How to break the vicious cycle of technology and economy in the backward regions---- based on comparative study of China and the United States

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Abstract: Based on the description and comparison of the regional distribution of China and the U.S. R & D funding, this paper found that the level of economic development and R & D Investment Intensity has a strong positive correlation, identified the main factors of influencing the geographical distribution of the R & D funding, Similarities and differences in the two countries, and described the programs and policy measures of the two countries to promote balanced regional distribution of R & D funding and to promote competitiveness of science and technology for the backward regions and the future endeavors.

Keywords: R & D funding; geographical distribution; Science and Technology Policy

People have formed a general consensus on relying on technological innovation to promote economic development. However, we can see, the more developed countries and regions, the higher the R & D investment, technology and economy can promote each other, and forming a virtuous circle. The more backward countries and regions, the lower the R & D investment, technological innovation can not effectively support economic development, and technology and economy form a vicious circle. How to break the vicious cycle of technology and economy in the backward countries and regions, becomes an important issue in the world. These problems need to explanation, and explore ways and means to solve.

Technological and economic developments of China and the U.S. are at different stages, but China and the U.S. have roughly the same land areas, and technological and economic development are uneven, with some comparability. Based on R & D expenditure of China's 31 provinces (excluding Hongkong, Macao, and Taiwan) and 51 states of the United States, GDP and other data, this paper compares the two country's regional scientific and technological and economic imbalances, analyses the reasons, explains the measures of breaking the vicious circle of regional science and technology and the economy, and presents future trends and policy recommendations. This paper includes the following six sections:

1. China R&D and GDP regional imbalance and analysis

2. United States R&D and GDP regional imbalance and analysis
3. The similarities and differences of R&D and GDP regional imbalance in China and the United States
4. The main factors of influencing R&D and GDP regional imbalance in China and the United States
5. The measures for breaking the vicious circle of science and technology and economy in the backward regions of China and the United States
6. Conclusion

There are many indicators to measure the technological and economic situations of a country or region. This paper takes R & D funding to measure the scientific and technological situation and GDP to measure the economic situation. The reasons are, First, R & D and GDP, respectively representative; Second, R&D and GDP have international comparability.

1. China R&D and GDP regional imbalance and analysis

As can be seen from Table 1, China’s provinces (including autonomous regions and municipalities directly under the central government, hereinafter the same) R & D funding, GPP (GSP), R & D / GPP, R & D percentage of the whole country, the cumulative percentage. The provinces R&D funding distribution was very uneven. The share of Beijing in 2007 was significantly large, 50.54 billion yuan, accounting for 13.6% of the country; the R & D funding of Beijing, Jiangsu, Guangdong, Shanghai and Shandong was more than half of the country, 52.8%; R & D funding of the top 10 provinces (From Beijing to Tianjin in table1) was 3 / 4 of the country; the final 10 provinces (Yunnan to Tibet) was 3.8% of the country, the final five provinces (Xinjiang-Tibet) was only 0.7% of the country.

As China’s eastern, central and western distribution of R & D funding,7 eastern provinces were in the top 10, but the western provinces of Sichuan and Shaanxi were also in the top 10. This showed that the distribution of R & D funding in China's western provinces was very uneven.

As economic scale of the provinces in China vary widely, and their R & D funding and proportion of China can not account for their R & D input intensity. "R & D / GPP" in Table 1 can show it. Beijing was No. 1, R & D / GPP was 5.4%, while Shaanxi was No. 4, 2.23%. The provinces that "R & D / GPP" of more than the average ratio of 1.49%, were only Beijing, Shanghai, Tianjin, Shaanxi, Jiangsu, Liaoning and Zhejiang. With R & D / GPP more than 1%, there were 12 provinces, whose R&D expenditure ranked 1~11 and 21. With R & D / GPP less than 0.5%, there were 6 provinces, whose R&D expenditure ranked among 24~31. Table 1 shows that the distribution of R & D funding in China's provinces was very uneven.

As can also be seen from Table 1, the uneven distribution of R&D expenditure in the provinces was obviously higher than that of GDP. R&D expenditure of top 5 provinces, Beijing, Jiangsu, Guangdong, Shandong, Shanghai was 52.8% of the country, while GDP of the 5 provinces was 37.9%. R&D expenditure of top 10 provinces was 75.0% of the country, while GDP of them was 56.3%. From the lower end of the table1, R&D expenditure of 10 provinces, from Yunnan to Tibet, was 3.8% of the country, while GDP of them was 10.5%. R&D expenditure of last 5 provinces was 0.7% of the country, while GDP of them was 2.5%.

