Comparative Study on Patents and Publications Productivity between Provinces of China and States of USA[1]

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Introduction

It was observed that the patent productivity and the publications productivity of a country could present big difference. Brazilian scholars Bernardes et al. noticed that less developed countries produced relatively fewer patents than papers, while industrialized countries yielded large amount of patents as well as papers (Bernades et al., 2003). We ask ourselves whether the similar phenomenon would happen within the different regions of a big country, since the population in a province or state of a big nation could be comparable to the population of a small country. To answer this question, we decide to compare the provinces of China with the states of USA in terms of their patent and publication productivity.

Data

The publication figure for USA states was derived from SCI database of ISI. The corresponding patent figure was drawn from the website of USPTO. The population figure was taken from the Statistical Abstract of U. S. Census Bureau. The publication figure of Chinese provinces was derived from China Scientific and Technical Papers and Citations Database (CSTPCD□, a database built and maintained by the Institute of Scientific and Technical Information of China. The patent figure was drawn from China State Intellectual Property Office. The population figure was taken from the State Statistical Bureau of China.

It is unimportant to examine least productive regions, so we only count Chinese provinces whose sum total of papers in 1993, 1997 and 2001 is over 1% of the national total in that year. Similarly, only those states of USA whose number of publications is larger than 0.5 % of the national total are included. Thus, 24 provinces of China and 36 states enter our scope of analysis.

Results

1 Trend in patents and publications per million populations

Fig.1 and Fig.2 reflect the numbers of patents and publications per million populations in USA and China in 1993, 1997 and 2001. It could be seen that the number of publications in USA is decreasing while the number of patents is increasing. In China, in comparison, both publications and patents are in growth.

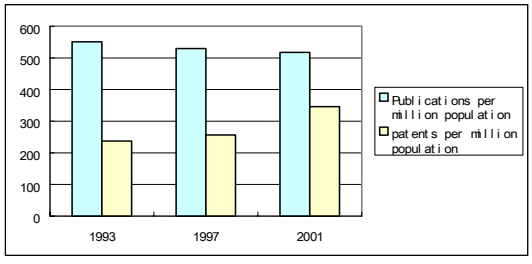

Figure 1 Trend in patents and publications per million populations in USA

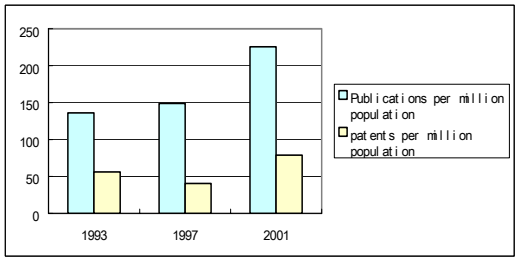

Figure 2 Trend in patents and publications per million populations in China

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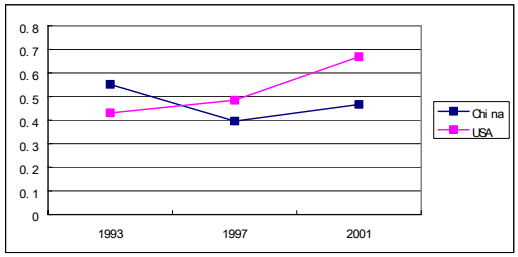

Figure 3 Trend in patent/publication ratio in USA and China

2 Patent/publication ratio

Fig.3 shows that patent/publication ratio in USA presents itself as growing gradually while China's ratio is fluctuating. According to Table 3, among 50 states of USA, 46 states (92%) witnessed its patent/publication ratio increasing, while all the 36 chosen states having their ratio in growth from 1993 to 2001.

Table 1 Patent/publication ratio in 36 USA states in 1993, 1997 and 2001

State	1993	1997	2001	State	1993	1997	2001
New-Jersey	1.151	1.119	1.405	South-Carolina	0.442	0.415	0.480
Minnesota	0.710	0.846	1.225	Pennsylvania	0.386	0.358	0.459
California	0.532	0.737	1.149	Georgia	0.299	0.342	0.447
Oregon	0.522	0.684	0.977	North-Carolina	0.229	0.303	0.441
Michigan	0.636	0.630	0.834	Tennessee	0.306	0.330	0.421
Colorado	0.449	0.533	0.802	Virginia	0.323	0.304	0.413
Ohio	0.572	0.637	0.786	Massachusetts	0.290	0.306	0.410
Arizona	0.414	0.515	0.774	Kentucky	0.247	0.253	0.404
Connecticut	0.643	0.583	0.748	Rhode-Island	0.317	0.356	0.387
Texas	0.432	0.508	0.748	Iowa	0.189	0.198	0.366
Florida	0.511	0.610	0.740	Maryland	0.256	0.293	0.338
Wisconsin	0.411	0.479	0.740	Louisiana	0.270	0.215	0.307
Oklahoma	0.763	0.493	0.684	Kansas	0.254	0.269	0.305
Washington	0.359	0.471	0.676	Missouri	0.254	0.275	0.299
Illinois	0.468	0.513	0.609	Nebraska	0.178	0.180	0.250
New-York	0.419	0.438	0.578	Alabama	0.181	0.181	0.239
Indiana	0.359	0.429	0.515	District-of-Columbia	0.051	0.048	0.060
Utah	0.314	0.424	0.511				
New-Mexico	0.356	0.348	0.501	**United-States**	**0.431**	**0.484**	**0.669**

