth in Texas, U.S.. Zhou Jizhong and Rao Juan [8] analyzed the overall situation of China's pharmaceutical market and development status quo of its pharmaceutical enterprises and made the comparisons between China and foreign countries in terms of economy of scale and marketing of pharmaceutical enterprises. Using the industry organizational theory, Hu Yuanjia et al. [9] argued that China's pharmaceutical industry was on the whole in the state of excessive competition. Peng Ke [10] analyzed the development trend and policy features of trade in the international bio-pharmaceutical industry, and China's trade status quo.

Last is the study in terms of innovation. The pharmaceutical industry has the development features of high technology, high inputs, high risks and long cycles. And the relationship between innovation activities, and innovation inputs and outputs of pharmaceutical industry is also one of the important aspects that have received attention from scholars. Horrobin [11] pointed out that there was a significant downward trend of R&D output ratio of the pharmaceutical industry after the 1960s. Wang Wei et al. [12] made the statistical analysis of patent applications in China's pharmaceutical industry at the country, region and industry levels. McMahon and Thorsteinsdóttir [13] made the comparative analysis of innovation activities in the regenerative medicine of three emerging economies, such as, Brazil, China and India, pointing out the dynamic mechanism peculiar to the innovation by developing countries in this sector.

The research contents of this paper cover the foregoing three aspects. Using the appropriate analytical methods and statistical data, the authors make the macroscopic analysis of location distribution evolution, regional economic growth and influence factors of China's pharmaceutical industry in the past decade.

EXPERIMENTAL SECTION

Composition of Pharmaceutical Industry

The pharmaceutical industry is an industrial sector with the extensive connotation. In terms of statistics, starting from 2012, China used the 2011 edition of national industries classification, and the pharmaceutical industry included 8 sectors, which were chemical medicines bulk drugs manufacturing, chemical medicines preparations manufacturing, traditional Chinese medicine (TCM) decoration pieces processing, production of finished traditional Chinese herbal medicines, veterinary medicines manufacturing, biological medicines manufacturing, general health materials and medicinal and pharmaceutical substances manufacturing, and medical equipment and appliances manufacturing. During 2002-2011, China adopted the 2002 edition of national industries classification, during which its pharmaceutical industry included 6 sectors: chemical medicines bulk drugs manufacturing, chemical medicines preparations manufacturing, TCM processing, veterinary medicines manufacturing, bio-products, and medical equipment and instruments manufacturing. The two kinds of classification had different numbers of sectors, but the types of enterprises were the same. When making the annual comparisons, this paper turns the 8 sectors in 2012 into the 6 comparable sectors (Table 1) corresponding to 2002. In 2012, the number of Chinese pharmaceutical enterprises with the size of annual sales revenue of RMB 20 million (or around USD 3 million) or above was 7,361.

Table 1 Number of enterprisesand sales revenue of pharmaceutical industry by sector

Sectors	Number of enterprises		Sales revenue (USD billion)	
	2002	2012	2002	2012
Chemical medicines bulk drugs manufacturing	728	965	8.0	53.0
Chemical medicines preparations manufacturing	1028	921	8.6	78.5
Traditional Chinese medicine (TCM) processing	1329	2243	8.3	81.3
Veterinary medicines manufacturing	261	502	0.7	12.6
Biological medicines manufacturing	335	639	2.1	31.4
General health products and medical instruments manufacturing	663	2091	2.6	43.2

SOURCES: STATS.

The past decade has witnessed a rapid development of China's pharmaceutical industry. In 2012, the numbers of enterprises and employees were 1.7 times and 2.1 times those of 2002, respectively. However, compared with other types of hi-tech industries, the role of pharmaceutical industry in providing employment opportunities was on the constant decrease. Among the hi-tech enterprises in the country, the percentage of employees in pharmaceutical enterprises lowered gradually from 28.0% in 2002 to 17.6% in 2012.