In order to overall reflecting the degree of uneven distribution of R&D expenditure in China's provinces, here borrows Gini coefficient which reflects resident income disparity. If the distribution of R&D expenditure in China's provinces and the GDP distribution are same, the Gini coefficient is 0; If the R&D expenditure of the country is in 1 province, the Gini coefficient is 1. Based on Table 1 data, and in accordance with the calculation of the Gini coefficient, the Gini coefficient of R&D expenditure distribution on GDP distribution in China was 0.21 in 2007 (calculated by the following box)

Gini coefficient G = A / (A + B), A and B separately represents area.

According to the principle of calculating Gini coefficient, the cumulative percentages of provinces' GDP accounting for the country's GDP are in a straight line (line OC with X axis and Y axis are a 45-degree respectively), while the cumulative percentages of provinces' R&D expenditure accounting for the country's R&D expenditure are in the arc OC.

Based on the data in Table 1, G = A / (A + B)= Σa / (A + B)= 0.1038/0.5 = 0.21

Based on the data in Table 3, G = A / (A + B)= Σa / (A + B)= 0.0952/0.5 = 0.19

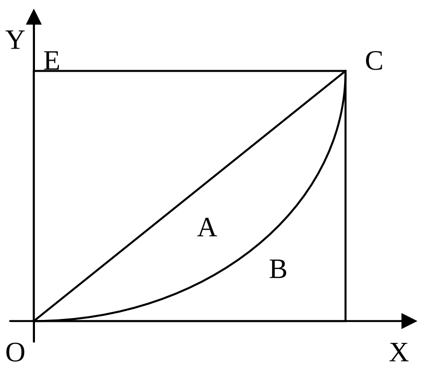


Table 1 The proportion of provinces' R&D to GDP and the proportion of provinces' R&D to China's R&D in 2007 [1, 2]18~19, 67

Rank/Province	R&D(￥100millions)	GDP (￥100millions)	R&D/GDP (%)	China R&D (%)	Cumulative percent
China	3710.2	249530	1.49	100	100
1 Beijing	505.4	9353.3	5.40	13.6	13.6
2 Jiangsu	430.2	25741.1	1.67	11.6	25.2
3 Guangdong	404.3	31084.4	1.30	10.9	36.1
4 Shandong	312.3	25965.9	1.20	8.4	44.5
5 Shanghai	307.5	12188.9	2.52	8.3	52.8
6 Zhejiang	281.6	18780.4	1.50	7.6	60.4
7 Liaoning	165.4	11023.5	1.50	4.5	64.9
8 Sichuan	139.1	10505.3	1.32	3.7	68.6
9 Shaanxi	121.7	5465.8	2.23	3.3	71.9
10 Tianjin	114.7	5050.4	2.27	3.1	75.0
11 Hubei	111.3	9230.7	1.21	3.0	78.0
12 Henan	101.1	15012.5	0.67	2.7	80.7
13 Hebei	90.0	13709.5	0.66	2.4	83.1
14 Fujian	82.2	9249.1	0.89	2.2	85.3
15 Hunan	73.6	9200.0	0.80	2.0	87.3
16 Anhui	71.8	7364.2	0.97	1.9	89.2
17 Heilongjiang	66.0	7065.0	0.93	1.8	91.0
18 Jilin	50.9	5284.7	0.96	1.4	92.4
19 Shanxi	49.3	5733.4	0.86	1.3	93.7
20 Jiangxi	48.8	5500.3	0.89	1.3	95.0
21 Chongqing	47.0	4122.5	1.14	1.3	96.3
22 Yunnan	25.9	4741.3	0.55	0.7	97.0
23 Gansu	25.7	2702.4	0.95	0.7	97.7
24 Inner Mongolia	24.2	6091.1	0.40	0.7	98.4
25 Guangxi	22.0	5955.7	0.37	0.6	99.0
26 Guizhou	13.7	2741.9	0.50	0.4	99.4
27 Xinjiang	10.0	3523.2	0.28	0.3	99.7
28 Ningxia	7.5	889.2	0.84	0.2	99.9
29 Qinghai	3.8	783.6	0.49	0.1	100
30 Hainan	2.6	1223.3	0.21	0.1	100
31 Tibet	0.7	342.2	0.20	0.0	100