Table 2 Patent/publication ratio in 24 Chinese provinces in 1993, 1997 and 2001

Province	1993	1997	2001	Rank of Marketization Level 2002	Province	1993	1997	2001	Rank of Marketization Level 2002
Guangdong	1.167	1.087	1.244	1	Jiangsu	0.429	0.298	0.376	5
Zhejiang	0.777	0.713	0.964	2	Tianjin	0.621	0.287	0.337	8
Fujian	0.376	0.626	0.796	3	Shanghai	0.282	0.209	0.324	4
Shandong	0.846	0.465	0.602	7	Hunan	0.760	0.324	0.318	16
Hebei	0.950	0.595	0.576	10	Heilongjiang	0.500	0.296	0.310	21
Liaoning	0.852	0.479	0.547	9	Chongqing	-	-	0.272	11
Guangxi	0.770	0.626	0.518	15	Anhui	0.350	0.184	0.238	14
Yunan	0.548	0.424	0.501	23	Beijing	0.365	0.166	0.199	6
Henan	0.599	0.420	0.489	18	Hubei	0.258	0.136	0.183	17
Jiangxi	0.606	0.480	0.478	19	Gansu	0.219	0.146	0.177	27
Sichuan	0.099	0.231	0.435	13	Shannxi	0.335	0.137	0.115	25
Shanxi	0.546	0.315	0.410	22					
Jilin	0.383	0.219	0.403	20	**China**	**0.523**	**0.436**	**0.341**	

3 Rank-frequency relationship for patents and publications

Chinese scientometrician Liang Li-ming (Liang et al., 1993; Liang and Wu, 1994) has found that no matter on national level or provincial level, there exists a negative power function relationship for rank-frequency distribution of publications. That is to say, general formula $y=x^{-\alpha}$ holds, where y is the number of publications, x is the rank of a nation (or a province) in terms of its quantity of publications, and α is a constant. From Fig 4 and Fig 5 we could see that a different function - logarithm distribution - is found for rank-frequency relationship of publications and patents. In Fig 4, there is not much difference between the two slopes for two regression lines, while in Fig 5, the difference between the two slopes is larger, which means that top publication producing provinces in China yield relatively less patents than their USA counterparts.

