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Transfer of Science and Technology Achievement for the development in China: The case of Independent Innovation Pilot Area of Hefei-Wuhu-Bengbu, Anhui Province

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Abstract

Hefei-Wuhu-Bengbu independent innovation pilot area is the first "comprehensive reform" pilot area with the theme of "independent innovation". It has made remarkable improvement in the regional innovation system construction and also achieved important results in scientific and technological domain. The main objective of this study is to identify the characteristics, routes, policies and roles of different institutions for the transfer of S&T achievements. By in-depth review of policies in the pilot area with respect to different stakeholders, we recognized four main existing models that facilitated the transfer of S&T achievements in the pilot area. These models are – government policies that promote S&T achievements, market oriented policies that linked market demand with the transfer of S&T achievements, production study research model that strengthen collaboration between university (resources) and industries (capital) for social development, intermediary service agencies that linked government with general public for technology diffusion in the society. We pointed out the existing problems and give some recommendations to the policy makers for the future development of independent innovation pilot area.

Keywords: Hefei-Wuhu-Bengbu, Independent innovation, Transfer of Science and Technology Achievements, Innovation model.

Introduction

At present, global competition is reflected through the science and technological strength. All the nations and regions are using science and technological (S&T) progress and innovation as the fundamental force for the socio-economic development (Audretsch et al., 2014). However, without technology transfer the achievements cannot be industrialized and create social impact (Macho-Stadler and Pérez-Castrillo, 2010). To improve the efficiency of those achievements technology transfer of a nation and region, become a severe challenge in front of modern researchers.

In 2008, based on high quality of educational resources, Anhui provincial party and the local government responded to the strategy of "*Rise of Central China*", which is forward by the Chinese central government. Henceforth, the first independent innovation comprehensive reform pilot area i.e. Hefei-Wuhu-Bengbu (HWB) was established. HWB independent innovation pilot area has played an important role in the development of regional economy and has become important hub for the development of Anhui province**.** The rapid development of this pilot area is witnessed by the S&T and industrial achievements. In first two quarter of 2014, the gross output value of high-tech industries in Anhui province reached up to 762.31billion RMB while the added value reached

189.41 billion RMB, which was an incredible increase of 17.1% and 15.6%respectively. The gross value of exported high-tech productions of the province reached 3.33 billion US dollar, the growth increased by 1.6 times as well. The total number of applied invention patent was 23,770, which ranked 6thin the whole nation. The growth increased by 76.3%compared to the previous years. The proportion of invention patent exceed utility model for the first time in the history of Anhui province. The structure applying invention patent was further optimized.

The aim of this paper is to find out how the policies of different stakeholders that influenced the transfer or S&T achievements.

Background of establishing HWB independent innovation pilot area

The State Council officially issued the Opinion of the Central CPC and also promoted Middle China's rising on April 15th, 2006.This put forwarded the strategy of developing six central provinces namely Anhui, Henan, Hubei, Hunan, Jiangxi and Shanxi. In 2007, 17th National Congress of the CPC clearly announced to enrich China's capability for independent innovation and become an innovative country. This was the fundamental concept of nation development policy and a crucial link in improving the overall national strength. In the beginning of 2008, State President Hu Jintao inspected Anhui province and pointed out that Anhui province has rich educational resources and advanced S&T strength. Even in some fields it has a leading position in China. In this aspect, Anhui province has its own advantages. Thus, independent innovation should make more achievements for Anhui province.

In response to China's development strategy of Promoting Middle China's rising and implement the important speech of the 17thNational Congress of the CPC, the CPC Anhui provincial committee and provincial government decided to setup HWB Independent Innovation Comprehensive Reform pilot area. The aim was to explore the effective ways of the development, to accelerate the economic development and upgrade industrial structure that drives the development of Anhui province as well. On October 17th, 2008, pilot area's construction was started when the officials have issued two documents: 1. Suggestions on the implementation2. Counter measures about implementing the work of comprehensive reform pilot area.