Table 2 R&D Expenditure of Institute, Business and University in 2007 [1]18~19 100 Millions

Rank/Province	R&D Expenditure （￥100millions）	R & D Institutes	Business	Large and Medium-sized industrial enterprises	Universities
China	3710.2	687.9	2681.9	2112.5	314.7
1 Beijing	505.4	237.8	219.9	61.2	47.7
2 Jiangsu	430.2	45.1	352.6	321.9	32.5
3 Guangdong	404.3	11.2	378.3	336.4	14.8
4 Shandong	312.3	10.7	291.5	245.1	10.1
5 Shanghai	307.5	58.0	223.2	162.7	26.3
6 Zhejiang	281.6	13.6	249.8	162.5	18.2
7 Liaoning	165.4	25.0	123.1	109.3	17.3
8 Sichuan	139.1	53.3	65.9	56.7	19.9
9 Shaanxi	121.7	67.0	41.2	35.0	13.5
10 Tianjin	114.7	9.4	90.3	62.1	15.0
11 Hubei	111.3	32.1	66.0	51.3	13.2
12 Henan	101.1	14.7	81.1	72.1	5.3
13 Hebei	90.0	20.4	63.5	54.9	6.1
14 Fujian	82.2	3.4	74.9	51.6	3.9
15 Hunan	73.6	6.9	53.5	42.5	13.2
16 Anhui	71.8	14.5	49.6	42.7	7.7
17 Heilongjiang	66.0	8.4	43.7	37.9	13.9
18 Jilin	50.9	11.5	31.0	18.8	8.4
19 Shanxi	49.3	5.1	40.2	36.4	4.0
20 Jiangxi	48.8	5.2	39.4	36.4	4.2
21 Chongqing	47.0	2.9	37.6	35.1	6.5
22 Yunnan	25.9	13.2	10.5	8.2	2.2
23 Gansu	25.7	7.0	15.8	13.5	2.9
24 Inner Mongolia	24.2	2.2	20.8	19.3	1.2
25 Guangxi	22.0	2.6	15.5	13.2	3.9
26 Guizhou	13.7	1.7	11.0	10.1	1.0
27 Xinjiang	10.0	2.1	7.1	7.0	0.8
28 Ningxia	7.5	0.4	6.8	5.7	0.3
29 Qinghai	3.8	0.7	2.8	2.4	0.3
30 Hainan	2.6	1.3	1.0	0.4	0.3
31 Tibet	0.7	0.4	0.2	0	0.1

Although 0.21 can overall reflect the unbalanced distribution of provinces' R&D expenditure on the distribution of GDP, it can't be judged its rationality of

provinces' R&D expenditure distribution. However, through comparing, especially summarizing the domestic and foreign relevant experience, we can explore the rationality of R&D expenditure distribution in China.

In order to analyze distribution of provinces' R&D expenditure, it is required to further clarify the R & D expenditure of three performing sectors, R & D institutions, business and universities, and their proportions (Table 2).

Based on the data in Table 2, the Beijing R & D expenditure was significantly higher than other provinces, the first was due to the R&D expenditure of R&D institutions obviously higher than other provinces. The R&D expenditure of R&D institutions in Beijing was 23.78 billion yuan in 2007, accounting for 34.6% of the expenditure of R&D institutions in China. The second was due to the R&D expenditure of universities obviously higher than other provinces, reached 4.77 billion yuan in 2007, accounting for 15.2% of universities in China. The third was due to the R&D expenditure of enterprises in Beijing, reached 21.99 billion yuan in 2007, accounting for 8.1% of enterprises in China. Beijing had two distinctive features: First, the R&D expenditure of R&D institutions was 47.1% of the Beijing total, while that of enterprises was 43.5%. Second, the R&D expenditure of enterprises in Beijing was higher, but that of large and medium-sized enterprises was lower, only accounting for 2.9% of R&D expenditure of enterprises in China, and accounting for 12.1% of the total R&D expenditure in Beijing. Obviously, the leading position of Beijing R&D expenditure has been mainly determined by the layout of China's science and technology, and the layout of universities. The development of High-tech industries and a lot of SME in Beijing in recent years has also been an important reason.

In the front 4 provinces of Jiangsu, Guangdong, Shandong and Zhejiang, every one had an obvious characteristic, which the R&D expenditure of enterprises was higher, whether absolute or percentage of the province and percentage of the country. The absolute number of every provinces was 28.1 ~ 43.0 billion yuan, accounting for 7.5% ~11.6% of enterprise's R & D expenditure of China, and 81.2% ~ 93.6% of the total R & D expenditure of their own provinces.Obviously, the guiding role of the four provinces for other provinces in China is more important.

