DSI DATA SCIENCE AND INFORMETRICS
VOL.1, NO.4, NOV. 2021

RESEARCH ARTICLES

Analysis on the differences in the development of basic researchers in the field of AI in China

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ABSTRACT

Artificial intelligence (AI) is an important driving force in the new round of scientific and technological revolution and industrial transformation, China must grasp the opportunity to its development. Basic researcher's ability was the inexhaustible driving force to promote the long-term development of AI. The paper focused on 2763 AI researchers who engaged in basic research. The paper analyzed the differences in city distribution and research direction of this group in China, and further explored the influence of different cities on research output, as well as the interactive influence between city and institution on their research output. The study found that there was a prominent phenomenon of aggregation of AI basic researchers in China, and their research fields were mainly focused on machine learning, computer vision, pattern recognition and data mining. The economic level of the city had a positive impact on the paper output and the project undertaken by researchers. The development vitality of the city had a positive impact on the researchers' patent output. The high-quality platform of the institution would make up for the disadvantages caused by the city's lower economy. Therefore, in China, it was necessary to determine the development orientation of cities at different levels so that they could play different roles in the industrial development. Economically underdeveloped cities should allocate resources rationally, enhance the deep cooperation between non-first-class institutions and local AI enterprises, and provide a good scientific research ecological environment for the growth of local AI basic researchers.

KEYWORDS

Artificial Intelligence (AI); Basic researcher; City influence; Research output

1 Introduce

In the context of intense international competition, all countries are building their own researchers' teams, promoting diversification and rational allocation of researchers. The countries want to get greater international competitiveness through researchers' development. China has achieved remarkable results in talent cultivation with the implementation of talent development strategy and a series of talent policies. The research environment is constantly improving. The total number of Chinese researchers ranks among the top in the world. The level of researchers' internationalization is constantly improving. The gap between China and

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developed countries in talent cultivation is constantly narrowing. The number of foreign experts working in China has increased substantially (Wang & Yang, 2016). In the list of highly cited scientists released by Clarivate Analytics in 2020, there were 770 people from the Chinese mainland. The number had surpassed the UK and ranked second in the world. With the reform of science and technology systems and mechanisms, China provided a good ecological environment for scientific and technological innovation, and researchers' capabilities and achievements had greater international influence.

China attached great importance to developing AI industry. Many cities had issued policies to lay out the development of the AI industry. In 2019, 19 provinces released AI industry development plans. In China, AI development focuses on urban construction. Each city played to its own strengths and promoted the deep integration of AI with economic and social development. Although the AI industry in each city had developed to a certain extent, there were still apparent differences among cities. The unbalanced economic development between cities was the main reason for the AI industry development disparity in China (Zheng, 2021). Enterprise scale, industrial structure, human capital and government investment had a significant positive impact on the AI industry's development. The AI industry's development and regional development were mutually influenced. The better the regional economic foundation was, the higher the development level of AI would be. The education level of the city also had a significant effect on AI development (Zhang, 2020). He (2019) thought that regional modernization level and information infrastructure construction had a significant impact on the spatial layout of China's AI industry.

Thus, the development of the AI industry was closely related to the economic level and education level of the city. Previous studies mainly focused on the development status and factors of the AI industry. But few scholars analyzed the regional differences of the AI industry from the perspective of AI talents.

Artificial intelligence (AI) is an important driving force in the new round of scientific and technological revolution and industrial transformation. China must grasp the opportunity to its development. As a high-tech AI is in the stage of rapid development. The lack of talent is the biggest dilemma facing China's AI industry. By 2025, China's AI talent gap will reach 10 million (Chang, 2021). Therefore, talents cultivation was the key to breaking through the bottleneck and realizing the rapid development of AI. Chinese universities had also set up AI teaching and research institutions, focusing on the AI basic research, including basic mathematical science, basic cognitive science, intelligent perception, machine learning, neuromorphic computing, etc. Chinese universities were aimed at cultivating and outputting AI talents with basic research ability.