HWB pilot area with "independent innovation" as its theme, integrates innovation with the resources of the three cities. It was based on the principle of "co-construction". The concern government encouraged it to become complete regional innovation system as soon as possible. Therefore, the independent innovation pilot area became an innovative strategy highland in Middle West of China. In short, this pilot project is known as "six six five five". It mainly included investment and finance policy reform, institutional reform, innovation and industrial project reform, innovative environment optimization project reform, innovation platform and connection reform, marketing and operational mechanism reform(Wei and Huang, 2010).

Elements of innovation in HWB pilot area

The regional economic strength of three cities has a leading position in Anhui province as well as in the nation. The geographical locations of three cities are in the middle, south and north of Anhui province respectively. All of the three cities enjoy rich S&T resources. Especially Hefei has national S&T innovation trial city that relies on eighteen scientific research institutions and national key universities and approximately thirty enterprises technology centres. The specific innovative elements of three cities are leading industries, innovation oriented enterprises, national significant scientific project, Research and development institutions, Colleges and universities, and innovative platform as given in Appendix-I.

Classification and Characteristics of S&T achievements

The S&T achievements are attained by observing test and dialectical thinking. These achievements should have academic or practical significance through identification (Chinese Academy of Sciences, 1986).S&T achievements can be divided into three types that are basic research, applied research and soft science achievements. Soft science achievements are attained by dialectical thinking, so it is excluded from the transfer of research achievement. Thus, S&T achievements only are divided into basic research and applied technology achievements.

Article 2 of the law is promoting the transfer of S&T achievements (1996).It refers to the activities whose objects have practical value to S&T research and development in order to improve productivity level - like trials, development, application and extension till the formation of new product, new craft and new material. Legal Affairs Office of the State Council published law of promoting the transfer of S&T achievements in June 2014. The second exposure draft continuously adopted this definition. The definition is made from three micro-levels that are transfer objects, activities and results. However, from macro-levels the transfer of S&T achievements is a systematic process which consists of the supply, transfer and demand to S&T and environment system.

The transfer of S&T is the process that develops and utilizes potential of commercial value. It has four characteristics 1) interest driving, 2) systematization 3) stage and 4) risks.

1. Interest driving: This process is not spontaneous. It needs the combined effect of inventors or investors and driving force of market demand. It has the potential for commercial value of S&T achievements that attracts behaviour of subject. Then only they can attain economic benefits. We can say that characteristics of interest driving are the principal characteristics of S&T achievements transfer and the fundamental force.

2. Systematization: From the perspective of macro-levels, as a systematic project, certainly there are closer relationship between S&T transfer, government, scientific research institutions, universities, colleges, enterprises and intermediary. The process is affected by country's economy, politics, culture and law.

3. Stage: The characteristics of systematization decide its characteristics of stage to a certain extent. Generally, it includes assumption, research and development (including medium trial), commercialization and industrialization stage. Excluding the assumption stage all other stages needed the coordination between government, research institutions, universities, colleges, enterprises and intermediary. At each stage, each subject's participation levels are different.

4. Risks: It is the process that innovate new technologies and new products. So, it has a lot of uncertainty that the product or technology cannot fulfil the market demand and capitalized cost is too high as well. Those risks related to technology, market and business might cause heavy loss. As a result, the driving force of S&T achievements transfer is weakened and restricts smooth development of these processes.

Routes for transfer of S&T achievements

In the recent past, Central and local government pays attention for the transfer of S&T achievement. Generally those routes can be divided into two types, direct routes and indirect routes.