Nevertheless, in terms of economic efficiency, the pharmaceutical industry showed a trend of improvement in the percentage of its sales revenue in that of the total number of hi-tech enterprises went up from 17.1% in 2002 to 18.5% in 2012, and the percentage of its enterprise profit increased from 29.8% to 33.2%.

Table 2 Percentage of China's pharmaceutical industry in the entire hi-tech sector (%)

	2002	2005	2009	2010	2011	2012
Number of enterprises	38.3	32.4	29.6	29.6	31.4	29.9
Employees	28.0	20.6	19.2	18.2	17.7	17.6
Sales revenue	17.1	12.9	16.8	16.9	18.1	18.5
Profit	29.8	25.9	33.7	29.9	33.5	33.2

SOURCES: STATS, SDPC, MOST. China Statistics Yearbook on High Technology Industry 2007, 2013. Beijing: China Statistics Press, 2007, 2013.

Research Methodologies

a. Location Gini Coefficient:

The phenomenon where industry, capital and population concentrate toward a certain location or region is called industry location clustering. Early in the 20th century, A. Weber, A. Marshall and other economists conducted research into the issue of industry location clustering. After the 1980s, with the overseas investment by MNCs, industry clustering went beyond national borders, growing up worldwide. The issue of industry location clustering caused the attention of new economic geographers represented by Paul Krugman, who interpreted industry location clustering, using economics of imperfect competition, increasing returns, path dependence and cumulative causation. In his study of competitive advantage of nations, Michael Porter [14] also emphasized the role of industry clustering in the international competitiveness of regional industries. Experts studying the issue of industry clustering put forward a series of methods for calculating the degree of industry agglomeration. Location Gini coefficient is the most representative, whose computational formula is as below:

$$G_i = \frac{1}{2n^2\overline{S}} \sum_{j=1}^{n} \sum_{m=1}^{n} \left| S_j^i - S_m^i \right| \quad \text{.....Formula (1)}$$

G_i in the formula is the Gini coefficient of industry i, S_j^i is the share of industry i of the country in region j; S_m^i is the share of industry i of the country in region m; n is the number of regions; $\overline{S}$ is the national average share of industry i. The value of location Gini coefficient varies between 0 and 2. The closer to zero the coefficient is, the industry i is more evenly distributed in location; the closer to 2, the industry i more concentrate in location.

Krugman [15] used the location Gini coefficient method to calculate the level of location agglomeration of 106 manufacturing industries in the U.S. in 1991. This paper will look at the macro level at the level of location agglomeration and features of historical evolution of the pharmaceutical industry in China's 31 provincial regions through calculating the location Gini coefficient of such industry in these regions.

b. Shift-share Analysis:

Shift-share Analysis is used to divide the variations in the economic aggregate of a region during a certain period, based on that at the national level, into three components (effects), i.e. national shares, industry mix and competitiveness, to illustrate the causes for regional economic growth and recession. Its principles are, when the economy of a country is in the competitiveness balance, various regional factors will have the same rate of return, and these regions will grow in light of their preliminary economic size and the same economic growth rate (national economic growth rate). In reality, because factor returns would vary from region to region, it causes unbalanced growth between regions. Growth of various regions can be divided into shared growth and transfer growth; shared growth refers to the situation where growth amount garnered by various regions based on national overall economic growth rate is called national share component, while transfer growth is the growth amount by which the actual growth amount of various regions deviates from the shared growth, which is called, total deviation component. Again, total deviation component can be divided into industry mix component and competitiveness component; industry mix component is produced because regional industry mix deviates from national industry mix, while competitiveness component is caused by the factor of regional competitiveness [16]. This paper analyzes the growth factors of the pharmaceutical industry in China's 31 provincial regions during 2002-2012. The calculation formula is as below:

$$\Delta SR_j = SR_j(t_1) - SR_j(t_0)$$

$$= \sum_i SR_{ij}(t_0)\left(\frac{SR(t_1)}{SR(t_0)} - 1\right) + \sum_i SR_{ij}(t_0)\left(\frac{SR_i(t_1)}{SR_i(t_0)} - \frac{SR(t_1)}{SR(t_0)}\right)$$

$$+ \sum_i SR_{ij}(t_0)\left(\frac{SR_{ij}(t_1)}{SR_{ij}(t_0)} - \frac{SR_i(t_1)}{SR_i(t_0)}\right)$$

