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Research on Pattern Evolution and Path Optimization of Cross-regional Flow of Heterogeneous Innovation Resources

-- From the Perspective of Gradient Transfer Theory

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Abstract

Innovation resources are important strategic scientific and technological innovation resources that lead and support China's construction of modern economic system and realize high-quality development. Based on the gradient transfer theory, this paper studies the theoretical connotation and dynamic process of heterogeneous innovation resources, puts forward the theoretical framework of cross-regional dynamic flow of resources. Then,This paper summarizes and analyzes the modes of introducing innovation resources at home and abroad, and holds that the foreign routes include talent introduction, scientific apparatus recruitment, technology and finance promotion, government precise recruitment, international scientific and technological cooperation, etc.The domestic routes include building comprehensive national science centers, building science and technology service platforms and building "offshore" bases. Finally, aiming at the current shortage of innovation resources in China, five countermeasures are put forward.

Keywords

Innovation resources; Science and technology talents; Optimal path; Pattern evolution.

1. Introduction

Innovation resources are important strategic infrastructure to cope with the future technological revolution, industrial transformation and the reconstruction of international pattern and governance system, to support the transformation of economic development mode and promote high-quality development. Introducing innovation resources is of great strategic significance to the innovation and development of a country or region. Speeding up the construction of the system for introducing innovative resources is conducive to promoting the construction of regional innovation centers and adapting to the construction of a modern economic system. Various types of policies introduced by advanced regions at home and abroad continuously attract innovation resources and effectively improve the level of regional scientific and technological innovation. Improving the introduction system of innovation resources will help to leverage the advantages of international business environment to plan the layout of scientific and technological innovation resources from a global perspective. It is beneficial to complement the shortcomings of science and technology supply to strengthen the support and guidance of science and technology for industrial upgrading and development. It is beneficial to actively integrate into and lay out the global innovation network to enhance the level of open cooperation in the new district. Coordinating and carrying out the strategic

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introduction and scientific deployment of innovative resources at the national level, accelerating the construction of a high-level, high-level and international scientific and technological innovation platform, attracting and making good use of international first-class talent teams, strengthening internal coordination and cooperation, and giving full play to the enthusiasm of all parties can promote the high-speed flow of innovation elements[1]. This paper selects domestic and foreign representative regions as cases, compares and analyzes their experiences and practices in gathering innovation resources, and provides ideas and references for other regions.

2. Literature Review

The related theories of innovation resource introduction can be traced back to 1950s. It is generally believed that innovation resource introduction is not only the introduction of talents, equipment and technology, but also the introduction of "invisible wealth" such as internal management, value system and supporting resources of corresponding institutions. This is an advantage that individual technology introduction, project introduction and talent introduction do not have.These "invisible wealth" have greatly promoted the technological innovation and creation of institutions, industries and even regions. Sun Zhipeng (2016)[2]thought that innovation resource is a kind of "new" resource, which is the key elements of all regional innovation activities, the foundation of creating regional innovation achievements and the core elements of promoting regional innovation ability and sustainable competitiveness. Lin Xianyang and others (2019)[3] studied the modes of introducing innovation resources in a region, and considered that the modes of aggregating global innovation resources in Guangdong-Hong Kong-Macao Greater Bay Area include core enterprise aggregation mode, regional platform aggregation mode, new institutional aggregation mode, university park aggregation mode, emerging industry aggregation mode, etc.. Zhao Yu (2015)[4]studied the influence of international innovation resources flow on regional independent innovation, and proposed that international innovation resources have a significant positive effect on China's independent innovation output, and the absorptive capacity of international innovation resources is also improving on the whole. Zhang Yongwei (2017)[5]thought that in addition to the traditional overseas mergers & acquisitions and technology & talents introduction, establishing incubators overseas, introducing international innovation platforms and establishing R&D centers overseas can directly promote the docking of foreign small and medium-sized companies with the domestic industrial chain, and achieve good results in introducing international innovation resources.

