CIC: A Chinese Triple-Helix-based initiative in universities to promote U-I-G cooperation

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Abstract

"2011 Program", an initiative to establish Collaborative Innovation Centers (CICs) in universities across the country, was implemented by the Ministry of Education (MOE) and the Ministry of Finance (MOF) of China to improve the universities' role in promoting U-I-G cooperation (University-Industry-Government cooperation). This is an important strategy for the central government to increase the independent innovation capability of China to accelerate the economic development. As a kind of Cooperative Research Centers, the CIC is a typical Triple-Helix-based organization. Other innovation sectors such as enterprises and research institutes are welcomed to join to promote the science and technology cooperative innovation. The purpose of the paper is to explore the characteristics and implementation strategy of CICs, and try to find some negative facts that may influence the success of CICs according to Triple Helix Theory and the practices and researches on CRCs. These findings will form the basis for

recommendations for the development of CICs in China and in other countries that also want to establish similar organizations.

Keywords: *2011 Program; Collaborative Innovation; Cooperative Research Center; Triple Helix; U-I-G Cooperation*

1. Introduction

Over the past two or three decades, China is one of fastest growing countries as well as one of the largest economies in the world. However, in recent years, China's economic development is facing severe challenges due to the slowdown of the world economy, the low level of domestic industry and rising labor costs etc. It is urgent for China to promote industrial restructuring and upgrading to make the economy take off again. To this end, the Chinese government proposed strategic emerging industry development plan in 2010 because innovation is absolutely the first driver of strategic merging industries.

University is an important part of the national innovation system in China. In 2010, basic research funding of Chinese universities has accounted for 55.4% of the national total. Chinese universities have become the largest department engaged in basic research activities. Meanwhile, Chinese universities has made a direct contribution to technological innovation and economic development in China through U-I-G cooperation (University-Industry-Government cooperation) since 1992 the first formal U-I-G cooperation project was jointly implemented by the State

Economic and Trade Commission, the State Education Commission and the Chinese Academy of Sciences. After more than 20 years' development, the scale of U-I-G cooperation enlarges, the forms of U-I-G cooperation innovate, and the fruits of U-I-G cooperation enriches. However, many problems and bottlenecks come into being, such as the low conversion rate of scientific and technological achievements, low capability to promote the development of new industries and to make major breakthroughs in the major industries, gaps between the university's technology supply and the enterprise's technical requirements, lacking of collaborative research funds, and poor external environment for cooperation.

In 2012, the Ministry of Education (MOE) and the Ministry of Finance (MOF) of China jointly promulgated "2011 Plan" in order to work in coordination with each body better in the national innovation system, especially to break up the cooperation barriers between university and industry, to accelerate the transformation of scientific and technological achievements, to enhance the contribution of university in the system. The first phase will fund 14 Collaborative Innovation Centers (CICs) in universities nationwide. University is the main part of CICs, but CICs actively absorb enterprises and research institutes, local government and international forces to join to promote science and technology cooperation and innovation. This is the latest strategy of the Chinese government to strengthen U-I cooperation and to accelerate independent innovation.

The purpose of the paper is to explore the characteristics and implementation strategy of CICs, and find problems during the development process of CICs according to Triple Helix Theory and the practices and research on CRCs. These findings will form the basis for recommendations for the development of CICs in China and in other countries which want to establish similar organizations.

2. State-of-the-art

2.1Triple Helix

Etzkowitz and Leydesdorff put forward the Triple Helix theory in 1990's(Etzkowitz & Leydesdorff, 1995), and enriched the theory afterwards. They explored how the government, industry and university cooperate to drive science, technology and economy forward from an organizational perspective under the background of knowledge-based economy. Firstly, the Triple Helix theory states that university, the main organization of knowledge creation and dissemination, is going through a "second academic revolution" and playing an enhanced role in industrial innovation in increasingly knowledge-based societies. It shifts form the position subordinated to industry and government to equally important position or even leading position in economic development(Etzkowitz, Webster, Gebhardt, & Terra, 2000). Secondly, the Triple Helix theory emphasizes the three sectors should cooperate mutually and each sector should play some additional roles that the other two sectors originally play. In some cases, the government