……Formula (2)

In the above formula, SR is sales revenue; j is region, with the value range (1, 2, ……, 31); i is type of industry, and pharmaceutical industry includes 6 sectors, with the value range of i being (1, 2, ……, 6); t_0 and t_1 stand for initial and end period, respectively.

In the above formula, on the leftist side is the growth amount of sales revenue of region j. On the rightist side, the first item is national share component; the second item is industry structure component and when the result is "positive", it indicates that region j is at an advantaged position in the nation due to some of its industries with fast growth; the third item is competitiveness component and when the result is "positive", it indicates that region j is at an advantaged position in the nation because it is more competitive than other regions.

c. Location Quotient:

Location quotient also called, regional specialization rate, is an analytical method frequently used in the study of regional science. It was originally used to reflect the level of specialization of a specific industry or sector in a certain region relative to this industry or sector at the national level, thus discovering the industry or sector with comparative advantages in this region [17].This paper uses the location quotient method to analyze which industry caused the pharmaceutical industry in various regions to have industry mix advantage in the country. The calculation formula is as below:

$$C_{ij} = \frac{SR_{ij} / SR_j}{SR_i / SR} \quad \text{……Formula (3)}$$

In the above formula, C is location quotient; i is type of industry with the value range of (1, 2, ……, 6); j is region with the value range of (1, 2, ……, 31); SR and SR_j are the sales revenue of the pharmaceutical industry at the national and region j level, respectively; SR_i and SR_{ij} are the sales revenue of sector i among the pharmaceutical industry at the national and region j level，respectively. If C_{ij}>1, then, it indicates that industry i in region j has the comparative advantage at the national level.

RESULTS

Regional Growth of Pharmaceutical Industry

a. Comparisons with Other Hi-tech Industries:

China's hi-tech industries are consistent with OECD statistic standards, including 5 industries, of which 2 are pharmaceuticals related industries and 3 others are aerospace manufacturing, electronics and communications equipment manufacturing, and computer and office equipment manufacturing. In 2012, the sales revenue of pharmaceutical industry amounted to USD 300 billion, which was 8 times that of aerospace manufacturing, 86% of computer and office equipment manufacturing and 35% of electronics and communications equipment manufacturing. However, in growth terms, the pharmaceutical industry was most outstanding. During the decade from 2002 to 2012, the average growth rate of sales revenue of China's pharmaceutical industry reached 22.4%, being higher by 5.8, 1.1 and 2 percentage points than aerospace manufacturing, electronics and communications equipment manufacturing and computer and office equipment manufacturing, respectively.

b. Regional Growth Features:

In the course of fast growth of China's pharmaceutical industry, various regions showed differing growth momentum. Of the 31 provincial regions, only 11 have managed to make their growth rate of pharmaceutical industry exceed the national average growth rate (22.4%) over the past 10 years. Among the 11 regions, the Central Region had outstanding performance, the number of such reaching 5. And the 4 provinces with the fastest growth were also in the Central Region, being Hunan (33.4%), Henan (33%), Anhui (32.6%) and Jiangxi (32.5%), all of which were higher by over 10 percentage points than the national average growth rate. Of the 11 regions, 3 were

located in the Eastern and 3 were in the Western Regions. And both Shandong and Jiangsu in the Eastern Region were most outstanding. In 2012, their sales revenue reached USD 44.4 billion and USD 42.1 billion, respectively, being far higher than Guangdong (USD 19 billion) which ranked third. Although the growth rates of Inner Mongolia and Qinghai were above the national average, they were relatively small in economic scale; in 2012, their sales revenue were USD 2.9 billion and USD 0.6 billion, respectively.

