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INNOVATION, INNOVATION POLICIES, AND REGIONAL DEVELOPMENT IN CHINA

DANDAN LI, YEHUA DENNIS WEI, CHANGHONG MIAO and WEN CHEN

ABSTRACT. Innovation policies have become an important element in national and regional innovation systems. This study presents a framework to analyze innovation policies and outputs, in terms both of knowledge and economic benefits, in China, with a focus on Jiangsu. We classify local innovation policies into seven major categories and twenty-one subcategories as well as five categories of national policies based on their characteristics. We find that main local policies vary largely depending on the level of economic development, and the spatial evolution of national policies is not homogenous, concentrated in the relatively more -developed region of southern Jiangsu (Sunan). Our analysis using a vector error correction model shows that the time lag effect of various policies on economic output is longer than on knowledge output, and cumulative local policies have a significant impact on both types of outputs. The model also confirms the important roles of innovation subjects, intellectual property, and talents related policies on outputs. Last, the questionnaire identifies the reasons for unsatisfactory implementation of policies, such as low level of policy awareness, insufficient financial support, and imperfect innovation and entrepreneurial ecological environment. Our study reveals innovation policies in China favor more-developed regions, which reinforces the digital divide and spatial polarization. Our study suggests that China's regional innovation policies need to be better integrated, should pay more attention to less-developed regions, and improve the role of the market in the allocation of innovation resources. *Keywords: technological innovation, innovation policies, regional innovation system, regional development, China.*

Since the beginning of major reforms in 1970s, China has achieved remarkable economic growth through a combined process of globalization, marketization, and decentralization (Wei 1999; Huang and Wei 2016). China has become the "world factory," as its enterprises largely are found in the low end of the global value chain, mainly relying on labor, land, raw materials, and other cost-effective resources to participate in global markets (Zhang and Wei 2015; Wei 2017). H-owever, with the decline of demographic and land dividends, as well as increased

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environmental pressure, China's comparative advantage is weakening (Fang and others 2014; Wu and others 2018). Thus, China's central government has put f-orward a number of policies promoting innovation as an essential element of future development, such as the construction of a national innovation system and encouraging mass entrepreneurship and innovation. Innovation has become a major policy focus in China's efforts to enhance its international competitiveness (Liefner and Wei 2014).

Furthermore, the emphasis of regional innovation theory has shifted from innovation resources to innovation environments, which highlights the role of innovation policies (Lin and others 2017; Diercks and others 2019). However, because of the complexity, time lag, and cumulative nature of innovation policies, how innovation policies affect innovation outputs in a region has not been thoroughly studied. Therefore, this study attempts to answer the following research questions. First, how can we classify innovation policies in the context of China's economic transformation? Second, what have been the effects of policy implementation on spatial structure over time in the various regions? Third, do national and local innovation policies have different effects on economic and knowledge outputs? Last, what degree of heterogeneity is there in the impact of innovation policies on different types of innovation outputs?

Literature Review

definition of innovation policies

Policies that address competitiveness are aimed at evening out regional economic inequality. Like all policies, they must be formulated at specific scales, such as local, regional, or national (Zehavi 2012; Magro and Wilson 2013). Moreover, the underlying concepts of various policies may overlap, for example, innovation, economic development, and science and technology (S&T) policies (Flanagan and others 2011). In fact, innovation policies often appear to be a synthesis of industrial, S&T, and other types of policies (Rothwell 1992; Hodler 2009). The concept of "policy mix" facilitates analysis of the interactions between policy types and the spaces of their implementation (Magro and Wilson 2013).

Owing to their public attributes and nonexcludability (Lundvall and Borrás 2005), innovation policies act as a decision-making method when the government regulates market failure (Mazzucato 2018). In addition, by overcoming barriers to the flow and conversion efficiency of innovation resources, mixed innovation policies aim to build cooperative innovation networks in order to promote the exchange of information, knowledge, and technology (Amsden and Hikino 1994). An additional goal is to strengthen spatial relationships of innovation-related elements at various levels such as cities, regions, and countries to improve the performance of national and regional innovation systems (Howells 2002; Lundvall and others 2009).

In sum, this paper defines innovation policies as aimed at improving local economic competitiveness by mobilizing the initiative of innovation subjects (for example, enterprises, universities, research institutes) and formulating policies that aim to boost essential elements of innovation progress, such as funding and science and technology infrastructure. They also provide regulations to guide the development of high-tech industries and accelerate the local concentration of various innovation elements and improve their output efficiency.

CLASSIFICATION OF INNOVATION POLICIES

In terms of policy classification, the earliest and most popular one was proposed by Roy Rothwell and Walter Zegvold (1981), who divided policies into three main categories— supply, environment, and demand—and twenty subcategories including, for example, credit, venture capital, taxation, foreign investment, contract research, and technical standards. Based on their classification, Ergas (1987) divided policies into mission-oriented policies and diffusion-oriented policies. Johansson and others (2007) believed that policies included general policies (for example, financial markets) and specific policies (for example, R&D and government procurement). Freitas and Tunzelmann (2008) divided policies into six categories: mission-based and diffusion-based policies, specific- and general-type policies, and local-led and central-led policies.