There were many factors influencing the scientific research ability of researchers, including their own internal factors (gender (Dubbelt et al., 2016), family environment, age, study abroad experience, cooperation network, etc.) and external environmental factors (research environment, evaluation mechanism, industrial development, etc.). Many studies have been carried out on the influencing factors of researchers' research ability, including international mobility (Chen & Xun, 2020), mentoring relationship and cooperative network (He et al., 2009). Wan (2014) interviewed 13 scholars, who were supported by The National Science Fund for Distinguished Young Scholars. The study found that financial support and assessment mechanism was the most important environmental factors affecting the innovation and development of scientific research work. Zhang et al. (2008) thought that as a member of the society, researchers could obtain more and better social capital, who occupied a higher social status and role. Thus, they were easier to realize goals. Zhou et al. (2016) found that social capital would improve the amount of researchers' output. Rational incentive mechanism was also beneficial to the research productivity (Albert et al., 2016). Konstantin Fursov's research found that it was the key to increasing scholar's research productivity that providing more opportunities for scholars to communicate and collaborate (Fursov et al., 2016).

Through previous studies, it was found that among the many factors affecting researchers' scientific research ability, many external factors were derived from the urban development and the institutions' scientific research ecological environment. For example, a perfect industrial production chain can provide more enterprise support, industry-university-research cooperation and application of achievements. A good ecological environment for scientific research can provide a fair evaluation mechanism, cooperation opportunities, and stable fund support. Advanced teaching and research facilities, abundant research funds, superior living conditions and innovative culture were all necessary for researchers to stimulate the innovation initiative.

The paper focused on AI researchers who engaged in basic research (AI basic researchers), and wanted to answer the following questions:

(1) Distribution difference of AI researchers in China;

(2) The differences of AI researchers research output among cities of different economic levels;

(3) The interactive influence of city type and institution type on researchers' research output, and the dominance of influence.

We hope the results could provide evidence-based support and policy suggestions for China's next layout of AI development.

2 Method

2.1 Research design

This study took AI basic researchers as the research sample. This study analyzed the differences of AI basic researchers in China cities of different economic levels, including the number, research direction and research output. What is more, the study also comprehensively analyzed the interactive effects of city-level and institution level on research output. Therefore, the research design is shown in Figure 1.

AI basic researcher mainly referred to talents engaged in basic research in AI field in Chinese universities and research institutes. Due to the large number, the authors were selected as research samples in this study, whose article citation frequency ranked in the top 10% published in the field of AI in WoS over the past decade.

City classification: China's first finance and economics released 2019 city commercial charm list according to their business resources, urban hub, urban agglomeration degrees people activity, lifestyle diversity and plasticity index. The list divided cities into five dimensions, respectively, first-tier cities, new first-tier cities, second-tier cities, three-tier cities, four-tier cities, five-tier cities (Baidu Baike, 2021). Research samples mainly worked in economically developed cities. Therefore, this study divided the cities into first-tier cities[1], new first-tier cities[2] and others according to the city commercial charm list.

[1] First–tier cities: Beijing, Shanghai, Shenzhen, Guangzhou

[2] New first –tier cities: Chengdu, Hangzhou, Chongqing, Wuhan, Xian, Suzhou, Tianjin, Nanjing, Changsha, Zhengzhou, Dongguan, Qingdao, Shenyang, Ningbo, Kunming

Institute classification: According to the Notice on The List of World-class Universities and Disciplines jointly issued by the Ministry of Education, the Ministry of Finance and the National Development and Reform Commission in 2017, there were 42 world-class universities in China (see the attached list). Due to the obvious gathering phenomenon among the researchers, this study divided the institutions into first-class institutions and non-first-class institutions. And first-class institutions included 42 world-class universities and the institutes of Chinese Academy of Sciences.

