

## A Study on Regional Innovation Policy under Innovation Paradigm 3.0: A Case of Jiangsu Province in China

Lei Ma<sup>1</sup>, Zheng Liu<sup>2</sup>, Min Jiang<sup>1</sup>, Ke Yu<sup>1</sup>, Jingxian Gan<sup>3</sup>

<sup>1</sup>School of Public Affairs, Nanjing University of Science & Technology, Nanjing, China

<sup>2</sup>International business School Suzhou, Xi'an Jiaotong-Liverpool University, Suzhou, China

<sup>3</sup>School of Intellectual Property, Nanjing University of Science & Technology, Nanjing, China

**Abstract**--Jiangsu is one of the economically developed Provinces in Yangtze River Delta of China, and it takes the first all the time in regional innovation ability of China since 2009. With some insights of the case study, this paper compares the Jiangsu's innovation policies of scientific talents, patent, R&D and so on from 1988 to 2015. Based on the evolution of innovation paradigm perspective, the paper analyzes the characteristics of innovation policy tools mix from innovation 1.0 to 3.0, purposes to establish analysis framework for Jiangsu's innovation policy from Innovation paradigm perspective and contributes to provide help for the governance of innovative policies in developing countries.

### I. INTRODUCTION

With the development of innovation paradigm, regional innovation policy becomes a hot topic. The study of innovation policy has experienced from the supply-side of innovation paradigm1.0, the supply-side and the environment-side policy of innovation paradigm2.0, to the third generation of innovation paradigm3.0 [1]. Elvira Uyarra[2] refers to the third generation innovation policy needs multidimensional thinking and innovation policy tools. The OECD's study of innovation policies in Australia, Belgium, Japan, South Korea, the Netherlands, Sweden and other countries points out that the first two generation of innovation policy take science & technology as innovation sources, but the third generation of innovation policy is an inter-departmental and cross-border framework. In 2003, the European Union issued a "declaration of Dublin", deployed the new generation of innovation policy focused on innovation ecosystem. Obviously, the study of evolution of innovation policy is the basis of promoting regional innovation practice. Jiangsu is one of the economically developed Provinces in Yangtze River Delta of China, and it takes the first all the time in regional innovation ability of China from 2009 to 2015. Why Jiangsu can transit from a traditional manufacturing Province to innovation leader[3,4], and how it uses the innovation policy tool to promote the development of regional innovation is a problem worth thinking about. This paper chooses innovation policies and practices of Jiangsu from 1988 to 2015, builds an evolutionary analysis framework for the regional innovation policy, analyzes the characteristics of innovation policy tools mix under different innovation paradigms, and give an advice on the formulation of regional innovation policy. The main structure of this paper is divided into the six following

sections: (1) introduction; (2) literature review;(3) research design and methodology; (4) a detailed case study of Jiangsu Province;(5) discussion of the case study; and (6) conclusion and further research.

### II. LITERATURE REVIEW

#### A. Innovation paradigm: innovation1.0 to 3.0

Along with the deepening of globalization, technology innovation cycle has shortened constantly, in the face of the high complexity and uncertainty of market competition, a series of changes have taken place in enterprise innovation mode, academic and practical fields have been paid close attention to the development and innovation paradigm change. In June 2013, the theme of "open innovation 2.0" held in Dublin, marks on the research and development of the third generation of innovation paradigm into a new stage of development. With the deepening research of quadruplex helix theory, the European Union put forward the innovation paradigm evolution of the European Union version 3.0. In 2003, Harvard Business Review "embrace Innovation 1.0" from the perspective of innovation process summed up the characteristics of the evolution of enterprise innovation paradigm, proposed the evolution route of enterprise innovation pattern: from the closed innovation in the enterprise Innovation 1.0 stage ( innovation resources limited within the enterprise) to the open innovation in Innovation 1.0 (widely available from the enterprise external resources), then to the embedded innovation in Innovation 1.0 (enterprises pay more attention to resources integration and other main body symbiotic development in the process of innovation).

Innovation 1.0 is the innovation form in industrial age. It's the product from R&D to market within an organization to complete the process, emphasis that enterprises establish internal research and development institutions when conducting research and development on its own. Innovation driving force comes from the demand and the scientific research of "the duplex". In the given supply-demand relationship (existing market), Innovation 1.0 can enhance the capacity of manufacturers supply, reflected in the price of a product or service competitiveness, price, delivery and service system, has also been defined as the closed innovation [5]. It can be viewed as a kind of linear innovation.

Innovation 1.0 refers that the enterprise innovation is opening, nonlinear process. The utilization of External innovation resources is the nature of open access, it

emphasizes on enterprise innovation resources effectively integrate inside and outside[5]. Lichtenthaler [6] also mentioned the open innovation is a process that through the use, possession, the development to organize the activities of the internal and external knowledge. Internal activities will affect the process of open innovation to a great extent, because companies only have a certain technical knowledge can promote the development of open innovation.

Innovation 1.0 is defined from the innovation process and the relationships among subjects. "User oriented innovation" has become increasingly important. Innovation subjects in the process of innovation across the border to make up the "government - enterprise - university research - the user" of the "quadruplex helix" to form a symbiotic relationship of cooperation. As Eric Von Hippel in "Democratizing Innovation" [7] pointed out in the open innovation is largely confined to the connection between the enterprise and the related producers, and the depth of the users to participate in the future market will fundamentally change the inner structure of innovation paradigm. The strategic focus of innovation is the relationship between creative design and the users. Innovation driven model is based on quadruplex helix "government - enterprise - university research - the user", that is "open Innovation 1.0" new paradigm.