Although the concept of a policy mix attempts to quantify policies by constructing an index system (Caloffi and Mariani 2018; Magro and Wilson 2018; Söderholm and others 2019), this field of research is new. However, the existing classification is based on a developed economy, and innovation policies in developing countries are still vague. This study seeks to address this problem.

THE ROLE OF INNOVATION POLICIES IN REGIONAL DEVELOPMENT

Innovation policies cover all areas from new ideas to new products. The role of innovation policies in regional development can be summarized as follows.

1) Accelerating the nonhomogeneous flow of innovation resources. Prior to innovation development in a region, R&D personnel, funding, and other innovation elements are not homogeneously distributed across space (Freel and others 2019). On the one hand, local governments try to enhance concentration of talents through the implementation of talents policies, such as the introduction of overseas talents, high-level personnel training programs, and the construction of professional and skilled personnel teams (Liu and others 2011; Geddie 2015). On the other hand, whether it is special funds for the transformation of inventions, preferential policies for R&D by enterprises, or policy-oriented funding such as venture capital subsidy funds, science and technology infrastructure construction funds, and other scientific and technological funding, these

policies are designed to promote the accumulation of local innovation resources (Nelson 2013).

2) Guiding the direction of high-tech industries. After considering the local industrial base and direction of industrial development, the government has implemented a number of guiding policies for high-tech industries as the starting point for enhancing the competitiveness of local innovations (Nelson 2013). The advantage of government intervention lies in its ability to stress local advantages, promote differentiated development, and avoid destructive competition. However, the disadvantage is that excessive intervention reduces the effectiveness of market-based regulatory mechanisms.
3) Mobilizing innovation initiatives through intellectual-property policies. Sound intellectual-property policies both enhance innovation by enterprises and educate the general public about the importance of protection of intellectual-property rights (Sweet and Maggio 2015). For instance, technical-standards policies are conducive to standardizing the production process, as well as accelerating innovation diffusion. These policies increase the enthusiasm of enterprises and universities in pursuing innovation and reduce the market uncertainty related to innovation activities (Mitze and Strotebeck 2019). However, because of the nonexcludable nature of knowledge, these regulations may increase the cost of acquiring new knowledge and technology (Howells 2002). Therefore, enterprises will tend to increase their R&D investment in an attempt to obtain a first-mover advantage.
4) Optimizing the innovation environment through knowledge-intensive-based service-industry policies. These policies include the management of public-service platforms, the standardization of S&T platforms, incubators, carrier platforms, and R&D center certification (Shearmur and Doloreux 2013). With the introduction of these policies, specialized services such as business services, product testing, market research, patent applications, and legal advice will become more professional, encouraging the agglomeration of high-tech industries (Feldman and Florida 1994; Kujath 2005).
5) A means of government intervention in urban development. First, industrial-park policies can enhance knowledge spillover among enterprises and reduce the uncertainty of information exchange, while innovation outputs can also increase as a result of agglomeration, or the proximity effect (Yang and others 2009; Wei 2015). Second, policies related to entrepreneurships encourage college students, high-level overseas entrepreneurs and migrant workers to start their own businesses (Audretsch and others 2007). Third, the choice of an urban innovation strategy, that is, being either a follower or a leader, has

a direct impact on urban competitiveness (Foray 2014). In addition, comprehensive urban innovation policies, such as an urban innovation and development plan and the standardization of science and technology projects, reflect a city's development direction over a certain period.

Further, although some scholars explain the various characteristics of policies from the perspectives of "policy space" and the complexity of multilevel policies (Magro and Wilson 2013), there is a lack of empirical research on the influence of policies at different levels on specific regions, as well as analysis of the temporal and spatial evolution of policies in different stages of regional development. In addition, qualitative descriptions of the relationships between innovation policies and outputs are often presented, but there is a lack of statistical analysis to support these descriptions, for instance, the cumulative or lagged effects of various policies on changes in innovation outputs. Therefore, this study focuses on these issues.

Research Design

Classification of Regional Policies and Their Interaction with Outputs

Based on the literatures, the interaction between policies and outputs is shown in Figure 1. In the process of building a regional innovation policy system, the priorities of policies may be various due to regional inequality. The implementation of the policies brings the agglomeration of innovation resource, perfection of innovation environment, complication of innovation network, and improved initiative of innovation subjects, which ultimately increase regional economic and knowledge outputs. However, the improvement of regional development will bring new demands to the policies, thus forming a dynamic evolution of innovation policies and regional development (Mckelvey and Saemundsson 2018). In addition, the cumulative, time lag, even the crowding effects should not be neglected when studying the relationship between polices and regional development.