In the eighth Sichuan and the ninth Shaanxi, both had an obvious characteristic, the R&D expenditure of R&D institutions was higher, 6.7 billion yuan for Shaanxi in 2007, accounting for 9.7% of the R&D expenditure of R&D institutions in China, and 55.1% of the total R&D expenditure in Shaanxi. The R&D expenditure of R&D institutions in Sichuan was 5.33 billion yuan, accounting for 7.7% of the R&D expenditure of R&D institutions in China, and 38.3% of the total R&D expenditure in Sichuan. Above these were closely related to the layout of China's science and technology and the "three-line construction".

In the latter 10 provinces (from Yunnan to Tibet), R & D expenditures of the three performing sectors and their proportions of the national were all lower. R&D expenditure of R&D institutions in the 10 provinces totaled 3.16 billion yuan in 2007, accounting for 4.6% of R&D expenditure of R&D institutions in China. Enterprises totaled 9.15 billion yuan, accounting for 3.5%; Universities totaled 1.3 billion yuan, accounting for 4.1%.

2 The Imbalance and Analysis of the U.S. states R&D and GDP

Table 3 Total R&D and gross domestic product, by state: 2007 [3] A 4-16

Rank/state	R&D (current $millions)	GDP (current $millions)	R&D/GDP (%)	Rank in R&D/GDP	U.S. R&D (%)	Cumulative percent
1 California	77,608	1,801,762	4.31	7	21.6	21.6
2 Massachusetts	24,557	352,178	6.97	2	6.8	28.4
3 New Jersey	19,552	461,295	4.24	8	5.4	33.8
4 Texas	17,853	1,148,531	1.55	30	5.0	38.8
5 Michigan	17,402	379,934	4.58	6	4.8	43.6
6 New York	15,939	1,105,020	1.44	35	4.4	48.1
7 Washington	15,061	310,279	4.85	4	4.2	52.3
8 Illinois	14,287	617,409	2.31	20	4.0	56.2
9 Maryland	14,130	264,426	5.34	3	3.9	60.2
10 Pennsylvania	13,510	533,212	2.53	15	3.8	63.9
11 Connecticut	10,228	212,252	4.82	5	2.8	66.8
12 Ohio	10,041	462,506	2.17	23	2.8	69.5
13 Virginia	9,473	384,132	2.47	17	2.6	72.2
14 North Carolina	9,204	390,467	2.36	19	2.6	74.7
15 Minnesota	7,533	252,472	2.98	11	2.1	76.8
16 Florida	7,158	741,861	0.96	41	2.0	78.8
17 Colorado	6,828	235,848	2.90	12	1.9	80.7
18 Indiana	5,980	249,229	2.40	18	1.7	82.4
19 New Mexico	5,663	75,192	7.53	1	1.6	84.0
20 Arizona	5,006	245,952	2.04	26	1.4	85.3
21 Wisconsin	4,555	233,406	1.95	28	1.3	86.6
22 Georgia	4,425	391,241	1.13	37	1.2	87.8
23 Oregon	4,333	158,268	2.74	13	1.2	89.0
24 District of Columbia	3,862	92,516	4.17	9	1.1	90.1

25 Missouri	3,754	229,027	1.64	29	1.0	91.2
26 Tennessee	3,659	245,162	1.49	32	1.0	92.2
27 Alabama	3,289	164,524	2.00	27	0.9	93.1
28 Utah	2,337	105,574	2.21	22	0.6	93.7
29 South Carolina	2,291	151,703	1.51	31	0.6	94.4
30 New Hampshire	2,146	57,820	3.71	10	0.6	95.0
31 Iowa	1,882	129,911	1.45	33	0.5	95.5
32 Kansas	1,697	116,986	1.45	34	0.5	96.0
33 Delaware	1,607	61,545	2.61	14	0.4	96.4
34 Kentucky	1,406	152,099	0.92	44	0.4	96.8
35 Idaho	1,115	52,110	2.14	25	0.3	97.1
36 Rhode Island	1,081	46,699	2.32	21	0.3	97.4
37 Louisiana	1,073	207,407	0.52	50	0.3	97.7
38 Oklahoma	921	136,374	0.68	46	0.3	98.0
39 Nebraska	900	80,360	1.12	38	0.3	98.2
40 Montana	859	34,266	2.51	16	0.2	98.5
41 Mississippi	838	87,652	0.96	42	0.2	98.7
42 Nevada	794	129,314	0.61	49	0.2	98.9
43 West Virginia	650	57,877	1.12	39	0.2	99.1
44 Arkansas	632	95,116	0.66	48	0.2	99.3
45 Hawaii	592	62,019	0.95	43	0.2	99.4
46 Vermont	534	24,627	2.17	24	0.1	99.6
47 Maine	485	48,021	1.01	40	0.1	99.7
48 North Dakota	327	28,518	1.15	36	0.1	99.8
49 Alaska	311	44,887	0.69	45	0.1	99.9
50 South Dakota	240	35,211	0.68	47	0.1	100.0
51 Wyoming	129	31,544	0.41	51	*	100.0