Generally speaking, at present, the research on the introduction of innovation resources is more about the connotation, and there is a certain foundation for the research on the introduction model, but no unified consensus has been reached. There are great differences in the modes and paths of innovative subjects introducing innovation resources in different regions, industries and stages, which are embodied as follows: First,The domestic research on the introduction of innovation resources started late, and the previous related research was mainly based on the analysis and reference of typical foreign policies and experiences. Secondly, the practice of introducing innovation resources abroad mainly depends on the relaxed research environment and superior research conditions, taking enterprises as the main body and cooperating with the active talent introduction policy to introduce global resources. Third, domestic scholars' research on the introduction of innovation resources mainly focuses on influencing factors, introduction mechanism and so on. Domestic and foreign scholars' research doesn't fit with the background of the current multi-polarization development pattern in the world and the present situation of Sino-US science and technology competition. How to do a

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good job in the introduction of innovation resources under the Sino-US science and technology competition environment has become one of the new research directions.

3. Teoretical Framework

Traditional innovation resource allocation theory holds that innovation resources are important strategic scientific and technological innovation resources that lead and support China's modernization economic system and realize high-quality development, including national scientific research institutions and platforms, major scientific and technological projects and achievements, high-growth future enterprises, high-level innovation teams and talents, etc [6] [7]. Introducing innovation resources is a systematic project, involving multi-agent and multi-field collaboration, which has extremely high requirements for top-level design of work. To promote work efficiently, it is necessary to use systematic thinking and holistic thinking to establish and improve the introduction system of innovation resources, systematically and coordinately promote work, promote the optimization and integration of resources of all parties to form synergy, promote the introduction of innovation resources and the coordinated and efficient operation of the ecosystem. Innovation resource introduction is the behavior that the government actively embedding into economic and industrial development, clarifying the role positioning and positive effects of the government and market in innovation resource introduction, giving full play to promising government and effective market forces, and driving the whole society to participate in innovation resource introduction has an important influence on local economic development [8]. Innovation resources have characteristics of scarcity and pursuing the maximization of its own value, and it always flows from regions with low marginal contribution rate to high. The process of introducing innovation resources is dynamic, which will change the scale and structure of regional talents and capital, improve the allocation efficiency of resources, and then play a positive role in promoting regional innovation activities. From the perspective of resource potential energy, the introduction of innovation resources essentially flows from regions with high resource potential energy to low, innovation resources themselves contain a lot of knowledge information, so their inter-regional flow is bound to produce knowledge spillover effects. Moving to regions with high marginal contribution rate and accumulating continuously will promote economies of scale in this region, reduce the average cost of innovative production, and then improve the innovation performance in this region.

Based on the gradient transfer theory, starting from the initial differences of innovation resource endowments, this paper divides the distribution of China's innovation resources into high-gradient areas and low-gradient areas, and the innovation resources in each area flow continuously according to the resource level. In the first stage, the high-gradient areas have more abundant innovation resource endowments, while the low-gradient areas have limited innovation resource endowments.According to neoclassical growth theory, the difference of innovation resource endowment among regions will lead to the essential improvement of production capacity in high-gradient regions, and the backward regions will be unable to form economic progress due to the lack of innovation resources. With the deepening gap between regional production and economic potential energy, the allocation capacity of innovation resources in high-gradient areas will also significantly surpass that in low-gradient areas. The second stage, driven by the higher efficiency of resource allocation and the policy of "efficiency first", the innovation elements will shift from low-gradient areas to high-gradient areas, that is, innovation resources will gather in high-gradient areas. On the one hand, the adjustment of the flow of innovation resources leads to the high-gradient areas constantly consolidating the resource hardware foundation and enjoying the benefits brought by the agglomeration of innovation resources; On the other hand, it will further reduce the weak innovation endowment

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in low-gradient areas, which will greatly inhibit economic growth. In the third stage, technology diffusion will be realized by means of technology trading platform, regional innovation network, demonstration and imitation behavior, etc. Under the resource allocation mode of "giving consideration to fairness", technology, manpower, capital, equipment and other factors began to flow to low-gradient areas, and the backflow of innovation resource agglomeration began to appear, which also pointed out a feasible path for low-gradient areas to seek economic catch-up. From the perspective of factor flow, gradient transfer theory presents the welfare changes in different regions in the process of innovation resource transfer.This way of resource allocation will help to bridge the economic gap in areas with scarce resources (low gradient areas). As shown in Figure 1.