Thus, from the Innovation 1.0 to 3.0, the process of enterprise innovation is more and more open, the border has become increasingly blurred, the cooperation with external subject be closely in the process of innovation, the utilization of external resources become more and more, and with the external subject to form value sharing, cooperative symbiotic ecosystem [8].

*B. Innovation policy tools*

In early studies, innovation policy tools can be divided into mission-oriented and diffusion-oriented [9]. Rothwell and Zegveld[10] classify the innovation policy tools into three categories: environmental-side policy tools, supply-side policy tools and demand-side policy tools. The environmental-side policy tools refer to the government by law, finance and tax system to improve the legal environment of technology innovation, and promote technological innovation and new product research and development from the side. The supply-side policy tools are to set up special funds by the government and fosters the talent to achieve more effective supply of source elements, then pull the innovation and new product development. The demand-side policy tools refer to the government with the help of purchasing control rules to reduce market risk and trade restriction, advance steadily in the market for the application of new technology, and promote innovation and new product research and development. Based on the theory of innovation process, innovation is the result of supply and demand both sides ongoing creative interaction. Innovation policy can be divided into two categories from the perspective of supply and demand: supply promotion policy and demand motivation policy. The former through the stimulation from

the suppliers of innovation (enterprises and scientific research institutes, universities, etc.) to promote innovation[11]. The demand-side innovation policy at present has not formed a unified definition, generally regarded as a series of measures in order to increase the innovation demand. Its purpose is to promote innovation absorption, improve the recognition and understanding of market demand, and accelerate the implementation of innovation diffusion. The researchers take R&D investment in technology innovation as the breakthrough point of the supply side of the traditional innovation policy, focus on public investment, basic subjects, information intermediary and Innovation Park, etc.[12]. But the demand side policy mainly includes the innovation oriented public procurement, rules and standards, cultivating leading the market, and promote the innovation from the demand side [11,13]. (See table 1)

TABLE 1. THE MAIN POLICY MEASURES OF THE SUPPLY-SIDE AND THE DEMAND-SIDE POLICY\*

The Demand-side Policy	The Supply-side Policy
Public Procurement	Public R&D (funding, tax incentives and risk investment)
Regulations	Strengthen scientific basis (research center, infrastructure construction, personnel training and flow)
Cultivating leading market	Information & mediation (international technology)
Innovation from demand-side	Network measures (incubators and science parks, industry cluster, etc.)
Systemic Policies	

\*Source: By literature [11]

The development of demand-side innovation policy in theory and practice level is gradually deep and be caused take seriously with the changing of innovation process. In 2008, the OECD in the process of making its innovation strategy in the new period, founded the working group on innovation and technology policy, aims to provide support for innovation strategy, then, as a relatively independent research, the OECD published in May 2011, the report "demand-side innovation policies", elaborated demand-side innovation policy in the theoretical development and the national innovation practice exploration in recent years. The OECD[14] report summed up the innovation policy demand side of the main policy tools and its characteristics (see table 2), including policy design target and policy effect, and must be noticed when implementing policies may risk, etc.

With the constant change of innovation paradigm, in the practice of innovation, the choosing of innovation policy tool is more and more important. Scope of the choice of policy instrument and combination is determined by innovation policy system and its joint decision goal[15]. For the differences and relation between the demand-side policy and traditional supply-side policy, Georghiou[11] thinks supply side and demand side policies like a pair of scissors wings, two kinds of policies and measures to use mutual cooperation rather than replace each other, to adapt the demand of innovation and development at different stages.

## 2016 Proceedings of PICMET '16: Technology Management for Social Innovation

TABLE 2. THE MAIN TOOLS' FEATURES OF DEMAND-SIDE POLICY SYSTEM\*

Demand-side Policy	Public Procurement	Regulations	Standards
Policy targets and scope	Products and service	Competition, social goals	The transparency of operation
The required input	Financial fund, related abilities	The legal process, multi-sectoral collaboration	Related coordination department
Incentive for participants	Increase of sales, preferential treatment for SME	Entrust agreement	Voluntary
Major executives	Government sector	Government sector	Industrial circle
Policy effects	Improve public services, stimulate innovation	Reduce market risk	Reduce market risk
Potential risk	Lack of experience	The target may have conflict, Program is too long	Technology blockade

\*Source: By literature [11]

### III. RESEARCH DESIGN AND METHODOLOGY

This paper adopted to help the single case in-depth analysis of research on extraction method, using the case data, and existing literature[16], constructing innovative paradigm based on the analysis framework of innovation policy evolution of Jiangsu Province in China.

Jiangsu Province is located in the Yangtze River delta region of China and economically developed eastern Provinces, the current population is 79.6 million, and GDP is 7.06 trillion RMB in 2015. By the end of 2015, in the national regional innovation ability in Jiangsu Province for seven consecutive years ranked in keep the first place. In 2015, the provincial scientific & technological progress contribution rate was 59%, and the whole society research and development (R&D) activities which accounts for 2.50% GDP, technology contract for the whole year turnover was 65.53 billion yuan, the Province enterprises, a total of 4.28337 billion patents, authorization for the whole year 2.00032 billion patents, including 1.4666 billion invention patents. The Province by the national high and new technology enterprises in the new standard accumulated up to 7703, identified 10277 provincial high-tech products, national key new product 151, and has built 133 national characteristics of high and new technology industry base. China scientific & technology development strategy research group releases a report about the innovation capability of the national provincial (excluding Hong Kong, Macao and Taiwan) from knowledge creation, knowledge acquisition, enterprise innovation, innovation environment and innovation. According to "the China regional innovation capacity report 2015" shows that Jiangsu Province regional innovation capacity ranks the first in 2015 and is one of the strongest creativity Provinces.