According to administrative hierarchy, innovation policies have national and local dimensions in China. National policies are generally macroscopic, top-down types, while local policies are more microscopic and focus on localized features. After reviewing the local policies issued by various cities, this study constructs a local innovation policy system based on the different policy objectives that is composed of seven first-level indicators and twenty-one second-level indicators (see Table 1). Organizing national policy honors obtained by each city, national policies can be divided into five types (see Table 2). All of the policies are searched from the official websites of local government departments, such as S&T bureaus, human resources, education bureaus, and financial bureaus, or ministry of science and technology of China. Furthermore, since innovation policies were rarely mentioned before 2000, the data is collated from 2000 to 2015.

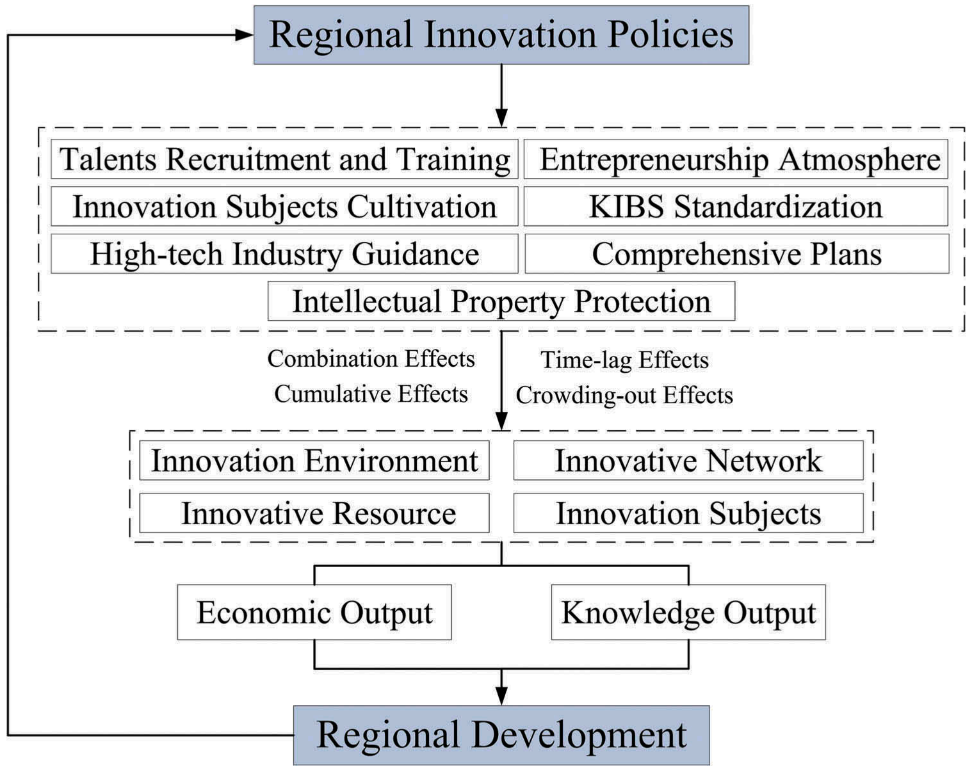

FIG. 1—The role of innovation policies on regional development.

RESEARCH SUBJECT

Located on the eastern coast of China, Jiangsu province has a leading economy in China and is part of the Yangtze River Delta, a world-class urban agglomeration. In 2015, its new product sales revenue and patent applications ranked first place and its GDP ranked second in China. Innovation has become a crucial way for Jiangsu to enhance its world influence. Jiangsu can be divided into three regions based on economic development from high to low: Southern Jiangsu (Sunan), Central Jiangsu (Suzhong), and Northern Jiangsu (Subei) (Fig. 2). In short, the development of Jiangsu is a microcosm of China's forty years of reforms and the study of Jiangsu can provide important implications for innovation policies in China and other developing countries.

MODEL AND QUESTIONNAIRE ANALYSIS

To investigate the spatial evolution of innovation policies on multiple scales, from provinces to minor regions to cities, we conducted an integrated analysis using the Arcgis software package. Additionally, an econometric model is taken to analyze the