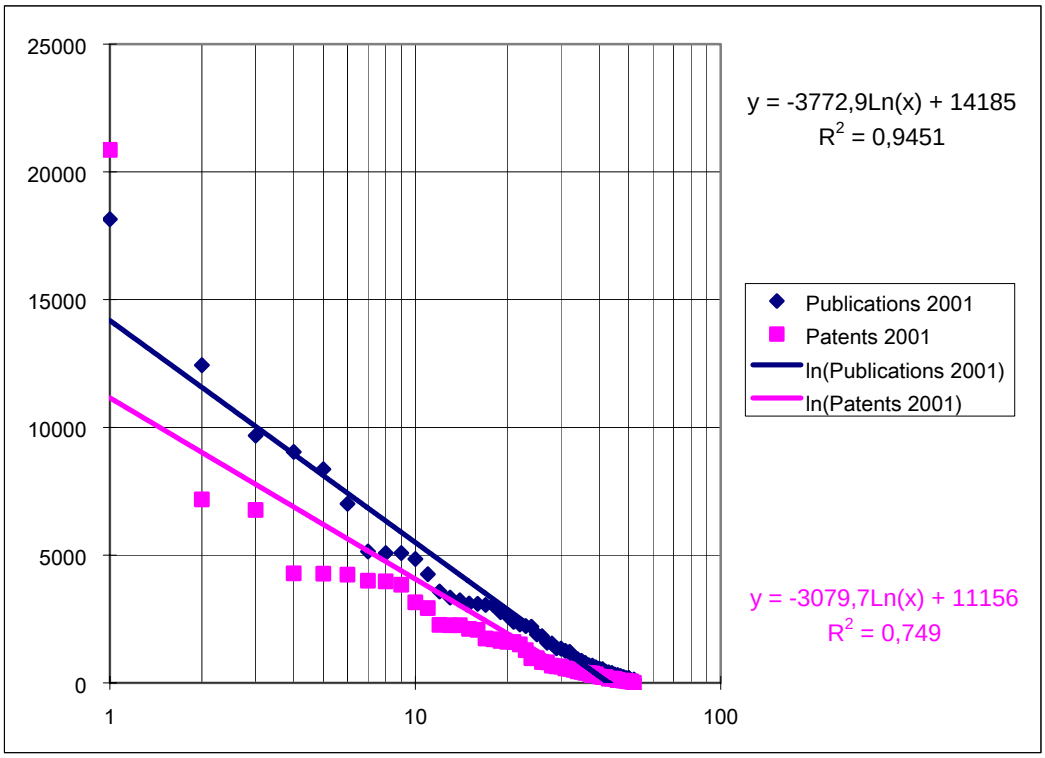

Figure 4 Rank-frequency relationship for USA patents and publications.

4 Patent and publication productivity vs. main impact variables

We take the rank in different terms in Table 3 and Table 4. Then we calculate the sum of squared "rank difference" between every rank pairs. When the least sum is found after calculating all the pairs, we show the rank difference of this pair in Table 3 and Table 4. For the case of USA states, publications rank has closest relation with the rank in R&D expenditure. For the case of China, the rank in marketization level is closely related to its rank in the number of patents.

In the case of 36 USA states, among the 18 poorer states in terms of GSP, there are only 7 states whose patent rank is higher than their publication rank, while among the poorer half of 12 Chinese provinces, there are only 4 provinces whose patent rank is higher than publication rank. In this sense, USA states and Chinese provinces do behave like countries, with the less advanced regions having weak capacity in producing patents.

5 Special case - Patent productivity vs. marketalization level of Chinese provinces

According to the Research Institute for National Economy (2004) in its Report on Marketization Level of Chinese Provinces (shown in Table 4), it is very interesting to note that among the top 10 provinces with most patents, 9 are also in the top 10 provinces with highest degree of marketization. It's more interesting to find that the three provinces with highest marketization level happen to be the provinces

with greatest patent/publication ratios. At least in China, patent productivity of a province seems to be closely related to its market maturity.

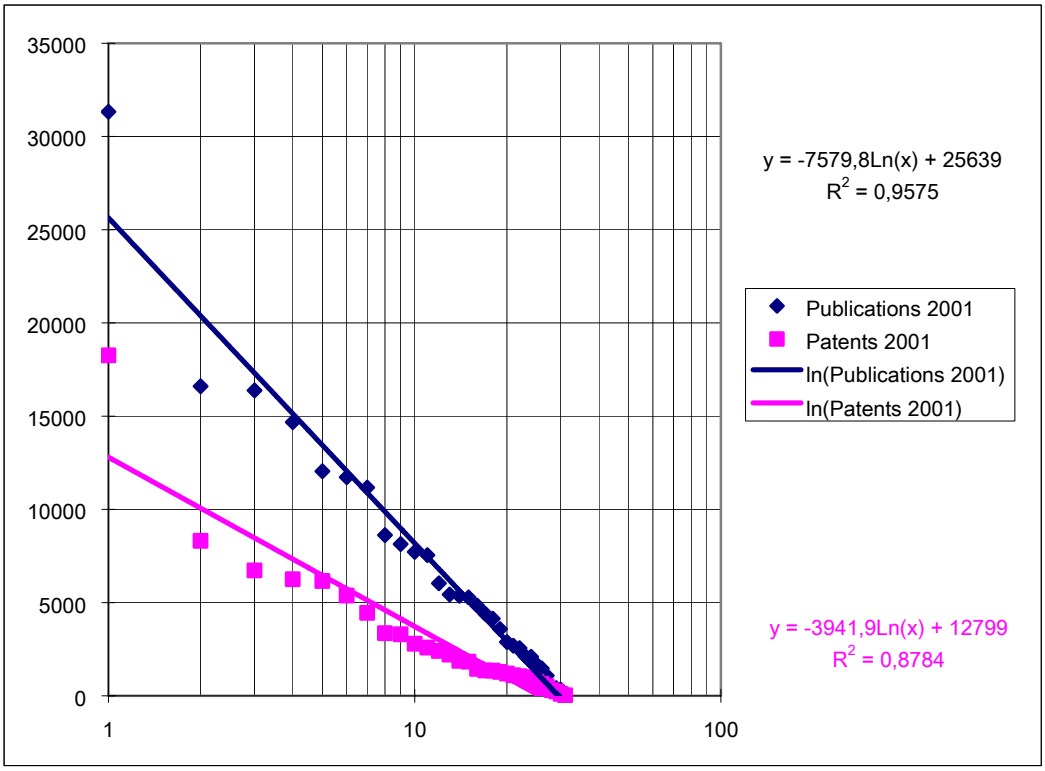

Figure 5 Rank-frequency relationships for Chinese patents and publications

Table 3 Ranks in terms of some indicators for USA states and their ranks in patents and publications