Of the 20 regions whose annual average growth rates were lower than the national average, 8 and 9 were located in the Eastern and Western Regions, respectively, and only 3 were in the Central Region. Of them, 5 had sales revenue of over USD 10 billion, which were Guangdong, Zhejiang, Hebei, Hubei and Beijing. Although both the sales revenue of Shanghai and Tianjin's pharmaceutical industry was over 60 times that of Tibet, their growth rates were similar, being 12.1%, 13.6% and 12.5%, respectively. Economic output growth rates vary greatly from region to region, which has been the overall features of development of China's pharmaceutical industry over the past 10 years.

c. Review of Results of Ten Years' Growth:
Over the past decade, have regional variations in the growth of China's pharmaceutical industry led to its being more clustered or dispersed in terms of location distribution? We used the sales revenue indicator to substitute into the foregoing formula (1) for computation, the results of which showed that in 2002, the location Gini coefficient of China's pharmaceutical industry was 0.93, belonging to the state of medium agglomeration; by 2012, the location Gini coefficient had reduced to 0.41, being in the dispersed state. It showed that in the course of rapid growth of China's pharmaceutical industry, originally relatively backward regions showed a faster growth.

These changes can also be seen from concentration ratios. In 2002, the five regions with the largest size in the pharmaceutical industry were Jiangsu, Zhejiang, Guangdong, Shanghai and Hebei, the sum of their sales revenue accounting for 43.7% of the national total. In 2012, the sales revenue of these 5 regions accounted for 32.9% of the national total, lowering by 10.8 percentage points. And during this period, the size of pharmaceutical industry of Shandong, Henan and Jilin exceeded that of Zhejiang, Shanghai and Hebei. In 2002, the sum of sales revenue of the 10 regions with the smallest size of pharmaceutical industry accounted for 5.8% of the national total, while by 2012, the percentage of these 10 regions in the national total had risen to 6.6%, which showed that backward regions were constantly developing and growing. Of these 10 regions, Anhui's ranking in the country rose from 23rd to 15th. This change indicated that China's pharmaceutical industry shifted from being clustered to dispersed, and competition between regions would thus become more intense.

Causes for Growth
Improvements in the national business climate are the driver of rapid growth of China's pharmaceutical industry. However, what were the causes for growth differences in various regions? According to the theory of Shift-share Analysis, differences in the growth of various regions lie on two aspects. First is industry structure effect, i.e. a certain region developed those types of fast growth based leading industries, thus driving the growth of regional pharmaceutical industry as a whole. Second is competitiveness effect, i.e. pharmaceutical enterprises in a certain region is relatively competitive, compared with other regions, thus gaining faster growth. We believe that there are two means of garnering competitiveness effect; one is to lure more external production factors, thus garnering the effect of scale economies; the other is to raise corporate efficiency and profitability through innovation activities.

a. Calculation Results:
Basing on the Shift-share Analysis, we used the sales revenue of pharmaceutical industry in various regions in 2002 and 2012 to substitute into formula (2) as mentioned above for calculation. The result showed that in the economic growth of pharmaceutical industry in various regions, except national share component, all regions had total deviation component to a varying degree. It indicated that many regions had their growth models different from those at the national overall level. And we calculated industry structure component and competitiveness component of various regions, the results of which are illustrated through Fig. 1.

It can noticed from Fig.1, of the 31 regions around the country, 5 such as, Jiangsu (as shown in first quadrant) had both industry structure and competitiveness advantages in their pharmaceutical industry; 7 including Beijing (as shown in fourth quadrant) garnered fast growth for their pharmaceutical industry through their industry structure advantage; 6 including Shandong (as shown in second quadrant) obtained growth for their pharmaceutical industry via their competitiveness advantage; 13 others including Hebei (as shown in third quadrant) had neither industry structure nor competitiveness advantages in the pharmaceutical industry, whose growth was derived only from the boosting effect of national pharmaceutical industry.

