The Breakthrough of Local Pilot Policy of Mixed-ownership of On-duty Inventions to the "Tragedy of the Anti-commons" in Universities

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Abstract: In the previous university property management system in China, the on-duty inventions of scientific and technological achievements in universities could not be utilized in order to deal with state-owned assets. Technology Transformation lacks inventors' participation, thus the scientific and technological achievements in colleges and universities become the "tragedy of the anti-commons" with high exclusiveness of resources and low rates of utilization. It's necessary to originate the "tragedy" to solve the problem. Sichuan Province has taken the lead in carrying out the pilot project of mixed-ownership of on-duty inventions in the whole country and make some achievements. This policy pilot provides a sample for promoting innovation and reform, and also provides a new idea for solving the problem of "tragedy of the anti-commons" of scientific and technological achievements in higher educations in China. In order to enrich the researches of technology transformation and policy pilot, taking Sichuan Province as an example, this article discusses the mechanism of local policy experiment in cracking the "tragedy of the anti-commons" of scientific and technological achievements in universities, and further discusses the realization of transformation of on-duty scientific and technological achievements in colleges and universities.

1. Introduction

Since the 1990s, China has made great efforts to develop its innovation system. As an important body of knowledge production and application in China, higher education institutions such as colleges and universities have played a pivotal role in the research and development of scientific and technological innovation. However, the production of knowledge has not been widely realized in economic and social development. For example, from 1978 to 2018, China's universities applied for 2.862 million patents, and 114,000 patients were assigned and licensed. With the conversion rate of 3.98%, the transfer rate of authorized invention patents is 8.21%1. The output of scientific and technological achievements of universities is high but the transformation rate is low. Limited by the previous management system, the public nonprofit organizations, represented by colleges and universities, have long suffered "tragedy of the anti-commons" in the transformation and application of the achievements.

The reform of China's economic and social development failed to touches upon the higher education institutions (HEIs), education institutions and the transformation rate of patents of universities keep lower than the West in a long period. The advancement of innovation and the in-depth development of reforms in China make the technology prominent and important in economic development. The cultivation of competitive advantage and the reality of social development call for more application of high-value patents. Therefore, as an important strategic reserve of science and technology resources, colleges and universities are endowed with "the third mission", that is, applying knowledge to promote social development and well-being of People, in addition to producing and disseminating knowledge.

With the deepening of the reform of science and technology, the management of scientific research achievements in colleges and universities are gradually more flexible and resilient. In 2015, China amended the *Law of the People's Republic of China on Promoting the Transformation of*

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Scientific and Technological Achievements, and regions begin to implement policies to promote the transformation of the achievements. Subsequently, Sichuan Province took the lead in exploring the mixed ownership of on-duty inventions or employee inventions as an incentive act, which marks the opening to private ownership of the on-duty inventions.

And the pilot colleges and universities in Sichuan have shown a certain effect on technology transformation and spin-offs. This pilot reform provides a unique sample for China's science and technology innovation and diffuses over the country. However, how the mechanism of this policy functions remains to be found, and whether this policy has the conditions to be popularized is still to be proved.

2. Literature Review

Since the United States passed the Bayh-Dole Act to grant patent ownership to universities in the 1980s, many countries began to carry out ownership reform of on-duty scientific and technological achievements and pose some influence on the output of patents [1-5]. The incentive of intellectual property ownership in some developed countries has been developing for decades and has formed relatively mature systems. The reform of the ownership of scientific and technological achievements of the universities is related to the third mission [6] of the universities. Therefore, through reasonable institutional arrangements, countries provide effective institutional incentives for the tripartite cooperation among the government, scientific research institutions and industries to jointly commit to the commercial use of government-funded achievements.