takes additional responsibilities, like supporting public-sector entrepreneurs and venture; the enterprises start to focus on both production and high-tech research and development, which is close to an academic model; and the universities begin to transfer technology and start spin-offs while creating knowledge and technology(Leydesdorff, 2001). Finally, the Triple Helix theory puts forward the concept of "Triple Helix Sphere", which is made up by knowledge sphere, convergence sphere and innovation sphere. Hybrid organizations are generating with the interaction between university, industry, and government in the innovation sphere, which take additional responsibilities or functions U-I-G can't complete(Etzkowitz, 2008).

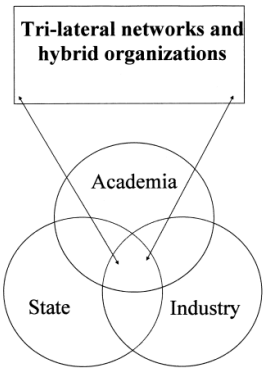

Fig.1 The Triple Helix Model of University-Industry-Government Relations(Etzkowitz & Leydesdorff, 2000)

2.2CRC (Cooperative Research Center)

CRC is a typical hybrid organization fitted with the Triple Helix III. "A cooperative research center (CRC) is an organization or unit within a larger organization that performs research and also has an explicit mission (and related activities) to promote, directly or indirectly, cross-sector

collaboration, knowledge and technology transfer, and ultimately innovation(Boardman, Gray, & Rivers, 2012). However, before the Triple Helix theory put forward, many types of CRCs have been established in universities, such as IUCRC, ERC in the United States etc. According to *Research Centers and Services Directory* (2010), there are more than 16,000 university-based non-profit research centers in the United States and Canada(Gray, 2011). As for the national innovation system, CRC can break down barriers between university and industry, promote U-I cooperation and apply more innovation and technology to industrial development through U-I-G cooperation(Gray, 2011). From the perspective of University development, Bozeman & Boardman found that researchers in a large interdisciplinary research center have more external contacts, conduct more researches and technology development cooperation, and are much actively engaged in patents and licensing. Also, they can better act as bachelor and master tutors. Doctoral graduates under their guidance prefer to work in industrial sectors(Bozeman & Boardman, 2003). All these studies can be arguments for the further study of CRCs within the Triple Helix theory, and enriches the content of the Triple Helix theory.

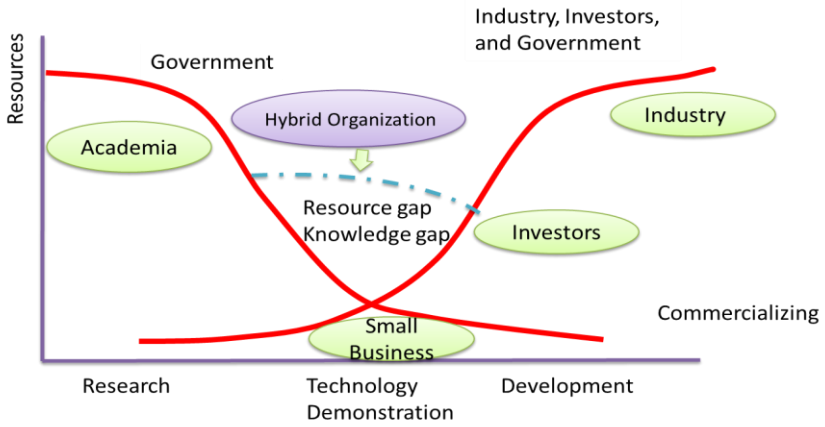

Fig.2 Positioning and Function of Hybrid Organization in Innovation Ecosystem

Source: Adapted from Jackson, D. J. (2011). What is Innovation Ecosystem? http://www.erc-assoc.org/sites/default/files/topics/policy_studies/DJackson_Innovation%20Ecosystem_03-15-11.pdf

3. Methodology

This paper adopts case study method. First, this paper analyzes the first 12 CICs as a whole case, by summarizing its characteristics and advantages, exploring and analyzing its operating mechanisms. Second, it explores the possible problems and challenges based on the Triple Helix theory and the existing CRC study; finally it puts forward relevant suggestions for improvement.

