

Research on the cooperation of industry-university-research in local universities based on game theory

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Abstract. As the main part of China's higher education system, local universities aim to serve regional economic and social development and focus on cultivating high-quality talents for the locality. However, compared with universities administrated by the ministry of education and other central agencies, local universities have certain disadvantages in the cooperation of Industry-University-Research. This research analyzes the difficulties and reasons of local universities in the cooperation of Industry-University-Research, and then puts forward corresponding suggestions for local governments and local universities from the perspective of game theory, including optimizing the promotion and regulation functions of the government, optimizing the mechanism of Industry-University-Research cooperation, and optimizing the school-running concept and evaluation system of local universities.

Keywords: Local universities, Industry-university-research cooperation, Game theory.

1 Industry-university-research cooperation

Industry-University-Research cooperation refers to industries, universities, and research institutes as the main innovation entities, under the guidance and support of relevant entities such as the government, intermediary organizations, and financial institutes, to jointly carry out scientific research, technological innovation, and talent training innovative activities. The main three subjects collaborate in the form of a strategic alliance, and the subjects provide resources to each other based on their respective strategic goals to achieve a win-win result.

In China, Industry-University-Research cooperation was first initiated in the Joint Development Project of Industry-University-Research in 1992, a major project jointly implemented by the State Economic and Trade Commission, Chinese Academy of Sciences and the Ministry of Education, in order to face the fierce world competition and improve

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the national scientific and technological research and development capacity. After nearly 30 years of rapid development, a model of Industry-University-Research cooperation featuring complementary advantages, benefit-sharing, risk-sharing, and common development has gradually formed, which has played an important role in promoting industrial technological innovation.

In recent years, China has paid more and more attention to Industry-University-Research cooperation and increased its support for Industry-University-Research cooperation. The Outline of the national medium and long term science and technology development program (2006-2020) proposed to comprehensively promote the construction of a national innovation system with Chinese characteristics with industry as the core and Industry-University-Research cooperation as a breakthrough point, and greatly improve the country's independent innovation capabilities. At the National Education Conference, Xi Jinping proposed to improve the ability of education to serve economic and social development, promote cooperation between industry, university and research, and focus on cultivating innovative, compound, and application-oriented talents. Therefore, strengthening Industry-University-Research cooperation and improving the level of serving local economic development has become one of the important responsibilities of local universities.

2 Local universities

The concept of local universities was formed from China's administrative management system. In accordance with administrative management, the universities are divided into: the universities administrated by the ministry of education and other central agencies; the universities administrated by the local governments and provincial department of education. The universities administrated by the local governments and provincial department of education are also called local universities. Local universities generally refer to universities that belong to provinces, autonomous regions, and municipalities directly under the central government, supported by local finances and allocated funds by local administrative departments. As the main part of China's higher education system, local universities aim to serve regional economic and social development and focus on cultivating high-quality talents for the locality.

In terms of the number of local universities, according to the list of national universities publicly released by the Chinese Ministry of Education in 2019, there are a total of 2,688 universities, only 118 universities administrated by the Ministry of Education and other Central Agencies. It can be seen that local universities occupy the vast majority of universities in China. However, universities administrated by the ministry of education and other central agencies have strong research capabilities and more research funding from the government. Compared with them, local universities are at a disadvantage in the competition. Therefore, from the perspective of game theory, this study analyzes the main reasons for the failure of local universities to participate in Industry-University-Research cooperation, and then puts forward suggestions to promote local universities to participate in Industry-University-Research cooperation.

3 Game analysis on industry-university-research cooperation of local universities

Game theory is a new branch of modern mathematics, is also an important subject of operation research. This research introduces game theory into the analysis of Industry-University-Research cooperation. Only by finding the equilibrium point of the interests of

all parties in cooperation can the long-term and effective Industry-University-Research cooperation be promoted. For universities, they want to find companies that can provide financial and equipment support, internships and market information. For enterprises, they hope to seek cooperation with universities with high quality students, targeted training of employees for enterprises, and able to solve technical problems for enterprises, so as to achieve the purpose of maximizing their own interests.

Hypothesis 1: Both parties of the game (local universities and enterprises) are homo economicus. The two parties will make strategic choices based on cooperation benefits and costs (cooperation, non-cooperation). The two parties will do an investigation before cooperation, assuming that the investigate cost is R . After investigation, the two parties agreed to cooperate, assuming that the expected benefit is E and the cost paid is C . The net profit of participating in cooperation is $E-C$, which is greater than the investigate cost R before cooperation, that is, $E-C > R$. Based on Hypothesis 1, the profit matrix of the game is established, as shown in Table 1.

Table 1. Game profit matrix between enterprises and local universities.

Strategic choice	University cooperation	University non-cooperation
Enterprise cooperation	$(E-C-R, E-C-R)$	$(-R, 0)$
Enterprise non-cooperation	$(0, -R)$	$(0, 0)$

From the game profit matrix in Table 1, it can be seen that (cooperation, cooperation) and (non-cooperation, non-cooperation) are the two game equilibriums of the game. However, in actual Industry-University-Research cooperation, in addition to choosing to cooperate with local universities, enterprises can also choose to cooperate with universities administrated by the ministry of education and other central agencies. Therefore, under the condition of equal net profit, enterprises are more inclined to choose to cooperate with the universities administrated by the ministry of education and other central agencies, which leads to the result of the game between enterprises and local universities (non-cooperation, non-cooperation).