1. Direct routes: Direct routes are mainly embodied in three aspects. To be specific, firstly, the integration model of enterprise's research and production. Enterprise independent research and development institutions mainly based on practical production of enterprise and combine with production demand to reform technology and do independent innovation. These types of S&T achievements are closely rely on the enterprise production with timely transfer and have obvious benefit. It is a direct route with remarkable result. Secondly, the independent developing industry model by colleges, universities and scientific research institutions. These institutions have key position of producing knowledge. The researchers of them have rich knowledge accumulation and a number of various S&T achievements. Among all market-oriented applied developing researches

have high market dynamics. Colleges, universities and scientific research institutions usually develop new high-tech industry or join company in the form of technology investment to carry out their work independently. Thirdly, the model of introducing technology is used to form industry. Introducing advanced technologies or products from abroad or other regions can be quickly transformed or developed according to the need. This way new technology or products will be formed. That realizes huge accumulation of productivity. Gradually industries will be formed, which effectively support rapid development.

2. Indirect routes: Mainly there are two indirect routes for technology transfer. Firstly, the cooperation model of production, study and research. For Innovation, enterprises collaborated with colleges, universities and scientific research institutions which will lead to improved competitiveness as well as promote regional economic development (Yun, 2013).Secondly, the constructive model of innovative platform base. Here new high-tech development zone, S&T industrial park is established combined with innovative public service centre of S&T and innovation centre to develop new high-tech industries. Then it promotes technology transfer. Those zones or parks has established with multi-party cooperation relationship with colleges, universities, research institutions and enterprises. Therefore, they can effectively integrate funds, talents and technology. So it is effectively promotes the technology transfer.

Different Models of Innovations

The economic development of Anhui province has rapidly improved and the GDP ranked 13thin the whole nation in 2013 after the establishment of independent innovation pilot area. Moreover, GDP was a step away toward 2 trillion RMB clubs and regional innovation capability was greatly strengthened (National Bureau of Statistics, 2014). Ministry of Science and Technology's annual report of regional innovation capability of China 2012 showed that rank of Anhui province of regional innovation capability jumped from 15thto 9thin the whole nation (Wanjia Real State, 2013).Technology transfer has made remarkable achievements. The amount and proportion of patent applications and grants ranked 1stin the middle six provinces and 50.7% and 54.2% respectively in the whole Anhui province. It won National Science and Technology award and Anhui province's Science and Technology award as well. Transaction volume of technological market is more than scale of billions of RMB and ranked 2ndin central six provinces (Anhui Provincial Bureau of Statistics, 2014).

The economic benefit of S&T achievements can be attained only by technology transfer. Technology transfer model of Anhui province mainly governed by government. The pilot area actively explored mixed model of technology transfer and innovation such as S&T innovation, production study research cooperation, independent enterprises, market-driving and introducing technology.

Government policy model for S&T achievements

Government mainly used administrative channel for the technology transfer in national level or provincial level like intermediary agencies of S&T, S&T service system (Ningning and Jiji, 2012). The pilot area mainly adopted policy to promote technology transfer. Firstly, innovation of personnel policy should be demonstrated in details. If S&T personnel belong to college or university or scientific research institution and wants to establish an enterprise in pilot area that can facilitate the transfer of achievements, then the enterprise will attain 50% registered capital and highest subsidized capital of two billion RMB. Secondly, establishment of business with the industrial policies. To explain, if the new high-tech industrial project is established in pilot area approved by state, then they can attain 50% of state funds and the highest subsidized capital of10 billion RMB. If the projects are approved by province, they can attain 10% investing capital of project, and the

highest subsidized capital reaches ten billion RMB. Thirdly, innovation of fiscal and taxing policy: the new high-tech products which have some added-value, then tax belongs to the city or province, after the identifying date. In three years, enterprise can get a reward. Fourthly, innovation of scientific, technological and financial policies which mainly are embodied at two aspects 1) Supporting financial institutions and guarantee the institutions to develop intellectual property mortgage, the pledge of stock right and movable property mortgage, new type mortgage loan. 2) It is required to clarify that scientific research institutions and inventor have the right of disposal for S&T achievements. The right of disposal means S&T achievements can take a stake in enterprise in the form of price and attain certain benefit. Fifth, innovation of S&T public service policy: the highest subsidy provided for the new constructed public technology research and development platform, testing and experimental platform, information platform, technology transformation platform in pilot area reaches five billion RMB. To the enterprises that operated by marketization, each year since three years after establishing, selected superior enterprises can attain 20% of the operating cost as subsidy, according to the service performance. At present, the three cities have more than 10 scientific and technological innovation bases and institutions, which provide a good service platform for technology transfer. A series of innovative measures provide power and guarantee technology transfer from independent innovation pilot area.