The existence and extent of “tragedy of the anti-commons” of the on-duty scientific and technological achievements in universities are not only related to the ownership of on-duty inventions, but also related to the systems of nations. Traditional science systems are open for public, and the spillovers as well as spin-offs brought by pure public goods can be seen as the comedy of commons [7]. But there is a perspective of “anti-commons” argues that the privatization of patents from Public funding in higher education institutions will be harmful [8] in the West, however it’s thought to be an obvious limit to the creativity and innovation that leave the patents unused in higher education institutions [9] for the sake of the management as state-owned assets in China. This paper argues that the role of science policies in the modern productivity differ in different countries, and it is the privatization of science ideas other than the achievements, idleness other than commercialization harmful to long run of science progress.

Based on the public nature and the path dependence of nationalization, few universities have the intention to realize the patent transformation. The transformation process of scientific and technological achievements in colleges and universities has been lacking in subjects and motive forces for more than ten years: On one hand, the colleges and universities with property rights do not encourage or allow inventors or applicants to transform on-duty patents privately; lacking supporting mechanism, the patentees, colleges, and universities, didn’t ready for transformation widely. On the other hand, the employees and faculty in universities are indispensable and important for patent transformation and technological achievements development. However, the management system and the risk of transforming the nation-owned patents make the number of papers other than technology transformation contribute to researchers’ careers. Considering that, the inventors and researchers don't have to turn their achievements into production. The optimal choice for the researchers is to output the researches and let along.

Pilot or experiment, as an important policy instrument, are widely used on dealing with global policy-making and implementation process especially in dealing significant issues in developing countries. Similarly, the ideas and practice of policy pilots implements play an indispensable role in all periods and fields of China’s reforms. Through the process of policy diffusion and policy learning, the beneficial experience in grass-roots level has been playing an important role in decision-making.

The political system of China encourages local experiments and formulates the useful experiences to national policies [11]. So as to the policies of science and technology, there are still many pilot experiments. Management of scientific and technological achievements always follows the pace of

development in technology and institution. When the mature conditions of the faculties' scientific research evaluation system are not sufficient, inventors and faculties tend to patent other than transformation, which results in a flood of questionable patents, adding the increasingly complex questions confront the innovation development [10], the legislation and regulation are meant to be changed. In addition, the transformation process of scientific and technological achievements in colleges and universities requires intellectual, human, material and financial resources. Among the intellectual elements, no one knows the work better than the inventors themselves. Without the follow-up of inventors in the process of transformation, which links technology and products, the exploitation and mining of existing achievements in colleges and universities are bound to be frustrated. The exploitation and transformation of scientific and technological achievements in higher education institutions lack sufficient initiative of inventors, which outstands the “tragedy of the anti-commons” of the scientific and technological achievements in colleges and universities [11].

3. Reform and Exploration: Practice of Mixed-ownership of On-duty Inventions

Public goods are naturally influenced by authority and institution. The property rights system of state-owned management of scientific and technological achievements in HEIs makes them and their faculties have little motivation and legitimacy to commercialize inventions and achievements. As many types of researches about “tragedy of the commons” and “tragedy of the anti-commons” mentioned, the core of "tragedy” is property rights [11]. To solve the problem of “tragedy of the anti-commons” of scientific and technological achievements in HEIs, the reform of management of the property rights shall be commenced to remove the obstacle, that is, excessive exclusiveness of public resources, formed by legal or institutional factors. So that to promote the transformation and commercialization of scientific and technological achievements in colleges and universities.

The practice of sharing or co-ownership of patents which also called “Mixed-ownership” came into being. Mixed-ownership of job-related or on-duty scientific and technological achievements refers to the entities to which the on-duty patents belong and the inventors share the on-duty patents. The first shot of this practice was triggered in 2010 by the enterprise run by Southwest Jiaotong University, which located in Sichuan. The university, the inventors and their teams or companies would sign an agreement, which mentioned that 70% of the intellectual property ownership renders to inventors’ team or their company (the university keeps 30%). Then the university would submit a document about transferring the intellectual property rights to National Intellectual Property Administration and other relevant departments to avoid the recessive legal risk. In 2015, during the comprehensive innovation reform and the revision of the Law on Promoting the Transformation of Scientific and Technological Achievements, the university gets the policy support from local government, and the concept was first proposed by Sichuan province in 2015 at the official level in China [12].