Hypothesis 2: In order to solve technical problems or use the resources of universities to generate greater profits, enterprises are determined to participate in Industry-University-Research cooperation. Assume that the benefits of cooperation between enterprises and local universities/universities administrated by the ministry of education and other central agencies are E , and the investigate cost is R . The cost of the enterprise is C , the cost of the local universities is C_1 , and the cost of the universities administrated by the ministry of education and other central agencies is C_2 . The net profit of participating in cooperation is $E-C$, which is greater than the investigate cost R before cooperation, that is, $E-C > R$. Based on Hypothesis 2, the profit matrix of the game is established, as shown in Table 2.

Table 2. Game profit matrix between enterprises and local universities and universities administrated by the ministry of education and other central agencies.

Strategic choice	Local university cooperation	University administrated by the ministry of education and other central agencies cooperation
Enterprise cooperation	$(E-C-R, E-C_1-R)$	$(E-C-R, E-C_2-R)$
Enterprise non-cooperation	$(0, -R)$	$(0, -R)$

It can be seen from Table 2 that in order to attract the cooperation of enterprises, local universities need to pay higher cooperation costs than universities administrated by the ministry of education and other central agencies, that is, $C_1 > C_2$ ($E-B-C_2 > E-B-C_1$).

In short, under the condition of market economy, interest is the direct driving force to promote the development of Industry-University-Research cooperation. Through Industry-

University-Research cooperation, local universities hope to improve the quality of running schools, cultivate high-quality talents and provide internship opportunities for students. Enterprises hope to obtain talents to meet their development needs and solve problems in technology through Industry-University-Research cooperation, so as to improve their competitiveness. Therefore, in order to make the result of the game between enterprises and local universities (cooperation, cooperation), on the one hand, local universities should actively participate in Industry-University-Research cooperation; on the other hand, local universities should focus on long-term benefits and pay more cooperation costs or reduce its own interests give it an advantage in the competition with universities administrated by the ministry of education and other central agencies. Meanwhile, local governments should provide policy support, such as bearing part of the research costs of Industry-University-Research cooperation, or tax reduction for enterprises that actively participate in Industry-University-Research cooperation.

4 Suggestions on promoting the industry-university-research cooperation

Although local universities have certain geographical advantages in the development of Industry-University-Research cooperation, there is still a big gap compared with the universities administrated by the ministry of education and other central agencies. It has become an important topic to explore the way of Industry-University-Research cooperation in line with the characteristics of local universities. Based on the game analysis of Industry-University-Research cooperation in local universities, this research puts forward suggestions from the perspectives of local universities and local governments.

4.1 Optimize the government promotion and regulation functions

As a government whose basic purpose is to safeguard and promote public interest, especially the local government where local universities are located, it is obliged to ensure the development of Industry-University-Research cooperation. The government plays a supporting and regulating role in the operation of the Industry-University-Research cooperation mechanism. The government functions can be optimized from two aspects. (1) Optimize government support functions. Local governments should encourage universities, enterprises and scientific research institutions to actively participate in Industry-University-Research cooperation through investment, taxation and other measures. (2) Optimize government supervision functions. The relevant departments of the local government should play their role of restraint and supervision, assess and supervise the enterprises and local universities participating in the Industry-University-Research cooperation, so as to ensure the quality of the Industry-University-Research cooperation.

4.2 Optimize the Industry-University-Research cooperation mechanism

A reasonable benefit distribution mechanism is the basis for guaranteeing and encouraging enterprises and local universities to participate in Industry-University-Research cooperation. Interests must be distributed fairly among the subjects, otherwise it will be difficult to achieve the improvement of the effect of Industry-University-Research cooperation.

In order to promote the healthy development of Industry-University-Research cooperation in local universities, on the one hand, local governments should reward local universities that have made significant achievements in Industry-University-Research cooperation by setting up special funds for Industry-University-Research cooperation

subsidies for the transformation of scientific and technological achievements. On the other hand, local governments should continue to improve the risk sharing mechanism, establish reasonable incentives and punishment mechanisms, increase the trust of the parties involved in the Industry-University-Research cooperation, and reduce the occurrence of speculation.

4.3 Optimize the school-running concept of local universities

The school-running concept of local universities should be based on the construction of first-class disciplines, and serve the local economic and social development as the foundation and support for the development of the university. Therefore, local universities should adjust the discipline and professional structure based on the development needs of local leading industries, pillar industries, basic industries, and emerging industries, and cultivate talents for local development needs, so that they can better connect with the local economy.

4.4 Optimize the evaluation system of local universities

A scientific and reasonable evaluation system is an important guide for the healthy and orderly development of universities. At present, teachers in local universities have similar evaluation indicators in title evaluation and performance evaluation, focusing on papers, projects, topics and others. However, in addition to the traditional evaluation indicators, teachers in the transformation of technological achievements, service to society, cooperation and education can also be used as evaluation indicators, so as to encourage teachers to participate in Industry-University-Research cooperation and contribute to local development.

5 Conclusion

The research uses the game theory method to construct a game model of Industry-University-Research cooperation, and analyzes the issues encountered by local universities in participating in the Industry-University-Research cooperation. Finally, the study puts forward suggestions from the perspective of local universities and local governments.

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