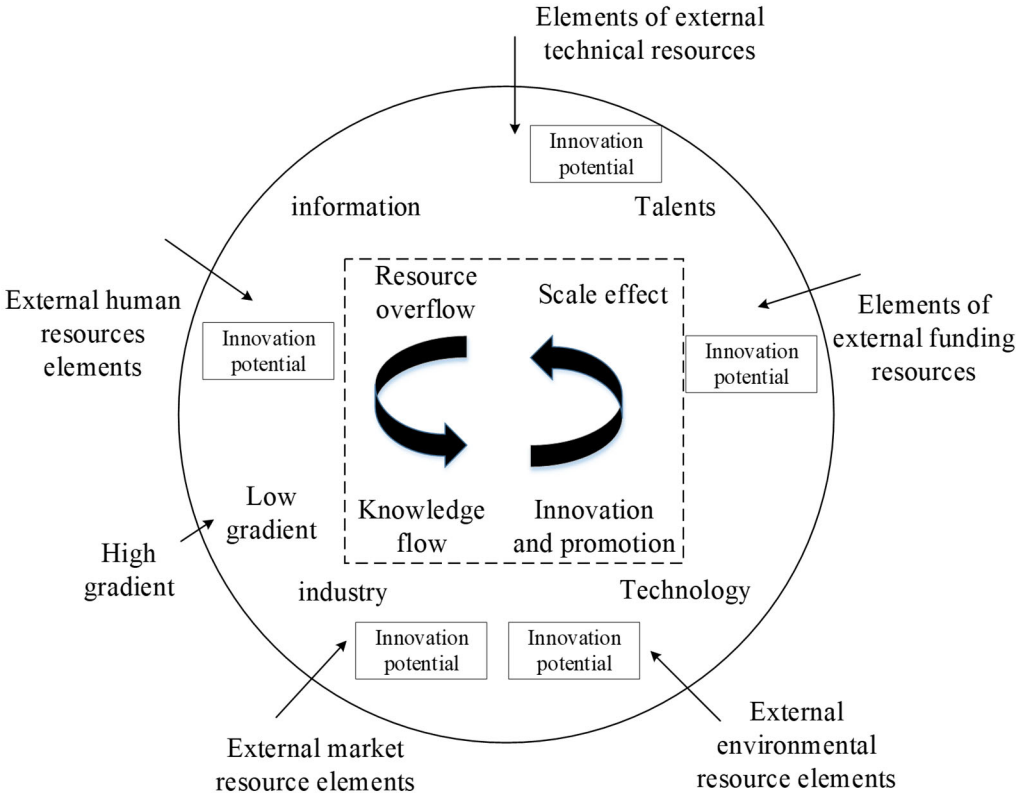

Figure 1. Gradient flow of innovation resources

4. The Main Path of Introducing Innovation Resources in Advanced Foreign Regions

Foreign advanced regions aim at scientific and technological innovation and industrial innovation, and constantly attract and gather innovation resources to promote scientific and technological innovation and economic development through various ways such as university clusters, scientific apparatus clusters, technology finance, technology and industrial policies.

4.1. Talent Introduction Mode

San Francisco Bay Area is one of the world famous high-tech R&D centers and the financial center of the west coast of the United States. San Francisco has a world-class university cluster, Stanford University and other universities have promoted the prosperity of the San Francisco Bay Area, making it the area where innovative talents, innovative projects, innovative platforms and innovative funds gather most. New york Bay Area has the world's top "Ivy League schools" cluster, as well as a public university cluster composed of new york State University and new york City University. Relying on this world-class university cluster, new york Bay Area has

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attracted a large number of students and scholars to study and work in new york, gathered and cultivated a group of cutting-edge innovative talents in emerging industries, and established a group of world-class research centers, formed a world-class High-tech industrial clusters. There are 225 universities in the Tokyo Bay Area, accounting for 29% of the total number of Japanese universities, and super-international universities account for about 46% of the total number in Japan. In addition, the academic research institutions in the Tokyo Bay Area account for about 40% of the country, and the number of researchers is more than 60%. A large number of institutions of higher education and research institutes have attracted and trained a large number of high-end talents, and continuously delivered fresh blood to enterprises in the Bay Area. At the same time, the intensive distribution of universities and research institutes in the Bay Area also laid a foundation for Industry-University-Research to promote industrial development.