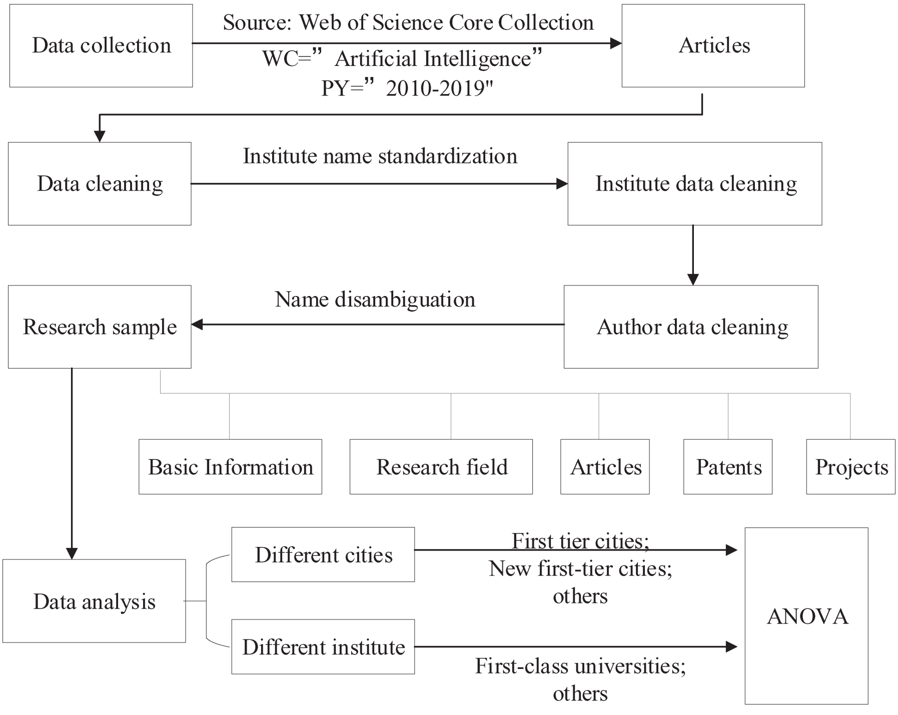

Figure 1 Research design

2.2 Data collection and analysis

Sample: 12,947 highly cited papers (citation frequency in the top 10%) in the AI field were collected in the Web of Science Core Collection from 2010 to 2019. The authors were extracted and disambiguated. Basic information of researchers was obtained from the official website, Baidu, and other websites. Researchers' published papers were extracted from Web of Science and CNKI. Researchers' invention patents were extracted from the National Patent Network and NSTL. Projects undertaken by researchers were obtained from the websites of the Ministry of Science and Technology, the Ministry of Education, the National Natural Science Foundation of China, the National Social Science Foundation of China, local science and Technology departments and local education departments.

We cleaned and disambiguated data through the information of researchers' institutions, cooperative relationships and so on. The study obtained 2,763 Chinese researchers' detailed information in the AI field, including basic personal data, number of published papers, number of invention patents and number of projects undertaken. Their research fields were extracted from their papers, patents and projects.

This study analyzed the AI basic researchers' research output and research fields in different cities. Then, this study explored the differences in research output among different cities through two-factor variance analysis. Finally, the interactive influence of institutions and cities on researchers' research output was explored.

3 Results

3.1 AI basic researchers´ distribution in China

AI basic researchers in China presented an obvious gathered phenomenon. More than 50 percent of AI basic researchers worked in Beijing, Jiangsu, Shanghai, Shaanxi and Hubei provinces, with 17.6% in Beijing, 10.57% in Jiangsu, 7.85% in Shanghai, 7.34% in Shaanxi, and 6.95% in Hubei. In China, the proportion of AI basic researchers in some provinces was less than 1%, like Shanxi, Hebei, Yunnan, Henan, Gansu, Guangxi, Jiangxi, Xinjiang, Guizhou, Hainan and Ningxia. Indeed, the proportion of AI basic researchers in Qinghai, Inner Mongolia and Tibet was zero (Fig.2).

According to the researchers' distribution, the top 10 cities were Beijing, Shanghai, Nanjing, Xi 'an, Wuhan, Chengdu, Hangzhou, Guangzhou, Harbin and Hefei. These cities have the following two characteristics. First, these cities belong to China's key industrial clusters, including the Beijing-Tianjin-Hebei Urban Agglomeration, the Yangtze River Delta, the Greater Bay Area, the Chengdu-Chongqing city cluster and Triangle of Central China. Second, these cities had many AI research universities and institutions, such as Xi 'an, Nanjing, Wuhan, etc., which provided a rich researchers reserve for the development of AI.