TABLE 1—CLASSIFICATION OF LOCAL INNOVATION POLICIES

FIRST CLASS (7)	SECOND CLASS (21)	DESCRIPTION
Talents	High-level talents	Introduction about overseas returned talents, leading talent, etc.
	High-skilled talents	Training and recruitment of professional and technical personnel
	General related talents	Urban talent development planning, human resources services approach, etc.
Innovation subjects	Achievements transformation	Technical transformation, achievement transformation funds and implementation opinions
	University-industry collaboration	Related to financial and operational programs
	Others	Identification of high-tech enterprises, R&D costs deduction, etc.
Hi-tech industries	Implementation instruction	Specific industry planning, special funds, etc.
Knowledge intensive business services	Financial services	Finance, securities, insurance, credit, etc.
	Science and technology service	Intermediary platforms, R&D centers, experimental bases, etc.
	Commercial service	Legal advices, investigations
	Information service	Information and communication infrastructure
Intellectual property	Implementation instruction	Special funds, rights protection assistances
Entrepreneurship	Innovation space	Venture platform identified, management and financial support
	University graduates	Special funds, loans
	High-level talents	Special funds, implementation methods
	Migrant workers	Venture fund guarantee, general advice
	Training	Training base of the identification and management
	Implementation instruction	Venture funding reviews at city level, mass entrepreneurship programs
Comprehensive plans	Urban innovation strategy	Plans, funds, system reform, etc.
	Innovative industrial parks	Identification and management
	Science and technology projects	Approval, acceptance, fund management, etc.

TABLE 2—CLASSIFICATION OF NATIONAL INNOVATION POLICIES

INDICATORS	DESCRIPTION	EXAMPLES
Innovative cities	Advanced science and technology cities, model cities of intellectual property rights, technical standards pilot cities, innovative pilot cities, etc.	National smart city pilot National innovative pilot city National intellectual property model city
Innovative parks	Sustainable communities, the university science parks, etc.	Sunan national innovation park The national university science park China national sustainable communities National agricultural science and technology park
Innovative bases	International science and technology cooperation base, innovative and venture bases for overseas talents, etc.	National e-commerce demonstration base National torch program featured industrial base National innovative talents training demonstration base National international science and technology cooperation base National science and technology correspondent entrepreneurial base National overseas high-level talents innovation and entrepreneurship base National new industrialization industry demonstration base
Innovative clusters	Innovative industrial clusters, pilot projects for regional cluster development in strategic emerging industries, agglomeration demonstration zone of industrial transfer, etc.	National innovative industrial cluster
Innovative organizations	Technology transfer demonstration agencies, productivity promotion centers, etc.	National model productivity promotion center National circular economy pilot demonstration unit National technology transfer demonstration organization National science and technology commissioner entrepreneurial chain

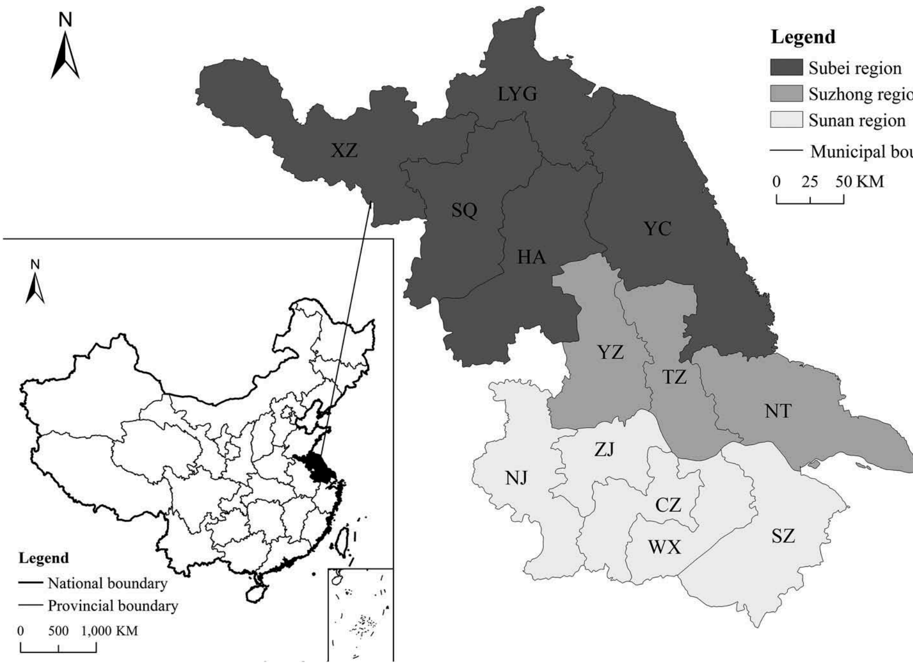

FIG. 2—Location of Jiangsu province in China. Notes: Sunan includes five cities, Nanjing (NJ), Suzhou (SZ), Wuxi (WX), Changzhou (CZ), and Zhenjiang (ZJ). Suzhong includes three cities, Yangzhou (YZ), Taizhou (TZ), and Nantong (NT). Subei includes five cities, Xuzhou (XZ), Lianyungang (LYG), Suqian (SQ), Huan'ai (HA), and Yancheng (YC). Hereinafter.

relationships between various policies and outputs as well as the time lags and cumulative effects of policies.