* = <0.05%

GDP = gross dometic product

Table 3 shows the distribution of R&D expenditures among States was very uneven in 2007. California, $77,608 million, accounted for 21.6% of the United States. The top 7 states (California ~ Washington) accounted for more than the half (or 52.7%) of the United States; The top 11 states (California ~ Connecticut) accounted for more than 2/3 (66.8%). The 27 lowest-ranking states (Missouri ~ Wyoming) accounted for less than 1/10 (9.9%); The 10 lowest-ranking states (Nevada ~ Wyoming) accounted for only 1.3%.

In terms of R&D/GDP, 9 states was higher than 4.0%, including new Mexico, ranked No.1, up to 7.53%, mainly due to the two largest federally funded research and development centers , Los Alamos National Laboratory and Sandia National Laboratory in the state, R & D funding of the federal government was 82% of the state total in 2007. The states with higher R&D/GDP located mainly on the east and the west coasts and the great lakes region. The 11 states with less than 1% of R&D/GDP, except Florida, ranked in lower than 34 of state's R&D expenditure, showing that R & D funding for small-scale and low intensity are closely related.

The distribution imbalance of R&D expenditure among states was higher than that of GDP in 2007. The 5 states (California ~ the Michigan) with the highest R&D expenditure, accounted for 43.6% of the U.S. total, and their GDP accounted for 30.2% of the U.S. total. The 10 states with the highest R&D expenditure, accounted for 63.9%, and their GDP accounted for 50.8%. The 20 states (Kansas ~ Wyoming) with the lowest R&D expenditure, accounted for 4.5% of the U.S. total, and their GDP accounted for 11.2%. The 10 states (Nevada ~ Wyoming) with the lowest R&D expenditure, accounted for 1.3%, and their GDP accounted for 4.1%.

Based on Table 3 data, and in accordance with the calculation of the Gini coefficient, the Gini coefficient of R&D expenditure distribution on GDP distribution in the U.S. was 0.19 in 2007.

In order to further illustrate the distribution of R&D expenditure among states, here are three R & D performers, Business, universities and the federal government, and their rankings (table 4).

Table 4 Top 10 states in R&D performance, by sector and intensity: 2007

[3]4-17

All R&Da			Sector ranking			R&D intensity (R&D/GDP ratio)		
Rank	State	Amount (current $millions)	Business	Universities and colleges	Federal intramural and FFRDCb	State	R&D/ GDP (%)	GDP (current $billions)
1	California	77,608	California	California	Maryland	New Mexico	7.53	75.2
2	Massachusetts	24,557	Massachusetts	New York	California	Massachusetts	6.97	352.2
3	New Jersey	19,552	New Jersey	Texas	New Mexico	Maryland	5.34	264.4
4	Texas	17,853	Michigan	Maryland	Virginia	Washington	4.85	310.3
5	Michigan	17,402	Texas	Pennsylvania	District of Columbia	Connecticut	4.82	212.3
6	New York	15,939	Washington	Massachusetts	Massachusetts	Michigan	4.58	379.9
7	Washington	15,061	Illinois	North Carolina	Tennessee	California	4.31	1,801.8
8	Illinois	14,287	New York	Illinois	Washington	New Jersey	4.24	461.3
9	Maryland	14,130	Pennsylvania	Ohio	Illinois	District of Columbia	4.17	92.5
10	Pennsylvania	13,510	Connecticut	Florida	Florida	New Hampshire	3.71	57.8

As can be seen from table 4, of the top 10 states in total R&D performance, 9 are also in the top 10 in industry R&D, 7 among the university R&D top 10 and 5 among federal R&D performance (both intramural and FFRDC) top 10.