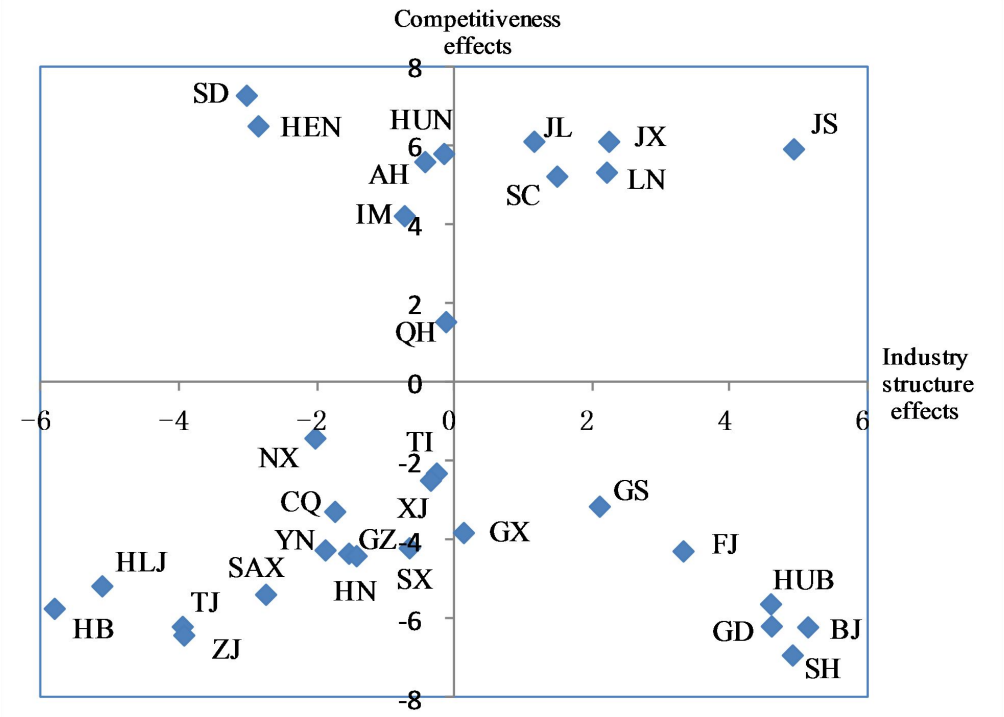

Fig. 1 Regional growth factors of pharmaceutical industry

Region abbreviations: JS:Jiangsu; JX: Jiangxi; JL: Jilin; LN: Liaoning; SC: Sichuan; SD: Shandong; HEN: Henan; HUN: Hunan; AH: Anhui; IM: Inner Mongolia; QH: Qinghai; NX: Ningxia; TI: Tibet; XJ: Xinjiang; CQ: Chongqing; SX: Shanxi; GZ: Guizhou; HN: Hainan; YN: Yunan; SAX: Shaanxi; TJ: Tianjin; ZJ: Zhejiang; HLJ: Heilongjiang; HB: Hebei; GX: Guangxi; GS: Gansu; FJ: Fujian; HUB: Hubei; GD: Guangdong; BJ: Beijing; SH: Shanghai.

b. Further Analysis on Regions with the Pharmaceutical Industry Structure Advantage:

According to the calculation results, the pharmaceutical industry of a total of 12 regions in China gained growth due to industry structure effects. In order to further discuss what kind of industry structure on earth had led to this effect, we used Formula (3) as mentioned above to make the calculation, the results of which are shown in Table 3. Of the 12 regions, 5 regions including Beijing had 3 advantaged industries; 4 regions including Guangdong had 2 advantaged industries; Hubei and Jilin had 1 advantaged industry each; and Fujian had 4 advantaged industries.