The VAR model examines the dynamic interactions between multiple variables and essentially constructs a regression model for each endogenous variable in the system as a function of all lag terms, and then tests the dynamic relationships among variables using Granger causality (Sims 1980). The variance decomposition method is used to verify the effect of each dependent variable on the independent variables during the period in question. The model can be expressed as follows (Equation 1):

$$Y_t = A_1Y_{t-1} + \cdots\cdots + A_mY_{t-m} + B_1X_{t-1} + \cdots\cdots + B_nX_{t-n} + \varepsilon_t \qquad (1)$$

A and B are parameter matrixes, X indicates the number of policies, ε is a random disturbance term, m and n are lag phases, t is the study period, and Y indicates knowledge and economic outputs. To test for cumulative effects, the original data (X_t) and cumulative data (X_t') are used for comparative analysis as follows (Equation 2):

$$Xt' = \sum_{t-1}^{t=2000} X_t \qquad (2)$$

The first step in constructing the VAR model is to perform a unit root test on all variables. If all variables are stable, the VAR model can be used directly. If the original value of any variable is unstable, but the differentiated data is stable and passes the Johansen cointegration test, the vector error correction (VEC) model is used to replace VAR model. The VEC model adds an error correction term to the VAR model for differential sequences essentially (Equation 3):

$$\Delta Y_t = \alpha ECM_{t-1} + A_1 Y_{t-1} + \cdots\cdots + A_m Y_{t-m} + B_1 X_{t-1} + \cdots\cdots + B_n X_{t-n} + \varepsilon_t \quad (3)$$

ECM_t is an error correction term that is based on the cointegration equation, and α represents the coefficients. In addition, whether the independent variable is endogenous or exogenous is determined by the joint P value of each variable. If the P value is less than 0.05, it indicates that the variable is an endogenous variable, and vice versa.

To quantify regional innovation development, the numbers of patents and published papers are often used to characterize innovation because of the ready availability of data, continuity, and comparability (Griliches 1991). In this paper, knowledge output is represented by the number of patents and economic output is represented by the output value of high-tech industries. Both of these data can be obtained from municipal statistical yearbooks. However, these two indicators have only been recorded since 2005, and so the output data are from 2005 to 2015.

However, it is difficult to quantify how much one policy is more effective than another. Nevertheless, the number of policies can indicate government's priority in building an innovative environment. The greater the number of certain types of policies, the more the government believes that such policies can promote regional outputs. Therefore, when quantifying the role of policies in outputs, this paper selects the number of each policies as an indicator.

The output value of non-state-owned enterprises as a proportion of the total output value of the manufacturing industry is a common indicator of market activity (Wong and Han 1998; Wei, 2015). As one of the open provinces in China, the city with a high degree of marketization in Jiangsu is precisely the city where foreign capital is concentrated. The indicator of globalization (FDI) has a highly collinearity with marketization (where VIF is greater than 10). However, marketization has a greater impact on innovation outputs than FDI in China, this paper adopts marketization indicators instead of globalization.

Moreover, for the control variables, the amount of R&D personnel and funds are commonly used (Wang and Wu 2012). However, because of the collinearity of these two indicators in this case, they were averaged to form a new indicator: resource. To ensure the comparability of data, all data were standardized to values of between 0 and 1 before model estimation. All variables, correlation matrix and VIF test results are shown in Table 3 and 4.

To supplement the model analysis, a questionnaire survey was taken. Data were obtained from the 2015 China association for S&T development research center. The center has established long-term cooperative relations with local

TABLE 3—VARIABLES AND THEIR INDICATORS IN VEC MODEL

VARIABLES		INDICATORS
Dependent variables	Economy output	The output value of high-tech industries
	Knowledge output	The number of applied patents
Independent variables	Local	The number of all the local level policies
	Talents	The number of such categories in local policies
	Innovation subjects	
	Hi-tech industries	
	KIBS	
	Intellectual property	
	Entrepreneurship	
	Comprehensive plans	
	National	The amount of all the national level policies
	Innovative cities	The number of such categories in national policies
	Innovative parks	
	Innovative bases	
	Innovative clusters	
	Innovative organizations	
Control variables	R&D personnel	The number of R&D personnel
	R&D funds	The number of R&D funds
	Marketization	The output value of non-state-owned industry in the total manufacturing industry