In 2007, business-sector R&D accounted for about 73% of the U.S. R&D total that could be allocated to specific states. University-performed R&D accounts for 14% of the U.S. total, and it also closely follows state total R&D performance. Representing about 11% of the state-distributed U.S. total, federal R&D performance (both intramural and FFRDC) is more concentrated geographically than performance in other sectors—and the relationship between its geographical distribution and that of total R&D is less significant.

The top four states (Maryland, California, New Mexico, and Virginia) and the District of Columbia represent 64% of all federal R&D performance. The high figures for Maryland (54%), Virginia (38%), and the District of Columbia (74%) reflect the concentration of federal facilities and administrative offices in the national capital area.[3]4-17

3. The similarities and differences of R&D and GDP regional imbalance in China and the United States

Comparing the regional distribution of R&D expenditure of China and the U.S., we can see some similarities. First, both have larger imbalance of their R&D distribution. For example, Beijing performed R & D expenditure as 13.6% of China, and California performed R & D expenditure as 21.6% of the United States. The top 5 provinces accounted for 52.8% of China, while top 7 states accounted for 52.3% of the U.S. The 10 provinces with lowest R & D expenditure accounted for 3.8% of China, while the 10 states with lowest R & D expenditure accounted for 1.3% of the U.S.

Second, the R&D/GDP distributions of China and the U.S. were both larger imbalance. For example, Beijing's R&D/GDP was 5.4%, while New Mexico's was 7.5%. There were only 4 provinces with more than 2% of R&D/GDP in China, while 8 states with more than 4% of R&D/GDP in the U.S.. There were 6 provinces with less than 0.5% of R&D/GDP in China, while 11 states with less than 1% of R&D/GDP in the U.S.

Third, the imbalances of the R & D regional distribution in both China and the U.S. were significantly higher than the imbalances of GDP. For example, in the top 5 provinces, their R&D accounted for 52.8% of China, and their GDP accounted for 37.9% of China. In the top 5 states, their R&D accounted for 43.6% of the U.S., and their GDP accounted for 30.2% of the U.S. In the lowest 10 provinces, their R&D accounted for 3.8% of China, and their GDP accounted for 10.5% of China. In the lowest 10 states, their R&D accounted for

1.3% of the U.S., and their GDP accounted for 4.1% of the U.S.

The Gini coefficient of R&D distribution on GDP distribution in China was 0.21 in 2007, while the Gini coefficient in the U.S. was 0.19. The imbalance in China was larger than the imbalance in the U.S., but they had not much difference.

Fourth, the two country's regional distributions of R & D expenditure were mainly determined by the distributions of business R & D expenditure. In 2007, the R & D performance in both China and the U.S. accounted for 72.3% of each country's total. The 7 provinces with highest R&D expenditure were among the business R&D top 7 in China. Of the top 10 states in total R&D performance, 9 were also in the top 10 in business R&D in the U.S.

Fifth, the two country's regional distributions of R & D expenditure were closely related to their regional distributions of university R&D. In the top 10 provinces of R & D expenditure, 8 were also among the university R&D top 10 in China. In the U.S. top 10 states of R & D expenditure, 7 were also among the university R&D top 10.

Sixth, the two country's regional distributions of R&D/GDP were jointly determined by the level of economic development and the layout of national science and technology. In 2007, the provinces with more than 1.49% of R&D/GDP in China, except Shaanxi, were all in the east area, and the provinces with lower than 0.5% were in the west. The top 10 states of R&D/GDP in the U.S., except New Mexico, were in the East and West Coasts and the Great Lakes region. Shaanxi ranked No. 4 in China and New Mexico ranked No. 1 in the U.S. were mainly determined by the layout of the each country's science and technology. Beijing with the highest of R&D/GDP and the U.S. capital region (Maryland, Virginia and District of Columbia) with high R&D/GDP, were mainly determined by the layout of the each country's science and technology.

There were some differences of the regional R & D distribution in China and the U.S. First, the average of R&D/GDP of China's provinces were about half of the U.S. In 2007, the average of China was 1.49%, while the average of the U.S. was 2.62%. This difference is mainly due to the two countries at different stages of development.

Second, the imbalance of the regional R & D distribution in China was larger than that of the U.S. Only 7 provinces with higher than the national average of R&D/GDP, accounted for 23% of China, while that of 13 states, accounted for 26% of the United States.