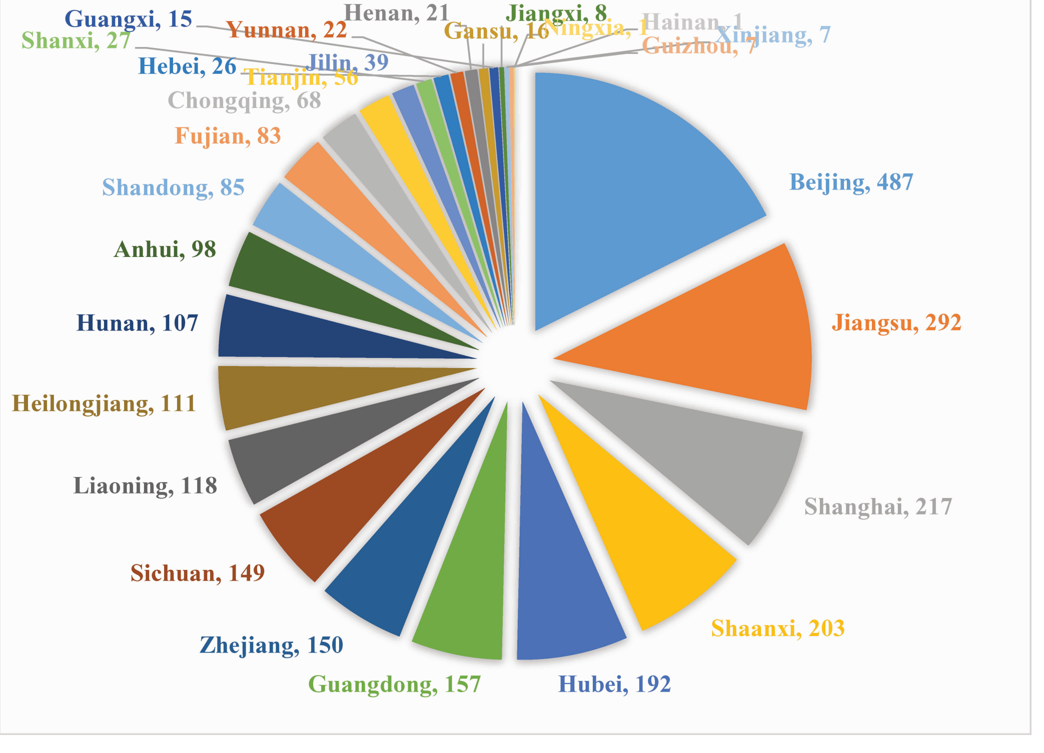

Figure 2 AI basic researchers' distribution in China

3.2 AI basic researchers´ research field in different cities

AI basic researchers were mainly concentrated in information science, mathematics and engineering three fields. As shown in Figure 3, 2763 AI basic researchers mainly study machine learning, data mining, pattern recognition, computer vision, control engineering and theory, algorithm, simulation, distributed computing, etc. According to the survey, 26.63% of researchers focused on machine learning, 21.46% on data mining and 20.63% on pattern recognition.

Based on the research direction cluster analysis of AI basic researchers, it was found that the current research directions were mainly in the basic research (machine learning, algorithm, distributed computing) and the technical research (pattern recognition, computer vision). It could be seen that the AI basic researchers' research direction was closely related to the national key layout and the industry's future development. At present, information technology is increasingly mature. Neural network research is developing rapidly. Machine learning has made new breakthroughs and become a new focus. China and Chinese enterprises both had invested much money to solve the bottleneck technology in AI development. In the AI projects of The National Natural Science Foundation of China from 2015 to 2019, the key research fields mainly focused on machine learning, robotics, neural network, target detection, etc. Chinese technology companies are also increasing investment in chips, algorithms, data computing, machine learning, computer vision, speech recognition and other fields.