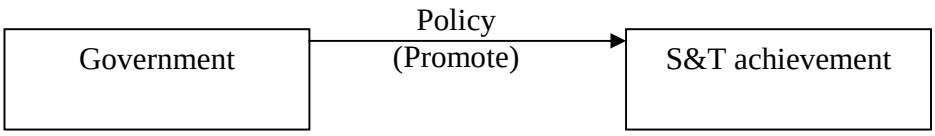

Figure 1: Government model of S&T achievement

Market driven transformation model for independent innovation

Market demand greatly influences transfer of S&T achievements. The change of industrial structure and economy plays an important role to S&T research and development and transfer of achievements. After establishing independent innovation pilot area, Anhui province setup Wan-Jiang urban belt – an industrial transformation demonstration area. According to the State's strategic conception it can be stated as "Change of Economic Development Mode, Impelling Optimization and Upgrading of Industrial Structure". It helps in the regional economic development with two regions HWB and Wan-Jiang urban belt. The industrial transformation area by Wan-Jiang urban belt included nine cities (Hefei, Wuhu, Maanshan, Tongling, Anqing, Chizhou, Xuzhou, Xuancheng and Liuan), which radiate in the whole Anhui province and joined Yangtze River Delta. Hefei and Wuhu city, which leads the development of HWB independent innovation pilot area and demonstration area of Wan-Jiang urban belt, become two economic growth pole promoting Anhui's sharp rise. Wan-Jiang urban belt owns Maanshan Iron Steel(Maanshan), Cherry Automobile (Wuhu), Jianghuai Automobile (Hefei), Xingma Automobile (Maanshan), Non-ferrous Metals (Tongling), Petrochemical (Anqing), and Conch Cement (Wuhu). The area has 80% automobile enterprises, 83% iron steel enterprises, 71% non-ferrous metal smelting enterprises and 92% household appliance production enterprises of the whole Anhui province. The leading role of automobile, iron steel, non-ferrous and household appliance industries become increasingly prominent in the Anhui province. It needs more research and development to support HWB pilot area and Wan-Jiang urban belt for further advancement which will play a prominent role to promote technology transfer.

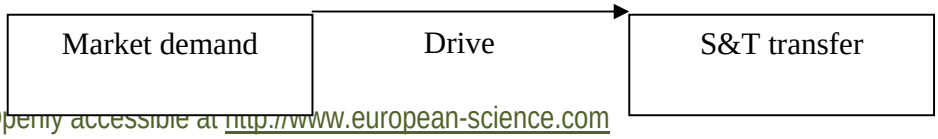

Figure 2: Market driven S&T transfer model

Production study research model

Production study research cooperation combined resources with industrial capital. It is an effective way to combine innovation with social development. This model is common in the world especially in developed countries. It is based on technological contract, guided by market and policies of the government which is the driving force to carry out the technical innovation activities. It also help to establish technical innovation platform in the pilot area with all kinds of innovative enterprises emerging one after another, enjoys rich scientific and educational resources. The pilot area is market oriented and focuses on enterprises to carry out S&T activities and strengthen the collaboration between universities and enterprises. The main objective is to promote construction of technology transfer centre in universities and research institutions that is supported by government. The CPC Anhui provincial committee, provincial government and Hefei municipal committee have taken successful examples of Silicon Valley (USA), Xinzhu (Taiwan) and Tuskuba (Japan) high-tech parks and zones. Research institution of University of Science and Technology of China (USTC), become important benchmark for the regional innovation cluster. The Institute of Advanced Technology (IAT) aims to integrate four domains i.e. S&T, education based on fundamental and applied research, R&D and financial investment. IAT has joint venture with Anhui provincial government for the construction of advance technology research institutes, Chinese Academy of Sciences for systemic achievements, collaboration with home research institutes and also in abroad. The advanced technology research institution has realized to integrate industry incubating model which collect talents, technology, industry and financial service that helps to improve coordination in the pilot area by polices, production, study and integration. Thus, the advanced technology research institutions become a leading institution to promote and improve the efficiency of transfer of S&T achievements in HWB pilot area.