TABLE 4—VARIABLE CORRELATION COEFFICIENT MATRIX AND MULTICOLLINEARITY TEST

INDICATORS	RESOURCE	MARKETIZATION	TALENTS	INNOVATION SUBJECTS	HI-TECH INDUSTRIES	KIBS	INTELLECTUAL PROPERTY	ENTREPRENEURSHIP
Resource	1.00	0.86**	0.21*	0.23**	0.02	0.21*	0.33**	0.24**
Marketization	0.86**	1.00	0.15	0.18*	0.03	0.11	0.32**	0.22**
Talents	0.27**	0.19*	1.00	0.61**	0.58**	0.28**	0.22*	0.67**
Innovation subjects	0.51**	0.41**	0.24**	1.00	0.10	0.42**	0.31**	0.19*
Hi-tech industries	0.15	0.03	0.01	0.56**	1.00	0.16	0.10	0.27**
KIBS	0.23**	0.24**	0.77**	0.74**	0.59**	1.00	0.58**	0.38**
Intellectual property	0.51**	0.46**	0.68**	0.56**	0.43**	0.40**	1.00	0.38**
Entrepreneurship	0.33**	0.30**	0.43**	0.40**	0.17*	0.16	0.20*	1.00
Comprehensive plans	0.23**	0.09	0.70**	0.69**	0.60**	0.76**	0.56**	0.25**
Innovative cities	0.25**	0.27**	0.04	0.06	0.02	0.01	0.22**	0.20*
Innovative parks	0.82**	0.72**	0.18*	0.10	0.02	0.07	0.27**	0.36**
Innovative bases	0.60**	0.54**	0.24**	0.17*	0.13	0.20*	0.20*	0.30**
Innovative clusters	0.13	0.16	-0.02	0.02	0.29**	0.08	0.14	0.02
Innovative organizations	0.58**	0.68**	0.19*	0.06	0.20*	0.18*	0.21*	0.22**
VIF	7.67	7.32	2.57	6.21	2.21	5.25	3.78	4.22

INDICATORS	COMPREHENSIVE PLANS	INNOVATIVE CITIES	INNOVATIVE PARKS	INNOVATIVE BASES	INNOVATIVE CLUSTERS	INNOVATIVE ORGANIZATIONS	VIF
Resource	0.15	0.33**	0.49**	0.56**	0.14	0.42**	4.84
Marketization	0.05	0.36**	0.57**	0.44**	0.16	0.39**	4.71
Talents	0.16	0.13	0.11	0.36**	0.08	0.11	1.59
Innovation subjects	0.34**	0.18*	0.29**	0.36**	0.22**	0.21*	1.48
Hi-tech industries	0.19*	0.19*	-0.01	0.28**	0.23**	0.11	1.45
KIBS	0.32**	-0.04	-0.02	0.20*	0.08	0.11	1.78
Intellectual property	0.32**	0.27**	0.42**	0.48**	0.15	0.38**	1.99
Entrepreneurship	0.11	0.30**	0.28**	0.47**	0.24**	0.14	1.34
Comprehensive plans	1.00	-0.08	0.06	0.22**	0.10	0.11	1.22
Innovative cities	-0.10	1.00	0.42**	0.37**	0.24**	0.14	1.38
Innovative parks	0.03	0.33**	1.00	0.67**	0.17*	0.44**	1.36
Innovative bases	0.09	0.61**	0.36**	1.00	0.13	0.51**	1.27
Innovative clusters	0.05	0.26**	0.12	0.27**	1.00	0.17*	1.47
Innovative organizations	0.14	0.27**	0.28**	0.53**	0.01	1.00	1.46
VIF	1.28	4.26	7.21	2.20	3.10	2.95	-

Notes: 1. Since the number of R&D personnel and expenditures are collinear, the paper normalizes the two values and averages them to form a new indicator-resource.

2. Upper triangular matrix represents the Pearson correlation of each variable of the original data. Lower triangular matrix expresses the Pearson correlation of each variable of the cumulative data.

3. VIF is an abbreviation for Variance Inflation Factor. When VIF is less than 10, there is no multicollinearity among the variables.

4. * and ** indicates significant at 95% and 99% confidence level respectively.

S&T agents of China, such as S&T bureaus, major high-technology companies, and university research institutions. They distributed the questionnaire to these agents and got feedback from them. For Jiangsu, the survey was conducted by 1,061 college students, researchers, and IT managers. Survey respondents with a PhD, master's, or bachelor's degrees accounted for 12.5 percent, 23.5 percent, and 46.1 percent of the sample, respectively, while most of the interviewees came from research institutes (20.3 percent), universities (19.0 percent), large enterprises (23.9 percent), or small and medium enterprises (23.4 percent).

National Innovation Policies in China

key points in relation to national innovation policies

National innovation policies had been characterized by significant stages. The years from 2000 to 2005 saw slow growth, with only nine policies introduced. A period of rapid growth commenced in 2006, with a total of 121 policies introduced from 2006 to 2010, including 35 policies in 2010 alone. However, the rate of increase in the number of policies slowed from 2011, with a total of 277 policies introduced from 2011 to 2015, including 60 policies in 2015 alone (see Fig. 3).