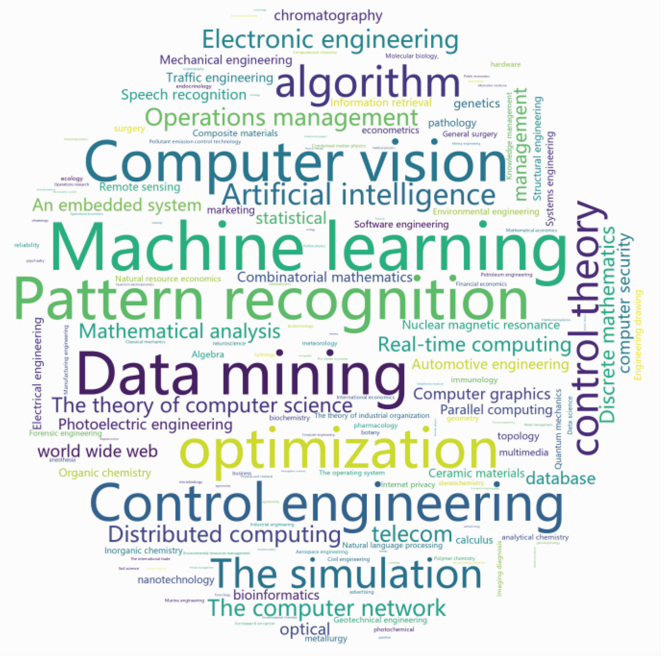

Figure 3 AI basic researchers' research direction

Different cities had different AI development directions and layout, so AI basic researchers' research directions were different. Beijing, Wuhan, Shanghai and Shenzhen all focused on the integration of core technologies and industries to promote the development of the whole industrial chain. And those cities all focused on breakthroughs in chips, sensors, computer vision, voice processing, robotics and so on. Fujian, Suzhou, Tianjin, Zhengzhou and Xi 'an have promoted the transformation of achievements to build smart cities based on big data technology, including smart medical care, smart manufacturing, smart terminals and smart transportation.

As shown in Table 2, researchers in first-tier cities were more focused on machine learning, computer vision and pattern recognition. And the researcher's proportion was significantly higher than that in new first-tier cities and other cities. In the direction of data mining and control engineering, the researcher's proportion in new first-tier cities was slightly higher than in first-tier cities and other cities. In the direction of algorithm, the researcher's proportion in first-tier cities was significantly lower than that in new first-tier cities and other cities.

Table 1 The distribution proportion of AI basic researchers in different cities

Research direction	first–tier cities	new first–tier cities	other cities
Machine learning	37.50%	28.98%	28.10%
Computer vision	31.54%	21.50%	13.19%
Pattern recognition	29.21%	24.17%	18.68%
Data mining	24.30%	25.98%	24.65%
Control engineering	17.99%	19.69%	17.11%
Simulation	14.49%	8.27%	8.48%
Algorithm	7.24%	14.02%	12.72%

3.3 Research output difference of AI basic researchers in China different cities

In China, AI industry has achieved certain development in different cities. In terms of published papers, Beijing, Jiangsu, Guangdong and Shanghai were the most active provinces. Cheng-Yu District and Triangle of Central China also showed the regional vitality of AI development. At the same time, according to the industrial positioning and resource characteristics of each city, the AI development showed its own advantages in different cities.

As can be seen from Table 2, 856 AI basic researchers worked in first-tier cities, 1270 AI basic researchers worked in new first-tier cities, and 637 AI basic researchers worked in other cities. AI basic researchers in first-tier cities published 166.765 papers on average, invented 20.874 patents on average and undertook 4.093 projects on average. AI basic researchers in new first-tier cities published 157.025 papers on average, invented 24.714 patents on average, and undertook 3.527 projects on average. AI basic researchers in other cities published 132.137 papers on average, invented 16.199 patents on average, and undertook 3.047 projects on average.

Table 2 Research output of AI basic researchers in China different cities

Cities	Number of researchers	Papers	Patents	Projects
First–tier	856	166.765	20.874	4.093
New first–tier	1270	157.025	24.714	3.527
Other	637	132.137	16.199	3.047

In order to further explore whether there were significant differences in the research output of AI basic researchers in cities of different levels, this study conducted variance analysis by SPASS.