Industry structure advantage of both Beijing and Jiangsu mainly came from chemical medicines preparations manufacturing industry, and that of both Shanghai and Guangdong were mainly reflected in general health products and medical instruments manufacturing. TCM processing industry was the most important sector to reflect the industry advantage of Hubei, Jiangxi, Gansu, Jilin and Guangxi, and the location quotients of this industry of Gansu, Jilin and Guangxi were all above 2. In addition, Gansu's industry structure advantage was also reflected in its biological medicines manufacturing industry and its location quotient reached 3.07. The industry with strongest industry structure advantage in Fujian, Liaoning and Sichuan is veterinary medicines manufacturing industry, and the location quotient of this industry of Sichuan reached 2.91.

Table 3 Regions with industry structure advantage and location quotients, 2002→2012

Region	Chemical medicines bulk drugs manufacturing	Chemical medicines preparations manufacturing	TCM processing	Veterinary medicines manufacturing	Biological medicines manufacturing	General health products and medical instruments manufacturing
Beijing	#	1.38→1.93	#	#	1.11→1.07	3.01→1.21
Jiangsu	0.66→1.08	1.14→1.51	#	#		1.85→1.42
Shanghai	#	1.43→1.41	#	#	1.04→1.32	2.18→1.43
Guangdong	#	1.50→1.33	#	#	#	1.04→1.60

Region	Chemical medicines bulk drugs manufacturing	Chemical medicines preparations manufacturing	TCM processing	Veterinary medicines manufacturing	Biological medicines manufacturing	General health products and medical instruments manufacturing
Hubei	#	#	0.72→1.25	#	#	#
Fujian	#	#	0.96→1.09	1.78→1.46	0.97→1.21	1.96→1.18
Jiangxi	#	#	2.39→1.61	1.49→1.30	#	0.63→1.09
Liaoning	1.39→1.25	#	#	0.35→1.35	0.97→1.30	#
Gansu	#	#	2.15→2.24	#	2.50→3.07	#
Sichuan	#	#	1.66→1.60	1.32→2.91	#	#
Jilin	#	#	2.71→2.87	#	#	#
Guangxi	#	#	2.54→2.30	0.86→1.78	#	#

Notes: # indicates that the industry's location quotient in 2012 was lower than 1 and therefore it was of no industry mix advantage.

c. Further Analysis on Regions with Competitiveness Advantage:

China had 11 regions whose pharmaceutical industry growth was derived from competitiveness effects. We believe that such competitiveness effects came from being attracted to capital investment in regional competition on the one hand, while being derived from outputs brought from internal innovation inputs, on the other hand. Two indicators were selected to analyze what factors resulted in the formation of regional competitiveness advantage. The first indicator was the fixed asset investment per capita. If the growth rate of such indicator of a region is above the national average during 2002-2012, this region will then belong to the strong capital investment region. The second indicator was the percentage of R&D expenditures in the sales revenue. If the growth rate of such indictor of a region was above the national average during 2002-2012, this region will then fall into the category of strong innovation region. Therefore, in theory, the 11 regions can be divided into 4 categories, i.e. strong innovation and capital investment region, strong innovation region, strong capital investment region, weak innovation and capital investment region. The calculation results are shown in Fig. 2.