4.2. Scientific Apparatus Recruitment Model

The San Francisco Bay Area has linear acceleration center, Lawrence Berkeley and other national laboratories, also has more than 10 internationally leading and complex experimental facilities and large-scale scientific devices including advanced light sources (ALS), particle accelerators, molecular casting factories, electron microscopes and linear high-energy electron accelerators.Numerous experimental facilities and scientific apparatus clusters have attracted a large number of high-end talents, promoted the cross and penetration between disciplines, and laid a foundation for the cultivation of high-end talents, technological innovation, the development of science and technology enterprises and the progress of emerging industries. At present, there are more than 1,000 academicians of the National Academy of Engineering and Academy of Sciences, tens of thousands engineers, attracting more than 1 million high-tech personnel from all over the world, and a large number of young entrepreneurs. Concurrent development has cultivated more than 10,000 innovative enterprises at different levels. Tsukuba Science City, located in the northeast of Tokyo, integrates a group of scientific devices such as proton synchrotron PS, pulsed spallation neutron device KENS and photon factory PF, which has led to the rise of Tokyo Bay Area and become the largest scientific center, knowledge center and talent gathering place in Japan, attracted a large number of microelectronics, new materials and bioengineering enterprises, and gathered NEC, Canon, Sony and other innovative leading enterprises.

4.3. Technology and Finance Boost Mode

San Francisco Bay Area has diversified, smooth, flexible financing channels and smooth exit channels, and the capital investment direction is mainly focused on scientific and technological innovative enterprises and high-tech entrepreneurial projects. The annual average venture capital investment in Silicon Valley is as high as about 7 billion US dollars, accounting for nearly a quarter of the United States, and the angel investment accounts for 87% of California.These investments and financing provide a powerful impetus for the whole Bay Area to introduce more innovative venture capital and projects, and attract innovative talents and innovative enterprises to settle down. New york Bay Area is a world-class financial bay area, and new york is the most important financial center in the world, where more than one tenth of the headquarters of Fortune 500 companies are located.Wall Street is home to nearly 3,000 foreign trade, finance, securities and insurance companies around the world. The status of an international financial center attracts a large amount of capital inflows, then technology finance, investment and financing are booming, which has injected a strong impetus into the concentration of innovation resources and technological innovation.

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4.4. Government Precise Introduction Model

New york Bay Area issued a series of development policies and landing measures to actively adjust the industrial structure and promote regional economic development; Strengthen the regional economic development strategy, and make the industrial structure of the Bay Area form a multi-complementary pattern through clear division of labor and reasonable functional orientation; Develop export-oriented services and other tertiary industries. Through this series of policy measures, New york Bay Area takes manufacturing and port industry, finance and insurance, biomedicine and nanotechnology as its core industries, forming an increasingly sophisticated and innovative industrial chain, which also creates high-quality conditions and atmosphere for the introduction of innovation resources in the whole industrial chain. Compared with the naturally formed San Francisco and new york Bay Area,the traces of advanced planning, design and precise implementation in the development of Tokyo Bay Area are more obvious. In the whole process of technological innovation and development in Tokyo Bay, the government has played a very important role, vigorously implementing the innovation-driven development strategy from the aspects of policy, capital, layout planning, enterprise guidance, the perfection of supporting facilities and services, etc.It accelerated the gathering of knowledge-based and technology-intensive industries and their supporting resources to the Bay Area, and promoted the industrial and economic development of the Bay Area.

4.5. International Science and Technology Cooperation Attracting Mode

As a powerful country in scientific and technological innovation, Germany has been carrying out extensive international scientific and technological cooperation for a long time, attracting and gathering global innovation resources by building laboratories, research centers, research institutes and other platforms, to promote scientific and technological innovation and economic development. Germany attracts high-end scientific research talents around the world through high reward funds to continuously improve the competitive strength of scientific research.Known as "the paradise of science and technology", Singapore insists on opening innovation, widely sets up "Contact Singapore" bases overseas as outposts for gathering overseas professionals; Encourages multinational companies to set up R&D headquarters, R&D bases, laboratories and other research machines in Singapore, and realize independent innovation and integrated innovation through digestion, absorption and re-innovation to promote scientific and technological innovation and development. Israel enjoys the reputation of "Entrepreneurial Country" and "Middle East Silicon Valley", it's government attaches great importance to international scientific and technological cooperation. At present, Israel has reached scientific and technological cooperation agreements with important innovative countries and international organizations around the world; The government introduced project financial support and tax incentives to attract investment from multinational enterprises.Israel has now become a gathering place of R&D centers of multinational corporations in the global high-tech field, which has bred many scientific and technological innovation products that have influenced the world, and has become a successful case of using global innovation resources to realize open innovation.

5. The Main Path of Introducing Innovation Resources in Domestic Advanced Areas

Advanced areas in China mainly adopt the way of building platforms for the introduction of innovation resources, gathering world-class innovation resources, increasing achievements transformation and resources landing guidance, and enhancing resource attraction and cohesion.