4. Findings and interpretation

4.1A brief overview of CIC

Emergence of CIC

In April 2011, former Chinese President Hu Jintao said in Tsinghua University's 100th anniversary that: “We should actively promote collaborative innovation. We should encourage interactions between different disciplines and subjects. We should encourage universities to have

deep cooperation with research institutions and industry so that they can share resources and engage in joining in major scientific research projects. "(Hu, 2011)In March 2012, MOE and MOF jointly issued two documents *Opinions of Enhancing Innovative Capacity of Higher Education Plan* (No.6 [2012] teaching skills)(MOE. & MOF., 2012b) and *Notice of the Implementation Plan on Enhancing Innovative Capacity of Higher Education* (No.7[2012]teaching skills)(MOE. & MOF., 2012a), and decided to implement the " Enhancing Innovative Capacity of Higher Education Plan"(the"2011 Plan"). The documents proposed to establish four kinds of CICs and publicize the first 14 selected CICs on 4th March, 2013. We can see that the "2011 Plan" is a plan proposed and implemented by the government.

Vision of CICs

"2011 Plan" aims to establish a number of 2011 CICs, which can give full play of higher education sector as the primary productive force and human resource by changing innovative ways to enhance the innovation capability of qualified personnel, discipline and scientific research; encouraging higher education institutions to have deep cooperation with research institutions and industries, and establishing strategic alliances to promote integration and development of education, technology, economy and culture. So that eventually CIC will become academic highland of international significant influence, research base of generic technology as well as leading place of regional innovation and cultural innovation so that to

promote knowledge innovation, technological innovation and regional innovation, finally to prop up the national innovation system.

Different kinds of Collaborative Innovation Center

According to the deployment of the "2011 Plan", CICs are divided into four types: scientific frontier-oriented, industry-oriented, regional development-oriented and cultural heritage innovation-oriented. Science-oriented CICs, the main body of which is the natural sciences, are to become a world-class scientific research and talent cultivation highlands. Industry-oriented CICs, the main body of which is engineering technology discipline, focus on fostering emerging strategic industries and reforming traditional industries and are to become important bases to prop up the development and transfer of core generic technology of Chinese industry. Regional development-oriented CICs, which led by the local government and focus on accelerating regional economic and social development, are in the leading position to enhance regional innovation and development. Cultural heritage innovation-oriented CICs, the main body of which is philosophy and social sciences, are to become the main camp to enhance national cultural soft power and increase the international influence of Chinese cultures.[1](MOE. & MOF., 2012a)

[1] Cultural heritage innovation-oriented CICs will not be studied in the paper, because we focus on science and engineering disciplines here.

Table.1 List of Collaborative Innovation Centers in China

Number	Center	Main Collaborative Organization	Type
1	Co-Innovation Center of Quantum Physical Sciences	Peking University, Tsinghua University, Institute of Physics Chinese Academy of Sciences etc.	Frontier
2	Co-Innovation Center of Quantum Information and Quantum Technology Frontier	University of Science and Technology of China, Nanjing University, Shanghai Institute of Technical Physics of Chinese Academy of Sciences, Institute of Semiconductors Chinese Academy of Sciences, National University of Defense Technology etc.	Frontier
3	Collaborative Innovation Center of Biotherapy	Sichuan University, Tsinghua University, Chinese Academy of Medical Sciences, Nankai University	Frontier
4	The Co-Innovation Center of Tianjin Chemistry and Chemical Engineering of Tianjin	Tianjin University, Nankai University etc.	Frontier
5	Co-Innovation Center of Advanced Aero Engine	Beijing University of Aeronautics and Astronautics, Aviation Industry Corporation of China etc.	Industry
6	Co-Innovation Center of Aerospace Science and Technology	Harbin Institute of Technology, China Aviation Technology Group etc.	Industry
7	Co-Innovation Center of Railway Traffic Safety	Beijing Jiaotong University, Southwest Jiaotong University, Central South University,	Industry
8	Non-ferrous Metal Oriented Advanced Structural Materials and Manufacturing Collaborative Innovation Center	Central South University, Beijing University of Aeronautics and Astronautics, Aluminum Corporation of China, China Commercial Aircraft Company, etc.	Industry
9	Collaborative Innovation Center of Grain	Henan Agricultural University, Henan Universityof Technology , Henan Academy of Agricultural Sciences	Region