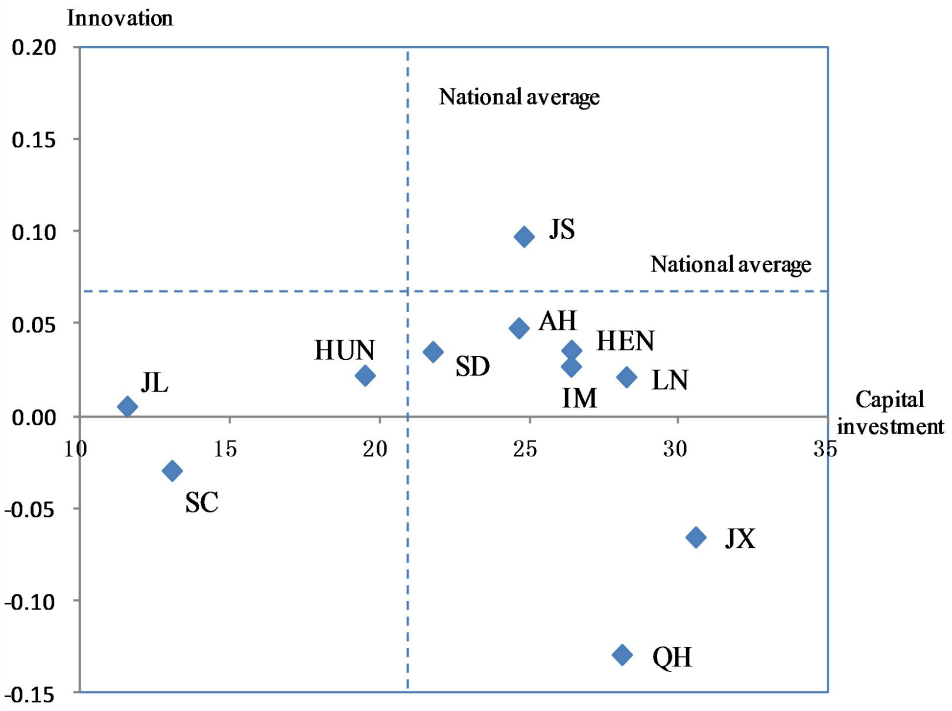

Fig. 2 Sources of competitiveness of regions with competitiveness advantage

Region abbreviations: JS:Jiangsu; SD: Shandong; AH: Anhui; IM: Inner Mongolia; HEN: Henan; LN: Liaoning; JX: Jiangxi; QH: Qinghai; HUN: Hunan; JL: Jilin; SC: Sichuan.

We can see from Fig. 2 that among the 11 regions with competitiveness advantage, the growth rates of both fixed asset investment per capita and R&D intensity of Jiangsu's pharmaceutical industry were above the national average, falling into the category of strong innovation and capital investment region. Shandong, Anhui, Inner Mongolia, Henan, Liaoning, Jiangxi and Qinghai belonged to those that relied on absorbing capital factors to obtain competitiveness advantage; Hunan, Jilin and Sichuan belonged to the weak innovation and capital investment region, whose competitiveness advantage was mainly reflected in attracting non-capital factors.

CONCLUSIONS

As an integral part of China's hi-tech industries, the pharmaceutical industry has been rapidly developing over the past decade; it has achieved impressive growth in terms of the number of enterprises, employment as well as economic scales. And the growth of its sales revenue was the fastest among various hi-tech industries with its garnered profits accounting for one third of those of hi-tech companies around the country.

Growth rates of pharmaceutical industry have varied greatly among China's 31 provincial regions over the past ten years. In terms of size of pharmaceutical industry, relatively big changes took place in rankings. It was discovered through the calculation of location Gini coefficient that China's pharmaceutical industry had evolved from the medium agglomeration ten years ago into the dispersed state at present.

According to the results of calculation based on the Shift-share Analysis, many regions showed different growth modes. There were 7 regions whose pharmaceutical industry brought about growth simply because of their development of some sectors conforming to their own comparative advantage, including Beijing, Shanghai, Guangdong, Hubei, Fujian, Gansu and Guangxi. And there were 6 regions whose pharmaceutical industry garnered rapid growth only because of their regional competitiveness advantage, and these were Shandong, Henan, Hunan, Anhui, Inner Mongolia and Qinghai. Also, there were 5 regions whose pharmaceutical industry obtained rapid growth due to development of some sectors of industries conforming to their own comparative advantage as well as bringing their regional competitiveness advantage into play, and they were Jiangsu, Jiangxi, Liaoning, Jilin and Sichuan. And Jiangsu's competiveness advantage came from not only external capital investment but also internal innovation; the rest 4 regions were the winners in competing with other regions in terms of capital or other factors.

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