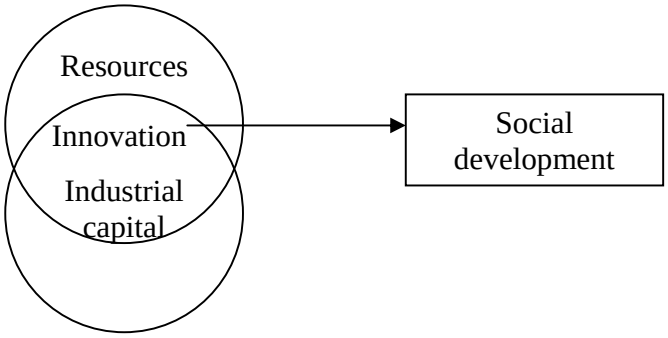

Figure 3: Production study research model for innovation and social development

Role of intermediary agencies in S&T transfer

Intermediary agency is the specialized service agency that helps in technology diffusion in the society. It is an important part of national innovation system and has a key point in transfer of S&T achievements. After establishment of independent innovation pilot area, technology intermediary service agencies have arisen as an inseparable part. For example, trading center of S&T achievements in Anhui province (Hefei), public service center of S&T innovation in Hefei and Wuhu city, technology transformation center in Bengbu city and exhibition and trading center of national patent technology (Hefei, Wuhu, Bengbu). Those service agencies fully accept all kinds of

customers' application such as enterprises, colleges, universities and scientific research institutions. They comprehensively developed services to build a bridge by which government and public can interact and exchange information. In HWB pilot area, if famous innovation consultant agencies want to establish their branch offices they will get one time subsidy. Innovation and industrial cluster area service agencies which operate in market independently will get 20% operating cost as subsidy after three years of the establishment according to their performance. The intermediary agencies help to improve the efficiency of transfer of S&T achievement in pilot area.

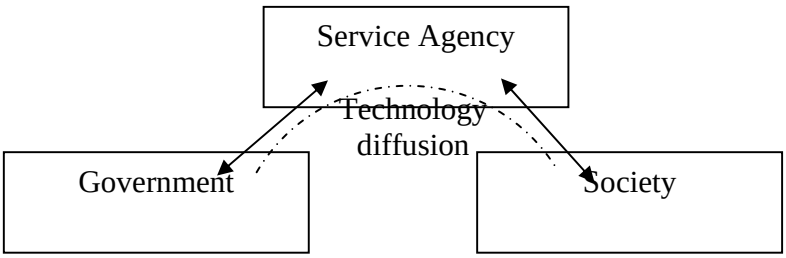

Figure 4: Intermediary agency model

Conclusion and recommendation

From the above study, we can conclude that HWB independent innovation pilot area has played an important role for the economic growth of three regions as well as the whole nation. With the establishment of this area coordination between government, universities, and research institute is strengthen. The resources of three cities utilized at its best. Still the efficiency of transfer of S&T achievements is not reached up to the standard of developed countries. It is reported that the rate of transfer of S&T achievements can bring economic benefit (Hongli et al., 2003). Presently it contributes only 30% to 50% of economic growth. While for developed countries it already has reached 50% to 70% (Yijun, 2003). Establishment of pilot area, have made remarkable achievements in industrial development and technological innovation. According to statistics, the efficiency rate of transfer of S&T achievements reaches above 45% which is higher than the national average level, but still has certain gap compared with developed countries. There are some problems, such as unbalanced regional development, small industrial scale, imperfect industrial cluster development, lacking of innovative capability, core technology and low specialization degree of S&T intermediary service agencies. So, for the future development of the technology transfer in the pilot area, we can list the following recommendations:

1. Improve system and mechanism - after establishment of pilot area, six items of reform were considered for the future development. These are attract new talents, strengthen research funds and infrastructure, establishment of public service platform, fiscal subsidies, long-term loan and tax preference and supporting polices. Government, colleges, universities, scientific research institutions and enterprises should pay attention to cultivate talents and intermediary organizations, which are specialized in technology transfer. In the pilot area, three cities should coordinate with each other to integrate colleges, universities, research institutions, enterprises and financial institutions to construct a technological and financial support system. Public service agencies in pilot area needs to identify nature of service provided, market position and summarize operational model of the developed countries in order to provide more convenient, fast and specialized technology transfer.

2. Regional development - Anhui Provincial Party Institute and the Government of Anhui Province needs to establish development plan of pilot area on the basis of regional industries.

They should promote cooperation in the field of infrastructure, industrial coordination, market development, resources sharing and regional innovation. Regional development and competitiveness should be improved with harmonious coordination. Three cities should formulate policies for industrial promotion according to their own leading industries. The pilot area should construct superior industries with a high-level of technology, great economy scale and strong independent innovation.

3. Emphasize on innovation of small and medium-sized enterprises - at present, there are a number of technological research and development institutions in pilot area. But most of them are large scale state-owned or private-owned enterprises. Development of small and medium size enterprise**s** is weak. In future, it is important to combine the innovative elements with small and medium-size enterprises in order to strengthen their technological innovation capabilities. It will expand channels and ways of technology transfer and improve efficiency.

4. Protection of intellectual property rights - from general point of view, there is no clear intellectual property strategy in the pilot area. The sense of protecting intellectual property is weak for a lot of enterprises. Application for patent and other protection work of intellectual property rights are not enough focused by enterprises. Though, according to statistical information published by website of Anhui intellectual property office shows that the number of application patent and patent granted has increased in past few years. The number of application patent was 6,653 in 2008 that become 46,500 in 2013. While the growth reached approximately six times. The number of patent granted was 2,507 in 2008 that increase in 24,152 in the year of 2013. The growth reached approximately nine times [10]. In recent years professional patent agencies have great market demand. It is required to establish a protection system of intellectual property right, so that protecting work of intellectual property right will be more effectively going on in the future.

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Appendix-I

The Integration of Innovative Elements in the Three Cities of Hefei-Wuhu-Bengbu independent innovation pilot area

Innovation elements	Cities		
	Hefei	Wuhu	Bengbu
Leading industries	electronic information industry, new material industry, energy saving and environmental industry, software industry, public security industry, equipment manufacturing industry, automobile industry, household appliances industry	New energy industry, animation industry, automobile and parts industry, new material industry, household appliances industry, equipment manufacturing industry	photovoltaic industry, biotechnology industry, new material industry, equipment manufacturing Industry, fine chemical Industry, electronic information industry
Innovation oriented enterprises	China Anhui Jianghuai Automobile Co., Ltd, Gree Electric Appliance Inc.（Hefei）,Longping High-Tech, IFLYTEK Co.,Ltd, Hefei Fengle Seed Co.,Ltd, Hefei Meyer Optoelectronic Technology Ing., Guozhen Environment Company, Anhui Sun Create Electronics Co., Ltd., Hefei BOEOptoelectronics Technology Co. Ltd.,	Chery Automobile Group, Conch Cement Group, Golden Bull Group, Token Technology Co,. Ltd, Xinlong Electrical Appliances Co,. Ltd, Hengsheng Heavy Machinery Manufacturing Co., Ltd, Shengli Braking Co., Ltd., Xinyi Group, TRUCHUM Investment Group, Solar tech Energy	BBCA Group, COFCO Biochemical Co.,Ltd., Bayi Chemical Industry Co.,Ltd, Globe Pharmaceutical Co., Ltd, Tianrun Chemicals Co., Ltd, Hofo Mechanical and Electrical Co., Ltd, Pule New Energy（Bengbu）, Double Circle Electronics Group Co., Ltd, etc. nearly