(1) Paper output

In terms of the impact of city type on paper output per capita, there was no significant difference (P=0.181) between first-tier cities (M=166.765) and new first-tier cities (M=157.025). The number of papers per capita in first-tier cities and new first-tier cities was significantly higher (P < 0.01) than that in other cities (M=132.137). According to analysis results, we found researchers who worked in first-tier cities and new first-tier cities had more paper output than those who worked in other cities. So, the economic level of the city affected the researchers' paper output. But the influence tends to weaken with sustained economic growth. When the economy reached a certain degree, the effect was no longer significant.

(2) Patent output

The number of patents per capita in new first-tier cities (M=24.714) was significantly higher (P=0.045) than that in first-tier cities (M=20.874). The number of patents per capita in first-tier cities (M=20.874) was significantly higher (P=0.043) than that in other cities (M=16.199). The results showed that there were significant differences in patents per capita among different cities. AI basic researchers worked in new first-tier cities produced the most patents per capita. New first-tier cities had more innovation vitality and development potential compared with first-tier cities, and had better economic conditions and foundations compared with other cities. It could be seen that the better the economic conditions, the higher the patent output of researchers. To some extent, the economic level of cities affected the patent output of researchers. However, when the economic level reached a certain level, other factors would become the key to affecting the patent output of researchers, like city development potential and enterprise vitality.

(3) Research projects

The number of projects undertaken per capita in first-tier cities (M=4.093) was significantly (P<0.01) higher than that in new first-tier cities (M=3.527). The number of projects undertaken per capita in new first-tier cities was significantly higher (P<0.01) than that in other cities (M=3.047). The results showed that there were significant differences in the number of projects undertaken per capita among different cities. The higher the economic level was, the more projects were undertaken by researchers. The economic level of cities had a positive impact on the number of projects undertaken by researchers.

Through the analysis, the study found there were differences in the research output of AI basic researchers worked in different cities.

3.4 The impact of institutional level on AI basic researchers´output in different cities

In this study, 1376 AI basic researchers worked in first-class institutions and 1387 worked in non-first-class institutions. Researchers from first-class institutions published 179.913 papers per capita, invented 20.880 patents per capita, and undertook 4.283 projects per capita. Researchers from non-first-class institutions published 124.038 papers per capita, invented 20.311 patents per capita, and undertook 2.829 projects per capita (Table 3). Through variance analysis, it was found that the researchers' papers and projects in first-class institutions were significantly higher than those in non-first-class institutions. However, the per capita number of invention patents of the two groups was basically the same.

Table 3 Research output of AI basic researchers in China different institutions

Institutions	Number of researchers	Papers	Patents	Projects
First–class	1376	179.913	20.880	4.283
Non–first–class	1387	124.038	20.311	2.829

It could be seen that first-class research institutions were conducive to improving the paper output and project output of researchers. In order to further explore the interaction between the type of institutions and cities on the research output of AI basic researchers, this study further analyzed whether there were significant differences in the researchers' output in different economic cities under the same level of institutions.

(1) AI basic researchers´ output of first–class institutions in different cities

Based on the AI basic researchers of first-class institutions, this paper analyzed whether there were differences in the research output in different economic cities. 1,376 AI basic researchers worked in first-class institutions. There were 446 researchers who worked in first-tier cities, with 186.74 papers per capita, 22.55 patents per capita and 4.67 projects per capita. There were 691 researchers who worked in the new first-tier cities, with 189 papers per capita, 22.71 patents per capita, and 4.34 projects per capita. There were 239 researchers who worked in other cities, with 160.27 papers per capita, 17.66 patents per capita and 3.78 projects per capita.

The paper output, patent output and project undertaken by AI basic researchers in different cities were analyzed by variance analysis. The results showed that there were no significant differences in paper output ($P=0.102$) and patent output ($P=0.155$) among the researchers worked in different cities. In terms of undertaking projects, there were significant differences. Researchers who worked in first-tier cities undertook more projects than those who worked in other cities ($P=0.005$). In comparison, there was no significant difference between first-tier cities and new first-tier cities ($P=0.18$), and new first-tier cities and other cities ($P=0.06$).