10	Collaborative Innovation Center of Green Pharmaceutical Engineering	Zhejiang University of Technology, Zhejiang University, Shanghai Institute of Pharmaceutical Industry, Zhejiang Institute of Food and Drug Control, Zhejiang Academy of Medical Sciences, National pharmaceutical Engineering Research Center etc.	Region
11	Suzhou Nano Tech Co-Innovation Center	Soochow University, Suzhou Industrial Park, etc.	Region
12	The Synergetic Innovation Center for Advanced Materials	Nanjing University of Technology, Tsinghua University, Zhejiang University, Nanjing University of Posts and Telecommunications, Institute of Process Engineering, Chinese Academy of Sciences etc.	Region
13	Collaborative Innovation Center for the South China Sea Studies	Nanjing University, National Institute for South China Sea Studies, Navy Command Academy, Renmin University of China, Sichuan University, Research Center for Chinese Borderland History and Geography CASS, Institute of Geographic Sciences and Natural Resources Research, CAS	Culture
14	Center of Cooperative Innovation for Judicial civilization	China University of Political Science and Law, Jilin University, Wuhan University.	Culture

Sources: Introductions of the centers from internet.

4.2Characteristics of CICs

This paper summarizes the characteristics and advantages of CICs through case study analysis, which are the advance and new trend of Chinese government in promoting U-I-G cooperation. The new trends are as follows:

(1) Focusing on the frontier of science and technology and the most needed fields in reality. By observing the research field of the first 12 CICs, we can find that: 2 CICs focus on quantum

science, 3 CICs on aerospace and aerospace technology, aircraft engines and aeronautical materials; 3 CICs on biology and green pharmaceutical; 1 CIC on nanotechnology; 1 CIC on advanced chemistry and chemical engineering, the other 2 CICs focus on the most needed fields in reality: grain and railway traffic safety. So we can see that the Chinese government attaches great importance to the current frontier of science and technology. China wants to occupy a place in the world technological frontier by investing heavily in conducting researches.

(2) Emphasizing inter-organizational cooperation. Different form previous small-scale funded research projects, CICs construction puts strong emphasis on inter-organizational cooperation. 1) Collaboration between universities. CIC can only be applied by at least two universities for co-construction. 2) Collaboration between university and research institutes. For example, Chinese Academy of Sciences participates in 5 CICs construction among 12 CICs. 3) Collaboration between universities and enterprises. Large and medium-sized state-owned enterprises are involved in regional and industrial type CICs. Take “Non-ferrous Metal Oriented Advanced Structural Materials and Manufacturing collaborative innovation center ” for example, except from Central South University and Beijing University of Aeronautics and Astronautics which take the lead, the other six organizations taking part in are mainly large-scale state-owned

enterprise, which is conducive to fully consider the needs of enterprises in scientific and technological research, and to transfer science and technology into practical productive forces.[2]

(3) Forming a relatively consummate management and organizational structure. Multi-objectiveness of the center will bring challenges to organizational management since participating institutions varies with nature. Thus, establishing a consummate and rational management organizational structure is a crucial measure to reduce management barriers and to promote cooperation in deep. CICs are generally set up in the leading universities. Director of the Centre is responsible for operational management of the center. Council, the highest decision-making department of the center, is composed by the leaders of the participating organization and center directors etc., whose main function is to coordinate with MOE, formulate development strategies and research direction, discuss and decide major personnel, financial, scientific and technological issues of the center, such as employment and exemptions. Two committees provide advice and consultations in development strategies, major policies, overall planning and management, namely, Steering Committee comprised of government officials and Advisory Committee by the academicians and experts. By establishing various research platforms and undertaking research projects, CICs achieve specific collaborative innovation.