Among the five types of national policies, the key points were innovation cities, innovation bases, and innovation parks. The number of policies introduced in these three aspects was 115, 114, and 111, respectively, accounting for 28.3 percent, 28.0 percent, and 27.3 percent of the total number of policies from

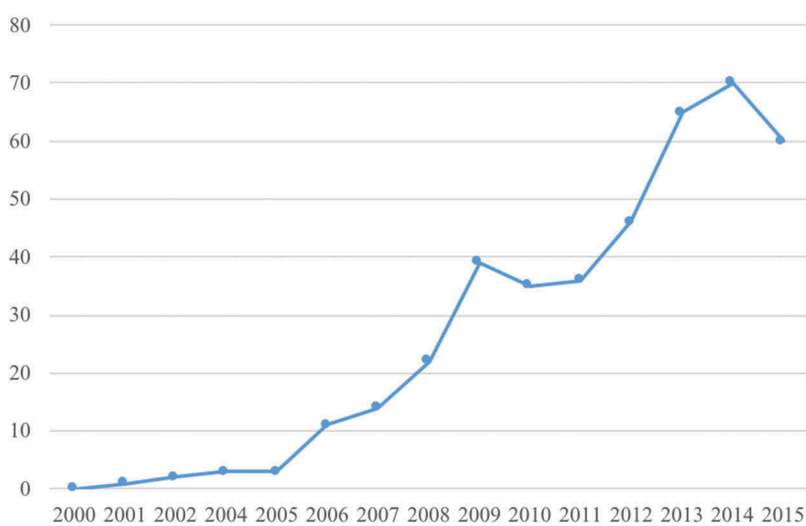

Fig. 3—The number of national policies, 2000–2015.

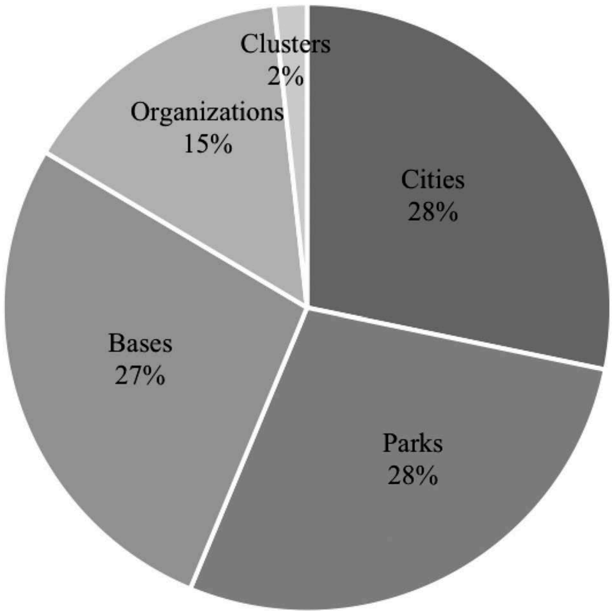

FIG. 4—Hot points of national innovation policies, 2000–2015.

2000 to 2015, respectively. However, policies about institutions (60) and clusters (7) were fewer (see Fig. 4).

VARIATIONS IN NATIONAL INNOVATION POLICIES

National innovation policies were mainly concentrated in the Sunan region, and the spatial distribution pattern was formed by one subject (Suzhou) and two branch (Nanjing and Wuxi) structures (see Fig. 5). Based on the number of policies in the three regions, the Sunan region accounted for more than 64 percent of the policies over the three stages, while the number of policies in the Suzhong region decreased by 5.3 percent from the first stage to the third stage. In contrast, the number of policies in the Subei region rose by 8.0 percent over the same period. Based on the number of national policies approved in each city, Suzhou had the most policies, accounting for 25 percent of all policies in the period 2000–2015, followed by Nanjing and Wuxi, which accounted for 15.5 percent and 14.0 percent of all policies, respectively. Other cities accounted for 3.4 percent–6.6 percent of all policies.

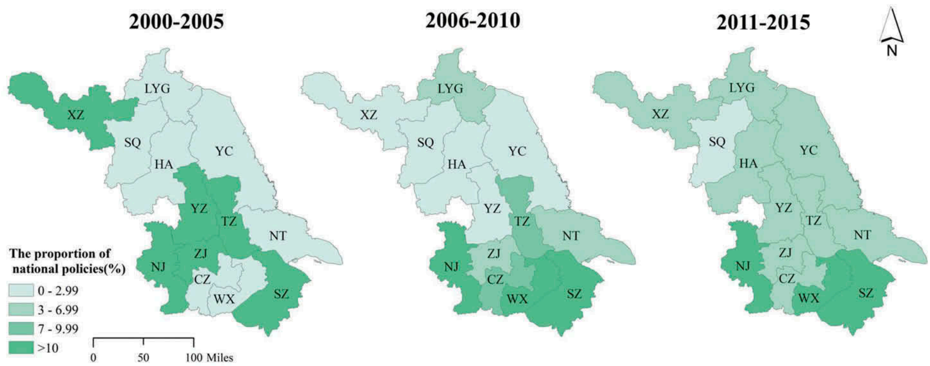

FIG. 5—Spatial distribution of national policies, 2000–2015.