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5.1. Building A Comprehensive National Science Center

Beijing Huairou, Shanghai Zhangjiang and Anhui Hefei gather the world's leading scientific and technological innovation resources by building comprehensive national science centers. Among them, Beijing Huairou deepened its cooperation with state-level universities, actively laid out a number of major scientific and technological infrastructures and major scientific research platforms, to gather first-class universities, research institutions, new research and development institutions and innovative enterprises, absorb all kinds of high-quality resources of the Chinese Academy of Sciences system and innovation resources overflowing from Zhongguancun, and gather financial capital and international innovation resources; Shanghai Zhangjiang relies on high-density large facilities and large device groups to attract domestic and foreign research institutions and universities to set up world-leading user experimental devices and scientific laboratories locally, and introduce international, high-level and cross-disciplinary first-class scientific research teams. Relying on Hefei Institute of Material Science, Chinese Academy of Sciences and University of Science and Technology of China, Anhui has introduced many high-level innovation platforms, such as national laboratories, cross-cutting research platforms and industrial innovation platforms, to attract first-class research teams aii over the world, as well as first-class scientific and technological talents and entrepreneurial talents engaged in basic research, cutting-edge high-tech development, and strategic engineering technology research and development to settle down, to guide domestic industries such as light source, gene technology, artificial intelligence, integrated circuit, high-end medical equipment and smart energy to develop in Hefei cluster.

5.2. Construction of Science and Technology Service Platform

In terms of building a scientific and technological service platform to link innovation resources, Beijing Zhongguancun Demonstration Zone strives to build an open, collaborative and globally distributed innovation and entrepreneurship environment, supports the development of new modes and new formats of scientific and technological services, and gathers scientific and technological service resources covering all fields and chains of scientific and technological innovation. It has brought obvious promotion effect to attracting more scientific and technological innovation subjects, driving more scientific and technological achievements, high-end talents, and high-quality enterprises to land in Zhongguancun; Jiangsu Industrial Technology Research Institute takes "one system, two systems" and project manager system to guide the innovation resources of colleges and universities to serve the innovation of enterprises and regions, connect with local parks, select leading talents, and introduce teams and major innovative projects through the whole system, carry out the integration of innovation resources on a global scale, explore new modes of innovative resource agglomeration, and build a "strong magnetic field" to attract innovation resources; Zhejiang Creates an "online+offline" technology trading market system, gathers scientific and technological resources and promote the transformation of achievements; Hong Kong's science and technology intermediary service agencies have a large number, detailed division of labor, high degree of specialization and internationalization, and relatively abundant and high-quality employees. The overall development of the science and technology service industry has effectively played the role of gathering more capital and talents from home and abroad.

5.3. Build An "Offshore" Base

The offshore innovation and entrepreneurship base refers to an international comprehensive entrepreneurship platform or a new R&D institution that adopts the offshore mode of "registration in the region, domestic and overseas operations" for overseas talents or projects, docking innovation resources at home and abroad, and internationalization with functions such as attracting talents, entrepreneurial incubation, and professional service guarantees[9].The offshore innovation and entrepreneurship base for overseas talents built in Shanghai Free

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Trade Zone, builds an international onshore and offshore entrepreneurial platform, and new entrepreneurial clusters such as offshore R&D, offshore finance and offshore trade by creating a space environment that is convenient for development, supporting all factors, introducing supporting policies such as talents, finance, commerce, foreign exchange, etc.. Hefei government issued the "Implementation Opinions on the Construction of Hefei National Offshore Innovation and Entrepreneurship Base for Overseas Talents", integrating the city's industry, double innovation, talent policies and talent resource introduction channels at home and abroad, accelerating the establishment of a new flexible talent introduction mechanism in line with the world, and forming the fertilizer accumulation effect of overseas high-end innovative and entrepreneurial talents, exploring the "Hefei Model" of overseas talents' offshore innovation and entrepreneurship. Haierhai Foreign Exchange has built offshore incubation bases in Qingdao, Nanjing and other places, it has promoted the global outstanding entrepreneurial projects and innovation resources such as Israel and Finland to gather and take root locally by building a new international cooperation model of "overseas pre-incubation+local accelerated incubation" .