This research takes innovation policy evolution of Jiangsu Province under different innovation paradigm as an example, analyzes the main findings of the case during 1988-2015. According to Wan Li[36] in the research of the development of the innovation policy for China, China science congress was held in 1978, restart the status of science in China's economic development; In 1995, China

held a national conference on scientific & technology, highlight the development of scientific & technology in the task of China's reform and opening up; Chinese technology innovation conference was held in 1999, has been clear about the driving action of innovation in economic development, this conference as a symbol of China[17], was called the national scientific research system age before, after can be referred to as the era of national innovation system in China, each generation of the duration of the innovation policy basic for 10 years or so. National strategy is the local government policy guidance, in the case of Jiangsu innovation policy evolution study phase is divided into three stages, 1988 - 1997, 1998 - 2007, and 2008 - 2015.

In the process of case study, the research team gained the firsthand data meeting by face to face interviews, telephone interviews, field observation, seminars, relevant government departments, enterprises, research institutes, conducted in-depth interviews with the innovation policy making departments and policy makers to supply dates and confirmed on public information, answers some problems we care about and difficult to determine. In this paper, one of the authors, from 2010, presided over the government innovation policy research topic in Jiangsu Province for many times, have been familiar with Jiangsu innovation policy and practice in recent years. The team collects and organizes second-hand data through the website information, news reports, professional magazines, internal data, and repeatedly verified and compared obtained as detailed information as possible.

### IV. DETAILED CASE STUDY OF JS INNOVATION POLICY

In the late 80s of 20th century, reforming and opening up brought big changes to China. The speed of economic development in Jiangsu province was also at the national advanced level. But due to the rapid expansion of economic scale and economy, the economic growth mainly supported by epitaxy expand reproduction, and a long time formation of inefficient extensive economy cause the increasing of material consumption as the main driving force. With the increased competition at home and abroad, the large

population and serious shortage of natural resources of Jiangsu Province, the extensive economy is difficult to make social and economic sustainable development<sup>[18]</sup>. Giving full play to the advantages of Jiangsu education resources and intelligence, to the progress of scientific & technology as the forerunner of efficient intensive economic transformation, is the only way for the sustainable development of Jiangsu's economy. This part introduces the general situation of the innovation policy of Jiangsu province at different stages and the main achievements of the three stages.

### *A. Innovation policies for scientific research system: 1988-1997<sup>1</sup>*

In 1988, Jiangsu Province was the first province to take innovation as development in the nationwide, and put forward the strategy of "science & technology to revitalize the province". The strategy aims to give full play to the role of science & technology as the first productive forces, promote economic and social steady, coordinated development of science & technology in Jiangsu Province. In 1994, Jiangsu put forward the strategy of "Science and education to revitalize the province", further defined the direction of the transformation of economic development in Jiangsu Province.

From 1988 to 1997, the province successively developed 5 legal regulations and implemented 100 regulatory policies, effectively guarantee the further implementation of the strategy of "science & technology to revitalize the province". These policies mainly include: established the technology contract registration system, the legal status of private science & technology services, operation and management, levied stamp duty on technology contracts, stipulated on patent service charge and so on. The formulation of these policies effectively promote the market from traditional extensive economy gradually transferred to the development of science & technology system. Especially in 1992, Jiangsu Province was the first to issue "the regulations on the Jiangsu Province scientific & technology progress". The release of this regulation provided legal protection for the strategy of "science & technology to revitalize the province".

In order to improve the innovation ability of enterprises, scientific research institutions and universities, Jiangsu Province issued "opinions on strengthening the management of the cities and counties in the development of science & technology fund" and "Jiangsu Province scientific & technology achievements appraisal method" and so on continuously, used science & technology R&D fund for enterprise technological innovation and scientific research in colleges and universities to provide financial support. At the same time, the 1991-1995 Of digestion and absorption of technology import expenditure has reached around 5%, opened credit channels of science & technology actively, formulated the financial mechanism can adapt to the

development of science & technology fund demand characteristics. Jiangsu Province also drew up encourage policies to push enterprises invest its own funds to scientific & technology progress, and carried out enterprise science & technology development fund special auditing system. Before science & technology system reform, the funds of scientific research institution was allocated by government's plan. In order to enhance the vitality of the innovation of the scientific research institutions, Jiangsu Province introduced funding system, promoting technical achievement commercialization of science & technology policies to make scientific research subject for research and development of the market demand. According to statistics, in 1997, the raised funds of science & technology is RMB 10.877 billion yuan and is 7.4 times in 1988, the scientific research institution self-raised funds rate reached to 72%.

Jiangsu Province also reformed of the science & technology, education system, increased investment in science & technology and education. Through the reform of science & technology operating mechanism, the personnel management system and organizational structure, Jiangsu Province issued various policies for science & technology personnel in various forms of technical contract and service to promote the combination of scientific research and production, and carried out the activities of science & technology for enterprise needs. In 1996, Jiangsu was the first Province in popularization the nine-year compulsory education in the whole country [3]. In 1997, the province has 1.9346 million various types of professional and technical personnel, every ten thousand people have professional and technical personnel 271 people on average, scientists and engineers is 1.0136 million, the proportion of all professional and technical personnel is 52.39%. The provincial government set up network consulting organization composed of a large number of technical experts and scholars provides the necessary guarantee for the province's policy of science & technology popularization. By conducting training and enforcement, the general awareness of the protection of intellectual property rights and its legal system of enterprises and personals was generally strengthening and promoted the development of the patent. Since 1985 to 1997, applications for patent of Jiangsu Province totaled 45062, including 24789 patents authorized.