	Rank of GSP per capita R1	Rank of Populations R2	Rank of R&D Outlay R3	Rank of GSP R4	Rank of Publications R5	Rank of Patents R6	R5-R3
Alabama	46	23	23	26	25	34	2
Arizona	37	20	20	23	24	18	4
California	9	1	1	1	1	1	0
Colorado	8	24	19	21	20	15	1
Connecticut	2	29	21	22	19	16	-2
District-of-Columbia	1	50	36	36	32	49	-4
Florida	39	4	10	4	11	10	1
Georgia	17	10	12	10	12	20	0
Illinois	14	5	7	5	6	5	-1
Indiana	32	14	18	15	16	21	-2
Iowa	36	30	24	30	23	26	-1
Kansas	31	32	32	31	31	37	-1
Kentucky	40	25	30	27	29	32	-1
Louisiana	28	22	25	24	26	31	1
Maryland	21	19	5	17	10	19	5
Massachusetts	5	13	6	11	3	8	-3
Michigan	25	8	9	9	9	6	0
Minnesota	12	21	22	16	21	11	-1
Missouri	30	17	15	19	14	24	-1
Nebraska	27	38	35	37	33	40	-2
New-Jersey	6	9	17	8	17	4	0
New-Mexico	41	36	31	38	36	36	5
New-York	7	3	2	2	2	2	0
North-Carolina	23	11	8	12	7	12	-1
Ohio	24	7	11	7	8	7	-3
Oklahoma	47	28	33	29	34	30	1
Oregon	18	27	27	25	28	22	1

(Table 3 continued)

Pennsylvania	26	6	4	6	5	9	1
Rhode-Island	22	43	39	46	35	39	-4
South-Carolina	45	26	28	28	30	29	2
Tennessee	33	16	26	18	22	25	-4
Texas	19	2	3	3	4	3	1
Utah	35	34	29	33	27	27	-2
Virginia	16	12	16	13	15	23	-1
Washington	15	15	14	14	13	13	-1
Wisconsin	29	18	13	20	18	14	5

Table 4 Ranks in terms of some indicators for Chinese provinces and their ranks in patents publications

	Rank of GDP per capita R1	**Rank of Population R2**	**Rank of R&D Outlay R3**	**Rank of Marketization Level R4**	**Rank of GDP R5**	**Rank of Publications R6**	**Rank of Patents R7**	**R7-R4**
Anhui	20	9	14	14	14	14	19	5
Beijing	2	28	1	6	15	1	4	-2
Chongqing	31	21	19	11		17	20	9
Fujian	7	19	16	3	11	18	9	6
Gansu	27	24	20	27	26	20	27	0
Guangdong	5	5	2	1	1	4	1	0
Guangxi	26	11		15	16	23	21	6
Hebei	11	7	15	10	6	16	10	0
Heilongjiang	10	16	17	21	13	12	14	-7
Henan	17	1	13	18	5	15	11	-7
Hubei	13	10	10	17	9	5	13	-4
Hunan	16	8	11	16	12	11	12	-4
Jiangsu	6	6	3	5	2	3	5	0
Jiangxi	21	15		19	17	24	23	4
Jilin	14	22	18	20	19	19	16	-4
Liaoning	8	14	8	9	7	9	7	-2
Shandong	9	2	5	7	3	7	3	-4
Shanghai	1	27	4	4	8	2	6	2
Shannxi	25	18	9	25	20	6	17	-8
Shanxi	19	20		22	21	22	22	0
Sichuan	23	3	6	13	10	10	8	-5
Tianjin	3	29	12	8	22	13	15	7
Yunnan	24	13		23	18	21	18	-5
Zhejiang	4	12	7	2	4	8	2	0

Discussions

From the above results we could observe that USA states seem to set greater store by patents than Chinese counterparts. As time elapses, the patent/publication ratio for USA states gets even bigger, but China's this ratio sometimes gets smaller as provinces produce much more papers. As China's marketization process deepens, however, we believe that China's patent/publication ratio will also grow gradually.

Based on the analysis of relevant data for 36 USA states and 24 Chinese provinces, it could be seen that the behavior of USA states is more homogeneous among themselves in terms of balanced patent and publication productivity, while the patent productivity and publication productivity of Chinese provinces are not so balanced and more haphazard.

Therefore, in building respective regional innovation system, two countries should have different priority. For China, accelerating marketization level seems to be most important, because this process would call for more effective and more efficient R & D investment, thus provinces would produce relatively balanced number of publications and patents in order to better meet the local needs in their socio-economic development. For USA, on the other hand, the priority seems to be strengthening the capacity of knowledge generation in those least developed states, so as to avoid to be further marginalized in emerging knowledge society.