Third, the uneven distribution of R&D caused by R&D institutions in China was more than that in the U.S. In 2007, R&D institutions accounted for 18.5%

of R&D expenditure of China’s total, while that was 11.7% in the U.S. The R&D institutions in Beijing performed 34.6% of this sector’s R&D of China, while no state in the U.S. performed as high as this percentage.

4. The main factors of influencing R&D and GDP regional imbalance in China and the United States

Based on the regional distributions of R&D expenditure in China and the United States and comparative studies, three points can be drawn: First, the regional economic scale and industrial structure are the main factors to determine the scale and intensity of regional R&D expenditure. Furthermore, the regional economic scale determines its R&D expenditure scale and the industrial structure determines its R&D expenditure intensity. This means that when a regional economic scale reaches a certain extent, the readjustment and upgrading of industrial structure become the main aspects of increasing R&D expenditure scale. Some industrials such as computer and electronic products, chemicals (including medicine), computer related services, the R&D services, automobile industry in the U.S. have relatively high R&D intensities. This means that increasing the share of these industries of R&D intensity can effectively increases the scale and intensity of R&D in a region or a country.

Second, the political and military are important factors to impact on the geographical distribution of the national R & D, mainly due to the geographical distribution of the national R&D institutions and facilities.For some regions, however, the geographical distribution of the national R & D becomes the main factor to determine their R&D scale and intensity. The capital areas in both China and the United States have high R&D scale and intensity, political is the most important factor. Shaanxi and Sichuan’s R&D scale and intensity are relatively high in China, military is the most important factor; New Mexico’s R&D expenditure intensity ranked NO.1 in the U.S., military is the determining factor.

Third, the geographical distribution of universities is the important factor to influence the regional distribution of R & D expenditure, but not the basic factor because the geographical distribution of universities is decided by economic, political and military factors, resulting in high consistency of the geographical distribution of universities and regional distribution of R&D.

5. The measures for breaking the vicious circle of science and technology and economy in the backward regions of China and the United States

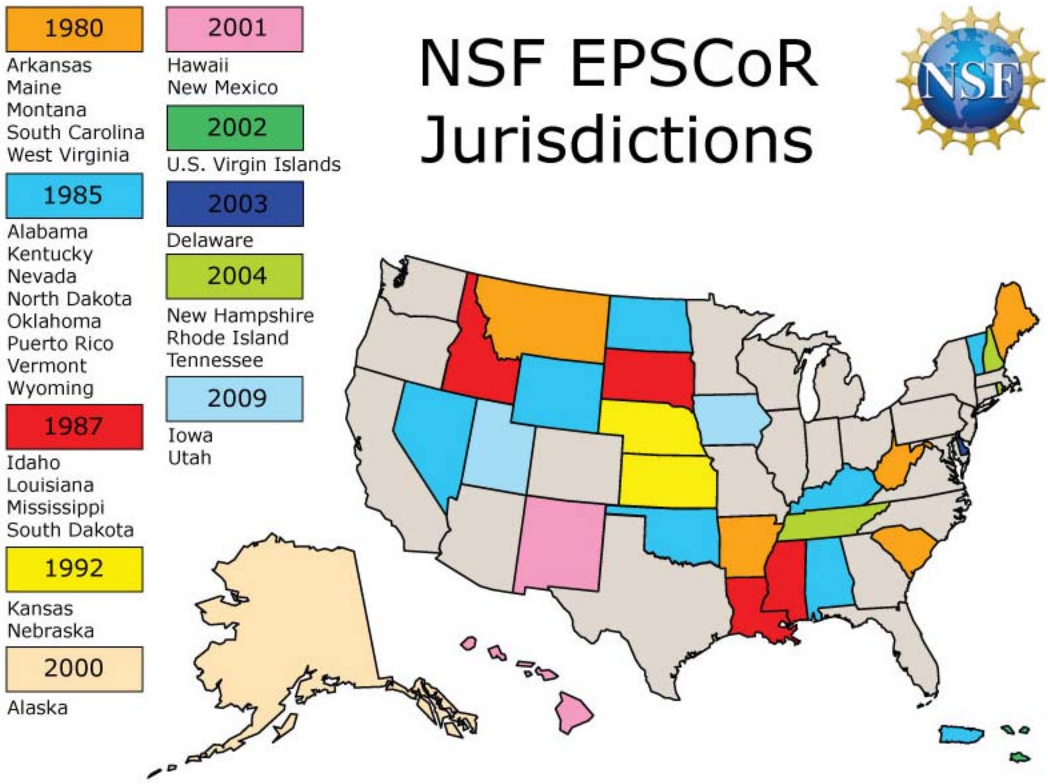
Both in China and in the United States, the more economically developed regions, the higher the intensity of investment in science and technology (R & D / GDP); the more economically backward regions, the lower the intensity. For the economically developed regions, the economic and technological development can form a virtuous cycle, while for the economically backward regions, the economic and technological development can form a vicious circle. How to break the vicious circle of technology and economy and promote the development of the backward regions is the common problem faced by China, the United States and other countries. In order to solve or alleviate this problem, both the United States and China have taken some measures.