With the deepening implementation of the strategy "Science and education to revitalize the province", technological content in economic growth of Jiangsu Province science & technology rose significantly. In 1997, the provincial scientific & technology progress monitoring statistics results show that the annual scientific & technology progress's contribution to the agricultural and industrial economic growth share has reached 51% and 37%, then in 1990 increased by 20% and 13%. Jiangsu Province relied on scientific & technology progress to achieve the historic leap.

<sup>1</sup> Date sources: Statistical bulletin of Jiangsu economic and social development 1988-1997

### *B. The Innovation policy in 1998-2006<sup>2</sup>*

With the continuous deepening reform of the scientific & technology management system, Jiangsu Province had achieved innovation-driven advances. But there are some problem existed, such as the lack of the self-innovation capability, the R&D process always imitate or introduce advanced foreign technology to produce, the shortage of key technical, the lack of own independent devices, the mainly dependent were on imitative innovation, the shortage of key technical and self-developed devices. The most high-tech enterprises had been in low position of the industrial chain. The University, research institute-industry (URI-I) links were not quite close. So, Jiangsu Province put forward to building an innovative city, accelerated the construction of technological reform system based on enterprise, improved the contribution of scientific & technological advances growth to economic and social advancement in 2006.

In this time, Jiangsu Province issued 50 policies on enhancing the capability of independent innovation and building Innovative Provinces, which included preferential tax policy, scientific & technology loan risk allowance, scientific & technology infrastructure operating subsidies, Determination of independent innovation products before government procurement, innovation fund of medium and small-sized sci - tech type enterprises, the listing transfer of service invention, outstanding contribution prize, etc. The Province also issued policy on “The implementation plan of Jiangsu Province science & technology infrastructure construction in 2003-2005” and “The overall plan of Jiangsu Province science & technology infrastructure construction in 2004-2014”, etc.

For example, in the 2006, The of Jiangsu Province spent 14.5 billion Yuan on developing significant scientific infrastructure projects, 87.6 million yuan on developing public scientific & technology service platforms, such as the super computing applications service platforms, the technological data and large instrument sharing service platforms. They also built two hi-tech key laboratories of Jiangsu Province and seven engineering technology research centers.

The Jiangsu encouraged enterprises to play a dominant role in technical progress and innovation, and increased their capacity for independent innovation. There were 222 new productions identified a state's key new product, 1693 as Province's high-tech products. There also had 111 projects received the national innovation fund for small and medium S&T businesses support of 54 million yuan, which ranked top in China.

They solved the scientific & technology problems accompanied with the economic society development by strengthened the application fundamental research on market demand orientation and implemented the original Innovation project in the field of information science and biological

medicine and new material and new material and modern agriculture, etc. The government developed multiple multi-level, various forms, such as industry-education-research institution collaboration cooperation forum and technological cooperation conference and technology exhibition meeting, and so on, promoted the URI-I links gets closer and closer. Give some examples: There were 45 out of 81 cooperation projects outside Jiangsu Province. The Province funds for the transformation of scientific & technology achievements supported 105 projects by the end of 2005.

Jiangsu Province built the carrier for the scientific & technology Enterprises and enhancing the ability of scientific & technology business services. Jiangsu Province had established 76 sci-tech incubation centers, spend 5.72 Billion yuan on supporting the startup and innovation which had totally incubated 1415 startup companies and got the revenue of 151.6 billion yuan in technology, industry and trade. The Province had 45.2 billion yuan in special fund of scientific & technology venture capital and guarantee, and had 73 guarantee organizations. At the same time, the Province had built International scientific & technology Cooperation platform, International technology transfer services platform, and such international cooperation platform like international technology incubation platform and R&D center.

In 2005, the R&D spending of Jiangsu Province accounted for more than 1.48% of the GDP, more than fivefold increase in 2000. In 2006, the R&D spending accounted for more than 1.55% of the GDP, the Province had 10.5 thousand researchers. The total value of technical contracts signed on technical markets reached 119.53 billion yuan, up 18.5% year-on-year, ranked third in the country. The number of patent grants ranked third in China, reached 19352, an increase of 42%. The enterprises R&D investment accounted for more than 70% of the R&D investment in Jiangsu Province and held 40% of all patents. The enterprises became the leading role of R&D investment, URI-I links and open allocate resources.

### *C. The Innovation policy in 2007-2015<sup>3</sup>*

In 2007 to 2015, Jiangsu Province started the “scientific & technology entrepreneurs plan”, established youth science fund and outstanding youth science foundation of high-level talent, implement “enterprise youth doctoral plan”, encourage enterprises to introduce high-level innovative talents. The Province had 480 person joined the “introduction plan of overseas Chinese high-level talents”, of which had the entrepreneurial class accounted for nearly 30%, ranked first in the country.

The URI-I links promoted the construction of school enterprise alliance, supported more colleges of Jiangsu Province cooperated with enterprises. Most of the universities set up scientific & technology achievements transformation

<sup>2</sup> Date sources: Statistical bulletin of Jiangsu economic and social development 1998-2006

<sup>3</sup> Data sources: Statistical bulletin of Jiangsu economic and social development 2007-2015

center, and open large-scale scientific instruments to the public which is built in colleges and universities. Promote strategic cooperation with central public-interest scientific institution in the area of transformation of important achievements into real productivity and important carrier construction, etc. Set up multiple type of URI-I links, such as "scientific & technology advisory group", "scientific & technology liaison officer", "mayor of scientific & technology group" and other research cooperation modes. Implement the "innovative international action plan" and the "Action plan for deepening the URI-I links". Construct a number of industry innovation international collaboration in the field of new energy, new materials, bio medicine, etc. Explore new channels and new systems of international innovation resources to cooperative alliance. Enforcing inter-enterprise communication and international cooperation and efforts to promote the cooperative R&D and technology transfer with famous multinational R&D institutions. In 2014, Jiangsu Province carried out scientific & technology incubator chain construction pilot. There were 515 of all kinds of scientific & technology business incubator completed, covered 27.69 million square meters, accounted for one-third of China. The number of national hi-tech innovation service center, national level university scientific & technology Park maintain the first in China<sup>[19]</sup>.