6. Countermeasures and Suggestions

According to the actual situation in China, in order to promote the introduction of international innovation resources, we can start from the following aspects:

First, strengthen the top-level design. Establish an introduction system of innovation resources such as universities and research institutes, high-quality innovative enterprises, high-end science and technology service institutions, and high-level innovation teams, which is guided by the government, supported by professional service networks, and operated by market-oriented multi-subjects. Strive to lay out and build a number of major scientific devices, support the construction of a number of high-level innovation research institutes, develop a number of international industrial technology innovation alliances and technology transfer institutions to create an innovative ecological highland with factor agglomeration, chain integration and system optimization, and promote the orderly flow and efficient allocation of scientific and technological research and development resources and industrial innovation resources to China. Establish and improve the working mechanism, cooperation mechanism and incentive mechanism to ensure the efficient operation of the imported system. Improve the market-oriented mechanism guided by the government, create an innovative atmosphere and entrepreneurial environment suitable for the utility of innovation resources to form a dynamic mechanism of spontaneous inflow and efficient allocation of resources.

Second, build innovative clusters in colleges and universities. New york Bay Area and other world-class bay areas have high-level university clusters. These university clusters attract and accelerate the integration of innovative elements such as talents, capital and technology, and cooperate with industrial clusters to develop, thus becoming the driving force for industrial upgrading in the Bay Area. Worldwide, powerful countries in science and technology attach great importance to the top-level design of gathering innovation resources, strengthen strategic planning and system layout to effectively promote the scientific and technological innovation and economic development of the whole country. For China, it is necessary to strengthen the top-level strategic planning in organization and layout, and optimize the intensive allocation of innovation resources with a long-term and overall view. Therefore, in the process of introducing innovation resources in China in the new period,we should give full play to the advantages of local science and education resources, build a high-quality higher education ecosystem, and build and cultivate world-class university clusters.

Third, establish scientific and technological service platforms. At present, the main industries in San Francisco Bay Area and new york Bay Area are professional services for scientific and

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technological innovation and financial services respectively. Zhongguancun promotes the construction of scientific and technological service platforms by issuing management regulations. Jiangsu, Zhejiang, Shanghai and other provinces and cities are also actively building online and offline service platforms to gather innovation resources.In the new period, China should continue to promote the construction of science and technology service platform and give full play to the resource gathering function of science and technology service platform institutions. San Francisco Bay Area is the center of technology and finance in the United States and the center of venture capital in the world. new york Bay Area is a world-class financial bay area and the most important financial center in the world. In view of this, China should further promote the development of technology and finance, accelerate the establishment of an international venture capital center. At the same time, actively introduce overseas venture capital and expand the introduction of capital-oriented innovation resources.

Fourth, establish an organizational working mechanism. Improve the horizontal coordination mechanism, establish an organizational operation mechanism that is coordinated by China's science and technology management departments and linked with organizations and personnel departments. Establish the linkage mechanism between ministries, provinces and cities, adhere to the combination of government guidance and market regulation, and strengthen the interaction with cities and high-tech zones in resource introduction.Through timely consultation meeting, coordinate the introduction of innovation resources around the country, focus on breaking through key problems, explore new measures of local work to promote the effective integration of all kinds of scientific and technological innovation resources at all levels and the organic combination of all kinds of production factors. Establish a multi-subject and multi-level joint conference system, give full play to the role of various subjects such as universities, scientific research institutions, enterprises and social organizations in the decision-making on the introduction of innovation resources, set up professional service teams that focus on the introduction and cultivation of innovation resources, promote the organic combination of attracting investment, attracting technology and attracting investment, and open up the horizontal sharing channels of information and resources to further promote the landing of scientific and technological innovation talents, projects and platforms, and form a good situation in which all parties work together to promote the introduction of innovation resources.

Fifth, establish a market-oriented coordination mechanism. The government should set reasonable policy objectives, formulate regional development plans for attracting investment and talents, explore the attracting and landing modes that are in line with local resource endowment conditions, let the market stimulate endogenous motivation, and create a good external environment for the introduction of innovation resources through policy and financial support and sound cooperative service guarantee system in Industry-University-Research. Give play to the decisive role of the market in the allocation of innovation resources, use market-based means to optimize the allocation of innovation resources and capital efficiency, give full play to the role of market-based mechanisms in the allocation of innovation resources, effectively connect administrative forces with market forces, and drive enterprises, R&D institutions, venture capital, financial institutions and other social forces to jointly promote the recruitment work to promote the transformation of achievements to the ground, improve the efficiency of resource introduction, and make the innovation vitality generate under the mechanism of marketization and socialization.

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