The Experimental Program to Stimulate Competitive Research (EPSCoR) was initiated by the National Science Foundation (NSF) in 1979 as a unique infrastructure-building effort to encourage local action to develop long term improvements in a state's science and engineering (S&E) enterprise. It was created in response to Congressional concerns about geographical concentration of Federal funding of academic research and development (R&D).

Currently twenty-five states, Puerto Rico, and the Virgin Islands have been identified as EPSCoR states. Through these federal-state partnerships, EPSCoR focuses on science, engineering and technology capabilities that promote national competitiveness. These partnerships help to balance the distribution of federal research dollars and use state or local control in the delivery of program goals.

The success of NSF EPSCoR in the 1980s led Congress to expand the NSF program in the 1990s and early 2000s and create EPSCoR-related programs in the Department of Energy (DOE), Department of Defense (DoD), Department of Agriculture (USDA), Environmental Protection Agency (EPA), National Aeronautics and Space Administration (NASA), and the National Institutes of Health (NIH) [4].

EPSCoR basically achieve the expected purpose, the pursuit of excellence and promoting fairness. By matching funding of federal and state, make more federal R & D expenditure to the relatively backward economic and technological state, and more equitable regional distribution of the federal R & D expenditures. EPSCoR has also promoted these states themselves to increase R & D investment, and effectively enhance their technological competitiveness and economic and social development.



In order to promote R & D investment and technological innovation in economically backward provinces, China has taken a series of plans and policy measures. For example, the National Natural Science Foundation of China began in 1989 to set up regional science fund to promote R&D in technological and economic backward western regions, remote regions, ethnic minority regions, including 11 western provinces. The Ministry of Science and Technology of China has taken a series of science and technology plans and policy measures to promote the national R & D investment in all provinces (autonomous regions and municipalities) evenly distributed, especially in central and western provinces (regions).

These plans and policy measures include two aspects: one designed to support the backward regions of science and technology and economy, such as technology-oriented poverty reduction plan. The other involved many nationwide science and technology plans, which require every province limits the number of applications, thereby increasing the technological and economic backward provinces the opportunity to access to national science and technology projects. In addition, the Ministry of Science and Technology of China requires local matching funds for some R & D projects, and through the city (county, district) science and technology assessment to promote local investment in science and technology, especially investment in the backward regions. These plans and policy measures have played a certain role in promoting national science and technology funds in all provinces in a balanced distribution, in particular, promoting R & D investment and technological innovation in backward regions.

6. Conclusion

Based on the above described and analyzed, the uneven geographical distributions of R & D expenditure are presented in the United States and China. The uneven distributions have certain rationality, which are determined firstly by the regional economic scale and industrial structure, secondly by the political and military factors; thirdly by the regional distribution of universities. In the background of market mechanisms for economic operation and competition mechanism for government investment in science and technology in China and the United States, this uneven distribution makes, the more economically backward regions, the lower the intensity of science and technology investment (R & D / GDP), resulting in the vicious circle between technology and economy.

In order to change or alleviate the vicious circle, enhance technological innovation capability and promote the development of backward regions, the U.S. has implemented the EPSCoR, and China has implemented technology-oriented poverty alleviation programs and other policy measures. Although these programs and policies of China and the United States are very different, but the core idea is same, which gives support to the backward regions on the basis of adhering to fair competition, and promotes local governments to support science and technology activities to enhance scientific and technological competitiveness. These programs and policies have played an important role, and should continue. At the same time, China and the U.S. should adopt the new programs and policy measures to break the vicious circle between technology and economy in backward regions as soon as possible, alleviate the uneven geographical distribution of R&D, and promote the accelerated development of backward regions.

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