Establishing a perfect science & technology awards and loans risk compensation mechanism, supporting the provincial science & technology loan risk compensation fund project, guiding the financial institutions to increase loans to high technology industry, scientific & technology enterprises, scientific & technology park construction support. And the cities and counties established local risk compensation funds. The government takes entrepreneurial venture capital guidance funds as the guidance, actively attracts private capital, foreign capital support for innovation and entrepreneurship, development of scientific & technology guarantee and technology insurance, formation of local scientific & technology guarantee company, increase the proportion of science & technology insurance premium subsidies, to help enterprises reduce the risk of innovation. In 2010, the government implemented such policies, like R&D expenses plus deduction, high-tech enterprises and so on, there were 12812 companies enjoyed preferential policies. In 2014, the government constructed a scientific & technology financial risk compensation fund pool, means to guide the banking financial institutions to further increase investment in scientific & technology of small and micro enterprises. By the end of 2014, they had spent more than 175 billion yuan in venture capital investment.

The Jiangsu Province promulgated the government indigenous innovation procurement catalog, formulated the policies of "government first purchase and order products of

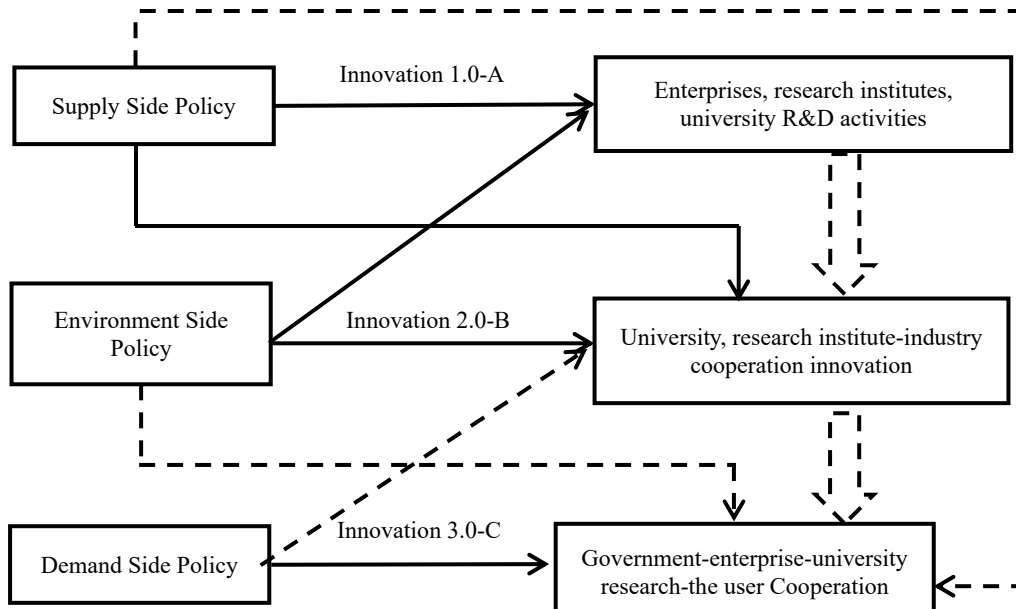
enterprises' products of self-innovation", especially in the field of medicine and biotechnology, software and electronic information, rail transportation and engineering equipment. They also developed such effective measures and approaches about government subsidy and the way to add points in bidding independent innovation products.

In order to optimize the layout of innovation and improve the regional innovation system, there were 19 new innovative counties and cities, more than 37 villages and towns constructed. Provincial scientific & technology Park reached 29, of which the national university science park reached 11, ranking first in the country. They constructed the science & technology public service platform, and improved the regional scientific & technology innovation service system, And they also started the construction of basic science & technology service network, focused on the construction of supporting for grassroots technology transfer, technology consulting, technology innovation, scientific & technology and financial services institution, and leded the public scientific & technology service platform transfer to high tech zone, county and city. In 2013, Jiangsu Province created the first scientific & technology combination city in China, and set up the Angel investment Guiding funds, and the venture capital management funds reached 150 billion yuan, more than doubled in 2010. In 2014, the regional innovation layout continued to optimized. The government established the national independent innovation demonstration zone in South of Jiangsu Province. The whole Province had 12 national high-tech zones, accounting for about of the country's 1/10.

From 2007 to 2015, Jiangsu Province increased the input of talent, enterprise innovation, Government-Business-University-Research-Usage Cooperation and innovative infrastructure, financial tax policy, government procurement pushed the R&D investment accounted for the proportion of GDP up from 1% to 2.5%. The Jiangsu Province's scientific & technological progress contribution rate increased from 49.1% to 59% in 2007 to 2014. In 2009 to 2015, the regional innovation capability in Jiangsu Province ranked first in the country for the seventh consecutive year.

## V. DISCUSSION

With the different perspectives review of evolution process of innovation in Jiangsu Province from 1988 to 2015, we find that the innovation practice of Jiangsu Province experienced from closed innovation (Innovation 1.0) to open innovation (Innovation 1.0) and then to open and symbiotic innovation (Innovation 1.0), according to the OECD (2010) policy tools of innovation, mix with innovative practice in Jiangsu Province, we proposal a Jiangsu innovation policy analysis framework of innovation evolution, as shown in Fig. 1



(Notes. The solid arrows represent strong interaction, the single dotted lines represent weak interaction.)