[2] Source: http://2011cic.csu.edu.cn/wygkcn_ShowArticle.asp?Wygkcn_ArticleID=8309

Research institutes and enterprises can actively participate in the construction of research platform and research projects.

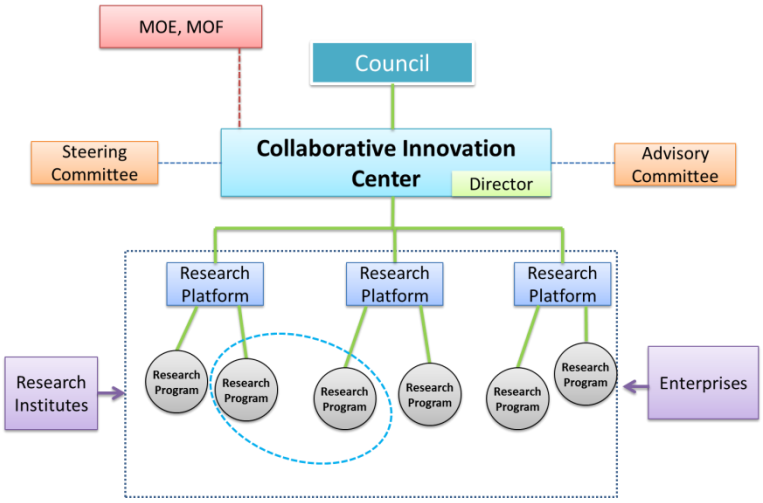

Fig.3 Typical organization structure of CIC

(4) Getting lavish backing from diverse sources. Historically, the major scientific discoveries and breakthroughs in frontier technology rely heavily on scientific equipments and collaboration of researchers. From the practical perspective, the undergoing scientific and technological researches also depend on advanced scientific equipments and technical team. Thus, adequate funding is very necessary in order to continue to conduct groundbreaking research to achieve the goal of CICs. Now, CICs benefit from a special preferential policy of funding from the central government to local government, universities to enterprises. MOF will provide at least 90 million dollars and the local governments provide 9 to 15 million dollars for each CIC. Enterprises provide fund based on their needs, for example, non-ferrous metal enterprises have invested 30 million dollars and aerospace users 5 million dollars to the “Non-ferrous Metal Oriented

Advanced Structural Materials and Manufacturing collaborative innovation center". Thus, each center will receive no less than 200 million dollars in four years cycle.[3] CICs can purchase advanced research equipments, recruit top research experts and students and maintain sustainable research with sufficient funds.

4.3Challenges and problems CICs faced with

The design of CICs has made impressive progress compared with the previous Chinese U-U and U-I cooperative research programs in organizational structure, mechanism design and funding sources etc. We can say that it is the best plan in recent years in China. But a plan, which expends large research funding and organizes so many researchers to carry out research is still needed to be improved in the current Chinese research environment. The probable problems are as follows:

(1) The function and position of government, universities, industry needs to be adjusted. As operating expenses are mainly from the government, the government plays the most important role in the design, operation, even management of the center, which is crucial to the development of the center. However, the government's top-level design is not good enough. For example, it does not explicitly provide capital amount, distribution method, and provision of intellectual property rights etc., which are the most critical factors impacting the development of the center.