Thus, Sichuan's implementation of the mixed-ownership reform for on-duty inventions or scientific and technological achievements has taken the lead in pushing the boundaries of property rights management in Chinese regions and universities. The generation of mixed-ownership of on-duty inventions and scientific and technological achievements in Sichuan Province follows the process which evolves “from point to surface” [13] and from bottom to top. From the secret experiment in university to the pilot reform initiated by Sichuan government, the mixed ownership system of scientific and technological achievements has developed an effective response to the practical problems in the transformation of scientific and technological achievements, which allowed the ‘illegal’ attempt to take place.

Proceeding “mixed ownership” reform, the grass-roots practical experience rose to the policy level and became an important reference for policy innovation reform. Sichuan Province, as one of the eight experimental areas of innovation and reform in China, has been given full autonomy to experiment. Carrying out the comprehensive innovation reform, Sichuan’s reform of mixed-ownership of the achievements of science and technology has shown the impact and transcendence of the policy pilot experiment to the gradual and mending systems, the policy

innovation in science and technology can be realized through the pilot within a certain fault-tolerant range.

Due to the trial-and-error feature of the mixed-ownership of the achievements in universities, in local and central government level, there are both ‘strong’ and ‘weak’ situations in the process of policy diffusion, learning and influence. In case of being contradicting to the current law and the positive expectation of the separation of ownership in practice, the process of policy diffusion does not necessarily promote the policy learning for unreformed regions and universities. The mixed-ownership of on-duty invention and achievements in universities, a reform to promote the transformation of scientific and technological achievements, not only struggles against the existing legal systems and normal cognition, but also competes with other methods to promote the transformation. There are disputes on this reform in universities themselves and regions in China. The recognition of this reform differentiates policy diffusion and learning intensity. At present, the incentive measures of promoting the transformation of achievements in Chinese HEIs contain stock ownership, income sharing and rewarding. Now the intellectual property or ownership of achievements in colleges and universities counts in some areas.

Table 1 Regional reform on ownership of scientific achievements in China.

Time	District	Rights given	Portion
2015	Central	right of disposal, use and revenue	≥50%
August, 2014; November, 2015; June, 2016; December, 2016; December, 2018	Sichuan	ownership	≥70%
June,2017	Wuhan	ownership	≥70%
August, 2019	Shanxi	ownership	-
July, 2019	Shandong	ownership/right of use	-
January/August, 2019	Guangdong	ownership	-
December, 2019	Beijing	ownership	-

4. Functional Mechanism: Changes of Property Rights and the “Mixed-ownership”

In China, the ownership of the scientific and technological achievements of the university has passed from state-owned to unit-owned, and the regional practice of mixed-ownership of scientific and technological achievements in Sichuan Province shows the trend of patent rights opening to the inventors in research institutions.

The policy pilot of on-duty inventions has pushed the property rights turn from units to individuals, which promotes the commercialization of scientific and technological achievements in HEIs. The endorsement of the local government makes it possible for universities in Sichuan to carry out a pilot even contrary to laws. The implementation of this pilot objectively made the ownership and rights turn to individuals partly and improve the transformation and commercialization of inventions and achievements. The invention-oriented reform has released the patent ownership in colleges and universities to allow the faculties and inventors to carry out the transformation of the achievements. Thus, the landing of mixed-ownership pilot in Sichuan Province has posed a light on cracking the “tragedy of the anti-commons”.

4.1 Change Mechanism of Property Rights of On-duty Patents in Chinese HEIs

During the transformation of achievements in colleges and universities, the core problem causing “tragedy of the anti-commons” lies in the management of property rights. The application of scientific and technological achievements in universities, contains the dimensions of exclusive rights granted by patent rights and the right to use within the ownership range. The weak and strong shapes four situations.