Fig. 1 Analysis framework for Jiangsu's innovation policy from Innovation 1.0 to 3.0

Fig. 1 shows that the different ways of regional innovation policy tools combination promote the regional innovation. In the Innovation 1.0, it is the combination of the supply side policy and the environment side policy, which is the dominant effect of the Environment Side Policy (as shown in Fig. 1 represented by A) promote the establishment of the Jiangsu scientific research system. In the Innovation 2.0, it is the combination of Supply Side Policy and the Environment Side Policy, supplemented by the Demand Side Policy (as shown in Fig. 1 represented by B) promote the establishment of a URI-I links system. In the Innovation 3.0, it is the combination of Supply Side Policy, the Demand Side Policy and the Environment Side Policy, which is the dominant effect of the Demand Side Policy (as shown in Fig. 1 represented by C) promote development of Regional innovation. We discuss the problem about what the characteristics of the policy tools used in different periods of Jiangsu, and what the role of policy tools played in the

construction of Jiangsu regional innovation system.

*A. Focus on the environmental side policy tools to guide the subject of tech-innovation developing innovation activities in the region*

It is the transition period of the economic development of Jiangsu Province from 1988 to 1997. Because of the extensive economic we ignored that the scientific & technology are productivity[20]. So structure of R&D system is not sufficient, the institute and universities according to the national plan to carry out scientific research activities but their achievements always divorcing from the enterprise 's actual demand. Therefore, Jiangsu reform scientific research system, developed programs to encourage enterprises, research institutes, colleges and universities to carry out innovation (as shown in Table. 3), and to encourage scientific research institute focus on the demand for innovation from enterprise.

TABLE 3. SIMPLE LIST OF INNOVATION 1.0 POLICY TOOLS

Classification	Policy tools	Policy content
Supply side policy	Financial support	1.R&D development and development fund; 2.Universities' innovative fund; 3.Intellectual property training to enterprises, scientific research institutions, Colleges & Universities, Citizens
	Human resources	1.Provision of Technical Advice; 2.Collaboration with foreign technical experts and Training Professional and Technical Personnel
Environment Side Policy	Laws and Regulations;	1.Methods for the identification of scientific & technological achievements; 2.Regulations of Jiangsu Province on scientific & technological progress;
	Scientific & Technical system reform	Project of scientific research personnel contract technology development

Source: By literature [14]

In this period, enterprises, universities, research institutes carried out innovation was following from the process of scientific research to the market which is closed innovation[5]. According to the division of innovation[6], the selection and combination of innovative policy tools in Jiangsu Province was determined by the innovation policy system and the common goals . Jiangsu Province introduced 100 innovative policies, for example, the technology talents policies promote the introduction of high-level talent etc., solve the problem of talent shortage when enterprises are improving their ability of innovation[21], chosen the combination of supply side policy and environmental side policy , especially emphasize on the environmental side policy tools , it appropriated to the situation of Jiangsu scientific research system in that time, and it conformed to the regular of the application of innovation policy tools to adapt to the stage of innovation development[11].In this period, various types of policies, improve the scientific research system in Jiangsu, and promote the enterprise as the main technological innovation activities.

*B. Supply side policy and environmental side linkage to promote regional cooperation and innovation*

The construction of scientific research system in the early stage of Jiangsu has laid a good foundation for the construction of regional innovation system. In 1998-2006 years, is to carry out the construction of innovation oriented Province of Jiangsu Province, the company opened the border, and universities, research institutes to carry out open innovation, entered Innovation2.0.

In this period, the construction of regional innovation system, reference the experience of Europe and America which are making more attention to the cooperation between University, enterprise and government[22,23], promote research cooperation is the focus of innovation policy formulation (See table 4). Jiangsu’ venture investment and financing policy make the small and medium-sized science & technology enterprise in Jiangsu in a leading position of China[24]. Jiangsu Province using environmental side policy like various funds, subsidies, project funding, personnel plan, and supply side policy like financial tax policy interaction

[25], to promote the enterprises, research institutions, the university open innovation, to promote URI-I links. Based on the scientific research system Jiangsu established the regional innovation system.

*C. Demand side policies leading to promote political research collaboration innovation*

In 2007 to 2015, Jiangsu Province with the goal of building the innovative Provinces firstly, formulated the innovation driven economic development strategy, and the innovation driven model was based on the "government enterprise university research users" quadruple helix[7]. This is so called the third generation of enterprise innovation. During this period, compared with the first two stages, Jiangsu use more Innovation policy tools which is covering the whole process from R&D to the commercialization [25]. From the perspective of financial policy, the supporting help enterprises to expand their financing channel, to promote their innovation activities[26,27], such as building science & technology input excitation mechanism, safeguards mechanism, talent introduction and training policy etc.[28]. The supply side policy increases the input to the science & technology park and technology platform which is promoting the aggregation effect of technology enterprises.

Especially in innovation policy formulation process, in view of the problems of the motivation and ability of the industry university research cooperation<sup>[29]</sup>, the government pay more attention to the demand side policy tools. At the same time, they increase the supply side policy and environment side policy support, which is among the forefront of the country in knowledge creation, knowledge acquisition, enterprise innovation, innovation environment etc.<sup>[30,31]</sup>, and they enhance the close cooperation between government, enterprise, university research, and users in innovation process (as shown in Table. 5). With the continuous innovation of science & technology management mechanism in Jiangsu<sup>[32]</sup> and comprehensive use of innovative policies make good results, in 2009 to 2015 the regional innovation capability in Jiangsu Province ranked first in China for the seventh consecutive year.