(2) AI basic researchers´ output of non–first–class institutions in different cities

Based on the AI basic researchers of non-first-class institutions, this paper analyzed whether there were differences in the research output in different economic cities. 1,387 AI basic researchers worked in non-first-class institutions. There were 410 researchers who worked in first-tier cities, with 145.40 papers per capita, 19.01 patents per capita and 3.48 projects per capita. There were 579 researchers who worked in the new first-tier cities, with 126.36 papers per capita, 26.85 patents per capita, and 2.73 projects per capita. There were 398 researchers who worked in other cities, with 102.23 papers per capita, 14.7 patents per capita and 2.29 projects per capita.

The paper output, patent output and project undertaken by AI basic researchers in different cities were analyzed by variance analysis. The results showed that the p-values of paper output, patent output and project undertaken of AI basic researchers from different cities were all less than 0.001. There were all significant differences.

Combined with the 3.3 result, the high-quality platform provided by first-class institutions made up for the disadvantage caused by the city's economy. For the researchers who worked in first-class institutions, the impact of city's economy on research output was significantly reduced. The difference between papers and patents was not significant.

For the researchers worked in non-first-class institutions, there were significant differences in all three aspects of research output. Compared with the results in Section 3.3, the difference was increased among different cities, the difference between first-tier cities and new first-tier cities was also significant in paper output.

4 Discussion

AI basic researchers in China presented an obvious phenomenon of aggregation. The research of Scott (1986) showed that high-tech in the growth center would form a huge radiating force of talent gathering, thus making the social interaction more intense. Therefore, the gathering of talents promoted more frequent and effective social and economic exchanges, and reduced the transaction cost and information cost of the economic system. In China, AI basic researchers were mainly concentrated in cities with key state support for the AI industry development and cities with many universities specializing in AI research. More than 50 percent of AI basic researchers were concentrated in Beijing, Jiangsu, Shanghai, Shaanxi and Hubei provinces. It was mentioned in the Report on Talent Development in Artificial Intelligence Industry issued by the Ministry of Industry and Information Technology that the Beijing-Tianjin-Hebei Urban Agglomeration, Yangtze River Delta, Greater Bay Area and Chengdu-Chongqing city cluster were the main focus areas of AI talents resources in AI industry. These regions accounted for 90.9% of China's total talent demand and 82.9% of China's total talent supply (Ministry of Industry and Information Technology, 2019).

In this study, it was found that there were certain differences in the scientific research output of AI basic researchers who worked in cities with different economic levels. In the case of a low level of city development, there was a significant difference in research output between different cities. But with the development of the city economy, the difference would gradually weaken or even disappear. Wang Ruoyu found in his research that with the growth of scientific researchers in universities, the impact of economic factors on them weakened, but the impact of public service increased. It could be seen that the economic influence on the researchers' growth showed a trend of strengthening first and then weakening. In this study, First-tier cities and new first-tier cities were significantly higher than the other cities in research output. Thus, in China, compared with other cities, first-tier cities and new first-tier cities were more conducive to scientific research. Mainly in economically developed cities, the government gave more policies and programs to support. It not only provided more opportunities and platforms for researchers to study and grow, but also attracted more excellent researchers from other cities. Zhang et al. (2021) also found that economically developed provinces, such as Beijing, Shanghai, Jiangsu and Guangdong, had sufficient funding for scientific research, which had a strong promotion effect on the basic research output of researchers. The city's own economic vitality was the main factor of researchers' flow in China. The inflow of researchers further enhanced the city's economic vitality and sustainable development ability (Sun, 2018).

Further analysis showed that there was no significant difference in paper output between first-tier cities and new first-tier cities, but there was a significant difference in patent output and project undertaken. Researchers who worked in new first-tier cities obviously had more patent output than those who worked in first-tier cities. New first-tier cities possessed a lot of high technology industrial parks and entrepreneurship centers, such as Suzhou, Chongqing, Wuhan, Hangzhou and so on. These cities made great efforts to attract innovative enterprises to join, promote the integration of industry and research, which was more conducive to the patent output. Sub-provincial cities such as Jinan, Chengdu and Changsha had formulated AI action plans to support the development of the AI industry. Shandong had formulated a special action plan to speed up the deep integration of AI with education and manufacturing.