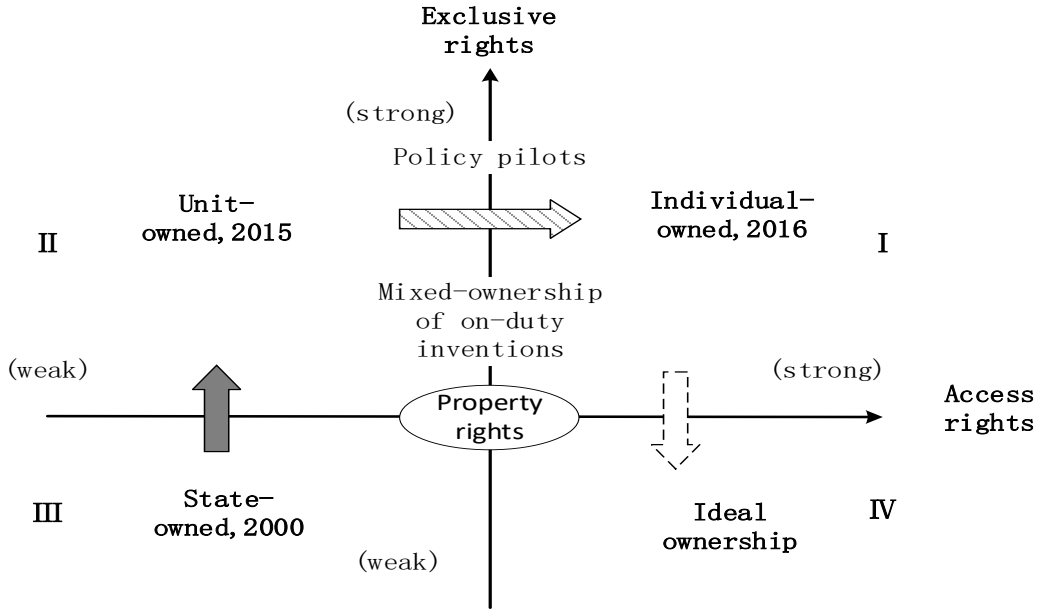

Figure 1 Change mechanism of property rights in Chinese colleges and universities.

In the case of state-owned on-duty scientific and technological achievements in colleges and universities (Quadrant III), property rights do not belong to individuals, individuals cannot obtain the ownership of patents and property rights management is highly centralized in practice, because the state machinery must reflects "public will" for public interest, thus everyone own the rights to use it but no one can implement alone. When the right of exclusivity and right to use are both weak, the public resources will present the characteristic of "inclusive but not exclusive rights". Powerful restrictions make such resources inaccessible to everyone theoretically. However, the patents in universities and colleges, especially the on-duty achievements, embody the public resource characteristic featured in theoretical non-exclusiveness and actual exclusiveness and led to the "tragedy of anti-commons" due to over-centralization instead of over-decentralization.

When the achievements of universities have transferred from state-owned to unit-owned (quadrant Ⅱ), the intellectual property rights are owned and managed by colleges and universities, and the scope of rights is narrowed down which makes the use of resources more exclusive. However, the normal trait of national colleges and universities in China is still restricting the autonomous application of state-funded achievements. So, colleges and universities actually have difficulty in disposal on-duty achievements, which treated as "state-owned assets" for a long time. And the enhancement of exclusive rights also failed in strengthening their rights to use. Consequently, the patent transformation and commercialization are mainly realized by license.

Given the problem of insufficient utilization of achievements in colleges and universities, after the revision of the Law on Promoting the Transformation of Scientific and Technological Achievements, Sichuan Province has adopted an endogenous attempt to share the ownership of patents with inventors by the pilot reform of "mixed ownership" of the achievements in colleges and universities. The design of pilot policy basically reflects the formation of achievements in universities, which includes inputs from three aspects: government funds, university resources and inventors' intellect. In the past decades, there was no dispute about the attribution of on-duty inventions in colleges and universities, they belonged to the state or units.