TABLE4. SIMPLE LIST OF INNOVATION2.0 POLICY TOOLS

Classification	Policy Tools	Policy Content
Supply Side Policy	Financial Support	1.SME Technology Innovation Fund ; 2.Special Funds for The Transformation of scientific & technology achievements; 3.Science& Technology Infrastructure Operating Subsidies; 4.Original Innovation Projects in Key Areas; 5.Incubator and High tech Park; 6. Identification of high-tech products
	Human Resources	1.“Ten, Hundred, Thousand and Ten thousand” Leading talents; 2.“Modern entrepreneur training project”; 3.Introduction and Training of High level talents at home and abroad
Environment Side Policy	Financial Policy	1.enterprise can gain stock from the development project of science & technology; 2.Science&technology venture capital; 3.scientific&technology guarantee fund; 4.Science&technology loan risk allowance; 5.Recognition of Hi-tech Enterprises

Source: By literature [37]



TABLE 5. SIMPLE LIST OF INNOVATION 2.0 POLICY TOOLS

Classification	Policy Tools	Policy Content
Supply Side Policy	Financial Support	1.SME Technology Innovation Fund; 2.Angel investment Guiding funds; 3.significant scientific & technological achievements transformation funds; 4.restructure and reinvigorate key industries funds; 5.Identification of high-tech products; 6.national-level university science park; 7.University-Enterprise alliance cooperation; 8.International Technology Incubation Platform; 9.national self-innovation experimental area
	Human Resources	1. Introduction of High level innovation and entrepreneurial talents plan; 2. Scientific & technology entrepreneur cultivation project; 3. Scientific & technology Advisory Group, science, technology liaison officer; 4.Doctor of enterprise assemble plan
Environment Side Policy	Tax Policy	1.R & D tax deduction; 2.Recognition of Hi-tech Enterprises
	Financial Policy	1.scientific & technology small loans company; 2.compensation funds of Scientific Achievements Transformation Risks
	Regulation and control	Local laws and regulations and supporting policies
Demand Side Policy	government procurement	1.Provincial independent innovation product procurement; 2.purchase and order system
	public service	1.construction of the science& technology infrastructure; 2.Science & Technology Public Service Platform; 3.International scientific & technology cooperation base and international technology transformation platform

Source: By literature [37]

## VI. CONCLUSIONS AND FURTHER RESEARCH

This conceptual framework is based on the empirical analysis of Jiangsu innovation policy tools, and analyzes the characteristics of innovation policy tools under different innovation paradigms. Illustrates the impact of the policy tools combination on the linkages among the various innovative subjects. With the evolution of innovation, the cooperation between different innovative subjects experienced from closed to open, and from cooperation to symbiosis cooperation. In this process, the combination of innovation policy tools is more and more complicated, the policy supply is more and more strength. The government of Jiangsu Province combined with the local practice to carry out innovation policy management<sup>[19]</sup>. The innovation policy tools are also evolving with the evolution of innovation paradigm<sup>[33]</sup>. The research of the framework based on Jiangsu's innovation policy in this paper will provide a theoretical and empirical advice on the implementation of innovation driven economic development strategy in the post development area.

## VII. IMPLICATIONS

With the enterprises' innovation evolving from 1.0 to 3.0 the innovation policy is also changing. This paper, through the study of the evolution of innovation policy in Jiangsu Province from 1988 to 2015, such as the advantages and disadvantages of the development of science & technology service industry<sup>[34,35,12]</sup>, will provide empirical support for the

new generation of innovation policy. The OECD studied innovation policy governance of developed countries in 2005, established the framework of innovation policy tools. This paper makes an empirical study on innovation policy in developing countries to enrich the framework of OECD and provide help for the governance of innovative policies in developing countries.

## VIII. FUTURE RESEARCH

In this paper, we study the characteristics of innovation policy tools mix in Jiangsu Province under different paradigms. The future research will focus on Jiangsu and the other areas of the same level other countries to improve regional innovation policy analysis framework.

## ACKNOWLEDGEMENTS

The authors would like to thank the support from NSFC Funding Program No.71272164, Research institution of Service-oriented Government Construction in Jiangsu Province, and NJUST Research Center for Sci – tech Innovation Policies and Management.

## REFERENCES

- [1] Lengrand L P. Innovation tomorrow, innovation policy and the regulatory framework: Making innovation an integral part of the broader structural agenda [R]. DG Enterprise, 2002.
- [2] Uyerra E. Fostering Innovation and Knowledge Transfer in Regions [M]. Warsaw, 2008.