Researchers who worked in first-tier cities undertook more projects than those who worked in new first-tier cities. Because first-tier cities have more project funding from the state and government. For example, Beijing, as the capital with highly concentrated educational resources in China, where researchers had far more opportunities to undertake national and provincial projects than other cities.

Therefore, in the development process of AI industry, it was necessary to determine the development orientation of cities at different levels, so that they could play different roles in the AI industrial development. First-tier cities should provide a good cooperation environment and opportunities for researchers, and provide more projects and infrastructure support. The new first-tier cities should further lead innovative enterprises, enhance the creativity of researchers, and play a radiating and driving role in the surrounding areas.

The high-quality platform of the institution would make up for the disadvantages caused by the city's lower economy. Compared with non-first-class institutions, the research outputs of AI basic researchers who worked in first-class institutions were not significantly different among different cities. The position of the first-class institution was to build a comprehensive university with world competitiveness. They had advanced research facilities and a perfect research evaluation system. They were devoted to training basic researchers and helping the basic researchers improve their innovation ability. National and local governments both gave more projects and funding to them. Therefore, even in non-first-tier cities, such researchers still had considerable development platforms and opportunities. On the contrary, for AI basic researchers in non-first-class institutions, the impact of city development on their research output was very important.

It could be seen that the growth of AI basic researchers in China was closely related to the city economic development, especially those researchers who worked in non-first-class institutions. The development and deepening of AI basic research not only required the investment of government funds, but also required in-depth cooperation with enterprises to form a complete industrial chain from basic support, core technology to industrial application. Therefore, more development platforms and opportunities should be provided to these groups. The government should be used as a bridge of communication to deep cooperation between institutions and local AI enterprises. And local resources should be rationally allocated. Finally, a good scientific research ecological environment should be provided for the growth of local AI basic researchers.

5 Conclusion

Researchers are the main force of scientific and technological innovation. It is a question worth more consideration that providing a good innovation ecological environment for researchers. Good innovative ecological environment could stimulate their innovation vitality to the greatest extent. In the development of the Chinese AI industry, different cities have their own advantages and positioning. So, cities should make full use of their own advantages, do a good job in talent management and service. This should be encouraged to build a trans-regional innovation cooperation network. First-tier cities and new first-tier cities should provide infrastructure, capital and researchers for the industrial development of neighboring cities to support the development of AI industry in other cities. The government needs to support universities, institutes, and community colleges to build open platforms for scientific research and innovation jointly. Thus, the different cities and institutions could give full play to the advantages of researchers, carry out industry-university-research collaborative innovation, and work together to tackle key and core technologies.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

Acknowledgments

This work was supported by a grant from:

1. "Research on Peer Review Method Model in Big Data Environment", National Social Science Foundation of China (19BTQ082).

2. "Research on the Discovery of Disruptive Technology Research Teams", General Program of Innovation Research Fund of Institute of Scientific and Technical Information of China (MS2021-08).

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Attached list：42 world–class universities in China

36 class A

Peking University,
Renmin University of China,
Tsinghua University,
Beijing University of Aeronautics and Astronautics,
Beijing Institute of Technology,
China Agricultural University,
Beijing Normal University,
Central University for Nationalities,
Nankai University,
Tianjin University,
Dalian University of Technology,
Jilin University,
Harbin Industrial University,
Fudan University,
Tongji University,
Shanghai Jiaotong University,
East China Normal University,
Nanjing University,
Southeast University,
Zhejiang University,
University of Science and Technology of China,
Xiamen University,
Shandong University,
Ocean University of China,
Wuhan University,
Huazhong University of Science and Technology,
Central South University,
Sun Yat-sen University,
South China University of Technology,
Sichuan University,
Chongqing University,
University of Electronic Science and Technology of China,
Xi 'an Jiaotong University,
Northwestern Polytechnical University,
Lanzhou University,
National University of Defense Technology

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Northeastern University,
Zhengzhou University,
Hunan University,
Yunnan University,
Northwest A&F University,