Nowadays, why should the ownership of achievements turn to the inventors? The reason for this change lies in the urgent need for the innovation reform to be driven by achievements. But past practice has proved that colleges and universities are not the best one to convert the inventions. Therefore, the exploration of individual transform has its realistic basis, and the way of granting property rights is one of the best and useful way to realize the incentives.

Due to the lack of realistic and legal basis in patent property rights by inventors in colleges and universities, the possible future for intellectual property rights in terms of achievements in HEIs may

share with individuals but not completely owned by individuals. Therefore, the ideal state of property rights reform of achievements should ultimately achieve low exclusivity and high utilization rate (quadrant IV). Different from the “tragedy of the commons”, the achievements are unlike natural resources and will not be exhausted for excessive use of technology. Instead, the extensive use of technology may well promote the prosperity and development of science and technology.

4.2 Pros and Cons of the Mixed-ownership of Scientific and Technological Achievements

In reality, Sichuan's reform is still controversial. The cons believe, the major missions for faculties in universities are teaching and research. The scientific achievements derived from the missions were funded by the state and units, and faculties in universities, with high status usually, obtain the corresponding material reward and income, which considered sufficient for the inventors and don't need to risk to segment the state-owned assets. However, the practice of sharing the ownership of achievements with inventors violates the public nature of colleges, and essentially hands intangible assets owned by the state to individuals.

While it is undeniable that the mixed-ownership reform of on-duty inventions is risky. the pros, take it into account from the practical issues confronted by the inventors and TTOs. For the sake of uncertainty of after-the-fact proportional incentives, they think the priority is to promote the realization of transformation. And the property incentives in advance are more likely to drive commercialization than bonuses. Once the transformation is done, preceding property rights make it inevitable that a pre-agreed share would be realized. The reformers argue that the profits have been enlarged by the promotion of the transformation. The pre-agreed portion of ownership not only realizing the value of scientific and technological achievements by transformation, but also boosting entrepreneurs, which follows employment, tax revenue and optimize the industrial structures. Moreover, universities still hold a certain proportion of intellectual property rights, and the incomes brought by the transformation of achievements form state-owned assets of universities, which can still reflect the public nature of universities.

5. Conclusion and Discussion

As a beneficial attempt, the mixed-ownership of the on-duty inventions in universities provides a sample for the realization of innovative development and transformation of achievements. The invention-oriented reform has released the patent ownership in colleges and universities to allow the faculties and inventors to carry out the transformation of the achievements. Thus, the landing of mixed-ownership pilot in Sichuan Province has posed a light on cracking the “tragedy of the anti-commons”. And the target of mixed-ownership of on-duty achievements is realizing the both private and public interests.

However, it should be notice that there’s risk to privatize the on-duty inventions in HEIs. In case of the patent giants or patent jungle, measures should be taken to balance the public and individuals' interests for long term. In addition, basic research and applied research are the both foundation of the application and transformation of achievements. Although university patent resources are different from natural resources, the occurrence of “tragedy of the commons" is due to the exhaustion of resources, ignoring the continuous advancement of basic research, applied research wouldn’t go further. Therefore, it is necessary to ensure the continuous investment as well as research and development of basic technologies and to prevent basic research from being impacted by the market-oriented transformation of applied technologies. In addition, some work must set to remove the institutional obstacles in the achievements transformation in colleges and universities, integrate of relevant resources, and constantly strengthen the institutional support and guarantee for policy pilots. In view of the implementation of the transformation of on-duty inventions, not only the supporting policies should be offered, but also the professional managers and practitioners of the transformation are needed. The application of achievements transformation should not only be confined to commercialization, but should also maximize the social benefits, and break down the barriers in technical and professional fields, making achievements be applied more widely.

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