- [3] China Science & technology development strategy research group. The China regional innovation capacity report 2015[M]. Science Press, 2016.
- [4] Zhang CS, Zhang Y. The comparison of independent innovation ability of Guangdong Province with Jiangsu Province and selection of upgrade path[J]. science and technology management research, 2011, 31 (8): 5-8.
- [5] Chesbrough H W. The era of open innovation [J]. Managing Innovation and Change, 2003, 127(3): 34-41.
- [6] Linchtenthaler U. Open Innovation: Past Research, Current Debates, and Future Directions [J]. Academy of Management Perspectives, 2011(2):75-93.
- [7] Hippel EV. Democratizing Innovation [M]. The MIT Press, 2006.
- [8] Li ZF, Zeng GP. OECD NIS project and it' s significance: from theory toward policy[J]. Studies in Science of Science, 2004, 22(2):206-211.
- [9] Chesbrough H W. The era of open innovation [J]. Managing Innovation and Change, 2003, 127(3): 34-41.
- [10] OECD. OECD review of innovation policy China [M]. OECD Publishing, 2008.
- [11] Georghio L, Edler J. Public procurement and innovation - Resurrecting the demand side [J]. Research Policy, 2007, 36: 949 - 963.
- [12] Li ZZH, Zhu GL, Liu AL. Comparative analysis on technology innovation policy of China and South Korea: based on the knowledge objectives, supporting and implementation[J]. Science of science and management of S. & T., 2015, 36 (4): 3-13.
- [13] Huang M, Zhu GL, Hu YJ. The classification selection and evaluation efficiency of innovation policy instruments [J]. Forum on science & technology in China, 2016(1).
- [14] OECD. Demand-Side Innovation Policies [R]. OECD Publishing, 2011.
- [15] Ye WW. Study on the Mechanism and Policy of university-industry collaborative innovation-based on ZJ Province [D]. Zhejiang University, 2009.
- [16] Eisenhardt K M. Building Theories from Case Study Research[J]. Academy of Management Review, 1989, 14(4):532-550.
- [17] Rothwell R, Zegveld W. Industrial Innovation and Public Policy, Preparing for the 1980s and the 1990s [M] Frances Pinter, 1981:59-82.
- [18] Wu XM. 30 years of reform and opening up in Jiangsu Province [J]. Journal of Nanjing University of Finances and Economics, 2008(5):1-7.
- [19] OECD. Governance of innovation systems: volume 1: synthesis [M]. OECD Publishing, 2005.
- [20] Wang YH. Speeding up the implementation of the strategy of prospering the province through liberation and development of science & technology productivity-The experiences of reform and development in Jiangsu Province of the past 20 years [J]. Jiangsu scientific & technology Information, 1999(1).
- [21] Wang Y. A case Study on the construction of the qualified team of scientists and technicians [J]. Journal of Southeast University: Philosophy and Social Science Edition, 2005, 7 (6): 46-51.
- [22] Huang XG. Comparison and analysis of Europe and America technological innovation policies[J]. Sci & tec information development & economy, 2005, 15 (4): 174-175.
- [23] Zhang YC, Li ZZ, Hu G. Research on the strategic selection and development of leading manufacturing industries in Jiangsu [J]. Journal of Nanjing University of Aeronautics & Astronautics: Social Science Edition, 2006, third (03): 57-61.
- [24] Liu LS. Thinking on the construction of Jiangsu science and technology venture investment and financing service platform [J]. Jiangsu Science & Technology Information, 2006(11):36-38.
- [25] Yang YH, Lu HJ, Chen L, Yuan YB. The established experience and thinking of Jiangsu science and technology public service platform [J]. science and technology management research, 2012, 32 (4): 58-61.
- [26] Gu HR, Hu HH. Evaluation on correlation between financial environment and technology innovation - Empirical analysis on four cities of Jiangsu Province [J]. Journal of Xidian University: Social Science Edition, 2009, 19 (3): 44-51.
- [27] Dou YQ, Li XZ, Wu WJ. Financial support of high - tech SMEs' innovation in Jiangsu [J]. science and technology management research, 2014, 34 (2): 6-10.
- [28] Han DL. Comparative analysis of regional scientific and technological input based on scientific and technological progress —— taking Jiangsu, Zhejiang, Shanghai and Anhui for Example [J]. Forum on science and technology in China, 2010(3):73-77.
- [29] Zhang YF, Gao K, Sun L, Wang J. Analysis on the exiting problems and causes of cooperation if industry, education and academy in Jiangsu province [J]. science and technology management research, 2012, 32 (11): 70-77.
- [30] Yang J. Research on the intellectual property system in the construction of innovation provinces-Taking Jiangsu Province as an example [J]. Journal of Ningxia University (Humanities & Social Sciences Edition), 2008, 30(1):75-78.
- [31] Han ZR. Analysis and Countermeasure of Jiangsu Provincial regional innovation capability -- Based on the data from “Annual report of regional innovation capability of China 2013” [J]. Technoeconomics & Management Research, 2013 (2): 124-128.
- [32] Zhang YF, Zhang WW, Gao RH, Wang XM. The study on science and technology management and capability of grass – roots government based on the empirical analysis of three counties of Jiangsu Province [J]. science and technology management research, 2015 (5): 44-48.
- [33] Zhang GX, Qiu NX. Comparison and reference of science and technology innovation in Jiangsu and Korea [J]. Statistical science and practice, 2013 (3): 32-34.
- [34] Mei Q, Zhao XW. The research on the development of science and technology service industrial agglomeration in Jiangsu province [J]. science & technology progress and policy, 2009, 26 (22): 74-76.
- [35] Lin SS. A comparative study of Guangdong and Jiangsu science and technology service industry [J]. Guangdong Science & Technology, 2010(13):22-25.
- [36] Li W, Chang J, Wang MJ. The third generation of innovation and Innovative Ecosystem [J]. Studies in Science of Science, 2014, 32(12):1761-1770.
- [37] Yu K. A comparative research on innovation policy of Jiangsu Province under innovation paradigm evolution[D].Nanjing University of Science&Technology, 2016.
- [38] Jiangsu Province Bureau of statistics. 1993-2003 Statistical bulletin of Jiangsu economic and social development [J]. Jiangsu statistics, 1994-2004.
- [39] Jiangsu Province Bureau of statistics. 2003 Statistical bulletin of Jiangsu economic and social development [J]. Xinhua Daily, 2004(B02).
- [40] Jiangsu Province Bureau of statistics. 2004-2010 Statistical bulletin of Jiangsu economic and social development [J]. Gazette of the people's government of Jiangsu Province, 2005-2011.
- [41] Jiangsu Province Bureau of statistics. 2011-2014 Statistical bulletin of Jiangsu economic and social development [J]. Statistical science and practice, 2012-2015.
- [42] Jiangsu Provincial Government. The government work report of Jiangsu Province in 2015[J]. Xinhua Daily, 2016(1).