[3] Source: http://2011cic.csu.edu.cn/wygkcn_ShowArticle.asp?Wygkcn_ArticleID=8309

Although enterprises actively invest in the construction of CICs, there is no policy to specify enterprise's identity in CICs, such as how to participate in research and how to share research fruits. And universities only focus on the application process, but they don't have innovative new ways to carry out specific collaborative innovations. There is a worry that universities just simply scrape together to apply for CICs. What's more, universities are primarily responsible to the government, so how to ensure the interests of the participating enterprises is also a problem.

(2) Excessive concentration of research funding. The composition of research platforms and researchers of CICs are composed by national and provincial key research bases and excellent academic leading talents. For example, "The Synergetic Innovation Center for Advanced Materials" has eight national and provincial key laboratories, four national engineering research centers, eleven academicians, sixteen experts of "Thousands Talent program", twenty-five winners of "National Outstanding Youth Science Fund Project", seven professors of Changjiang Scholar Program, ten scientists of 973 National Chief Scientist Program[4]. These research platforms and researchers have substantial research facilities and funding to prop up their scientific researches. While through powerful combination by joining in CIC, they will gain several times the original fund. In the law of diminishing returns to scale, the fund may not

[4] Source: http://2011.njut.edu.cn/view.asp?id=20&class=6

achieve their fullest value. As national research foundation is fixed, invest on outstanding young faculty who are lacking of fund may yield more fruits.

(3) There is still a lack of evaluation of the program. CIC project is the largest capital investment collaborative research project in China now. How to ensure CIC forge ahead along a predetermined path and engender the expected results is one of the key issues of CIC construction. Currently, in the document of *Notice of the Implementation Plan on Enhancing Innovative Capacity of Higher Education* issued by MOE and MOF (No.7 [2012]teaching skills), there proposed a "performance evaluation" approach. The document proposes to establish an "evaluation method of combining annual reports and periodic assessment. Annual checks mainly depend on the self-examination of collaborative innovation body. After four years' running, MOE and MOF will commission a third party to organize the evaluation. "(MOE. & MOF., 2012a)From my perspective, we agree with the "performance evaluation" approach, but we have different opinion toward the specific implementation method. Because it is difficult for CICs to recognize their own operational problems with the self-examination approach, sometimes they will deliberately conceal existing problems to evade accountability of the government. Before the third party performing the evaluation, the center may deviate from the goal, which may lead to irreparable situation. Then the third-party evaluation will lose its significance.

5. Conclusion and policy implications

This paper begins with a brief analysis of present situation and problems of U-I-G cooperation in China, and states that “2011 Plan” is a critically important part in Chinese national innovation system and a significant measure to make up the gap among U-I-G to accelerate U-I-G cooperation in China. This paper adopts case study method to analyze the characteristics of the first 12 CICs based on Triple Helix theory and the practices and researches on CRCs. Different from previous U-I-G cooperation, CICs have the characteristics of focusing on technological frontier, emphasizing the cross-organizational collaboration, owning consummate organizational management and sufficient funding sources. At the same time, there are also some problems to be solved, including obscure functional positioning of U-I-G, excessive concentration of research funding, inappropriate evaluation methods and so on. Finally, some practical suggestions will be addressed as the following:

(1) Government departments should strengthen top-level design of the plan. We suggest that MOE formulate relevant management regulations on the issues affecting the running of CICs, such as basic organizational structure and collaborative model, the amount of the government's fund and distribution method and intellectual property policy as soon as possible to ensure that government funds invest into scientific collaborative innovation. Simply splitting apart fund and scraping result of scientific research together can bring great harm.

(2) Implementing several kinds of CICs with different levels. To solve the problem of excessive concentration of research funding, we suggest to establish several kinds of CICs with different levels and to dispense fund on different levels and categories. Also, we are inclined to give more funding opportunities to outstanding young faculty and research teams to carry out researches.

(3) Pay due attention to the evaluation of CICs. First, MOE should establish a complete evaluation system by changing “self-examination approach of submitting an annual report" into “a third party evaluation and assessment report directly submitted to MOE". Second, MOE should employ a number of part-time evaluation specialists together with the third-party evaluation agency to evaluate CICs.

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