	Anhui Wantong Technology Co. Ltd etc. nearly 700 companies	Corp., Fushan Heavy Industry, etc. nearly 300 companies	100 companies
National Significant Scientific Engineering project	National Synchrotron Radiation Laboratory phase I/II engineering project, HT-7U Superconducting Tokamak Nuclear Fusion Experimental System, EAST, Steady High Magnetic Field Laboratory		
Research and Development Institutions	Government R&D Institutions: National Pressure Vessel and Pipeline Safety Engineering Technology Centre, National Environmental Optics Monitoring Instrument Engineering Technology Research Center etc. R&D Laboratory in Colleges and Universities : synchrotron radiation national laboratory, microscale national laboratory, National Key Laboratory of University of Science and Technology of China and Hefei University of Technology etc. Enterprise Technology Centre: Technology Centre of China Anhui Jianghuai Automobile Group, Technology Centre of Royal star Sanyo, Technology	Government R&D Institutions: National Energy Saving and Environment Protecting Automobile Engineering Technology Centre, National Key Laboratory Cultivating Base Co-founded by Anhui province and the Ministry of Science and Technology, Technology Transfer Demonstrative Institution of provincial level etc. R&D Laboratory in Colleges and Universities: Anhui Normal University, Anhui Engineering University etc. and national key laboratory in colleges and universities. Enterprise Technology Centre : Energy	Government R&D Institutions: National University Science Park, National Engineering Research Centre for Fermentation Technology, National Bio-industry Base, Photovoltaic Industry Park etc. R&D Laboratory in Colleges and Universities: local colleges and universities and professional research and development centre in military academies etc. Enterprise Technology Centre: Research Centre for Metal Surface Treatment Technology of Yu Cheng Hardware Industry and Trade Company, Biotechnology Research Centre of TH-DARING,

	Centre of IFLYTEK, Technology Centre of SUNGROW etc.	Saving and Environment Protecting Engineering Research Centre of Conch Cement, JinDing Boiled Waste Heat Generation Equipment Research Centre	Research Centre for Filter of Guo Wei Company etc.
Colleges and Universities	University of Science and Technology of China, Hefei University of Technology, Anhui University, Anhui Medical University, Anhui Agricultural University, Anhui Jianzhu University etc. nearly 100 colleges and universities	Anhui Normal University, Anhui Engineering University, Wannan Medical College etc. 11 colleges and universities	Anhui University of Finance, Bengbu Medical College, Anhui Science and Technology University and Bengbu College etc. nearly 20 colleges and universities.
Innovative Platform	Technology Innovation Service Centre in Anhui province, Public Service Centre of Science and Technology Innovation in Hefei city, Development Research Centre of Science and Technology in Anhui province, Business Incubator Centre of Science and Technology Park of Hefei University, Hefei Technology Transfer Centre of Chinese Academy of Sciences, Technology Transfer Centre of university of Science and Technology of China	Wuhu Service Centre Technology Innovation, Wuhu New and High-Tech Industrial Park, Wuhu Exhibition Centre of National Patented Technology, Service Centre for Small and Medium-Sized Enterprises in High-tech Zone Wuhu, Assets and Equity Exchange for High-tech, University Science and Technology Park in Wuhu city	Innovative Characteristic Park in High-tech Zone Bengbu city, Technology Transfer Centre in Bengbu city, Technology Transfer and Consultancy Centre of Bengbu College, Exhibition and Exchange Centre of National Patented Technology in Bengbu, Bengbu Base of National University Science and Technology Park of University of Shanghai for Science and Technology

The source of data:
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