LOCAL INNOVATION POLICIES IN CHINA

KEY POINTS IN RELATION TO LOCAL INNOVATION POLICIES

The number of policies varied significantly over time. The total number of local innovation policies was 1607 from 2000 to 2015, which can be divided into three stages according to the annual number of policies introduced (see Fig. 6). (1) Low-growth stage (2000–2005): Cities had not stressed the importance of regional innovation, and thus the number of policies rose slowly, from 8 in 2000 to 35 in 2005. (2) Rapid-growth stage (2006–2010): Cities began to understand the role of innovation, and thus the number of innovation policies increased rapidly, climbing to 132 policies in 2010 with an average annual growth rate of

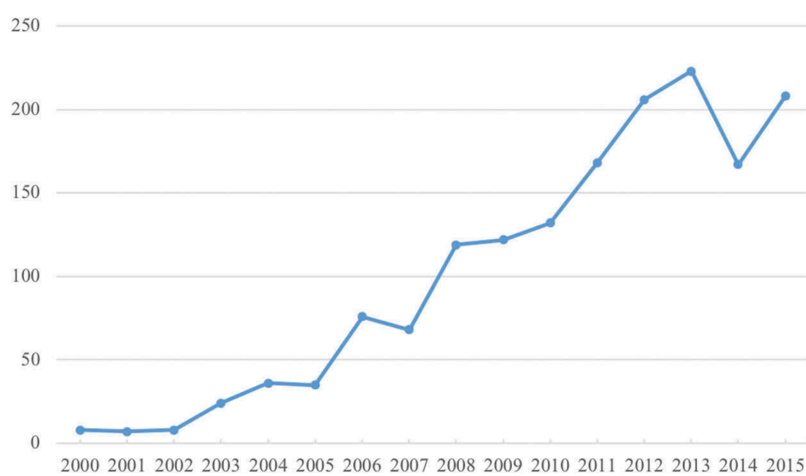

FIG. 6—Number of local policies, 2000–2015.

14.8 percent. (3) Stable-growth stage (2011–2015): The average annual growth rate in the number of policies fell to 5.5 percent, and most of the added policies were supplements to existing policies. However, the policy system was continuously enriched with the gradual popularization of innovation.

In general, the policy pattern in Jiangsu is consistent with the national innovation strategy. In December 2005, the State Council promulgated the "guidelines for the medium-and long-term national science and technology development program (2006–2020)," which signaled a period of acceleration in China's innovation and development. After the global financial crisis in 2008, the central government paid increasing attention to the role of innovation in enhancing national competitiveness. In 2010, China's medium-long-term talent development plan (2010–2020) was announced by the State Council. Until 2015, the formulation of mass entrepreneurship and innovation policies aimed to improve the institutional environment, which was a key factor in encouraging people to start their own businesses.

Policy priorities varied at each stage (see Fig. 7). In the first stage, the cultivation of innovation subjects and recruitment and training of talents were the main aims, accounting for 26.3 percent and 20.3 percent of all policies, respectively. In the second stage, the number of policies related to innovation subjects fell by 11.2 percent. From 2006, with the introduction of the concept of "entrepreneurship driving employment" and the increasing role of the innovation services environment in regional innovation systems, the number of policies related to start-ups and knowledge-intensive based services (KIBS) rose

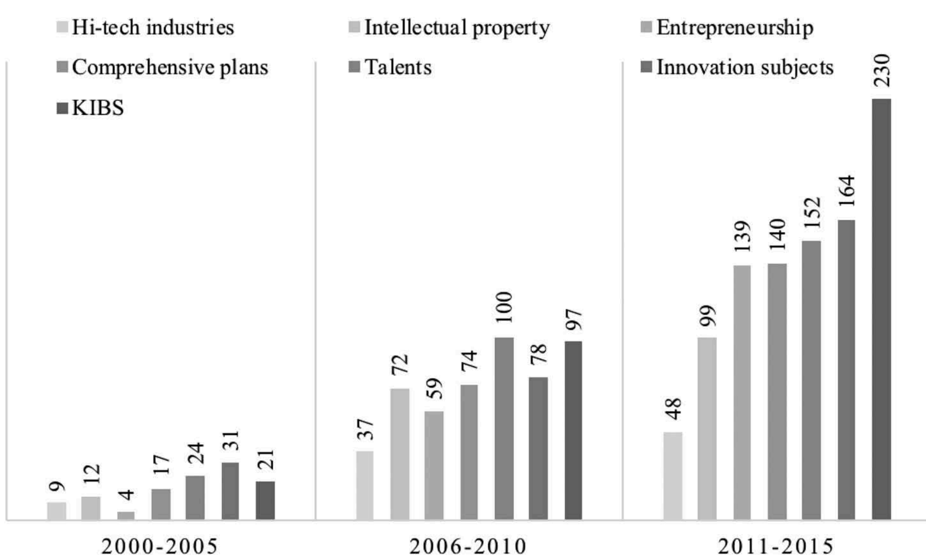

FIG. 7—Shifting policy emphases, 2000–2015.

significantly, accounting for 18.8 percent and 11.4 percent of all policies, respectively. In the third stage, talents and subjects remained the focus of local policies, but the number of policies fell by 4.7 percent and 9.4 percent, respectively, compared with those in the first stage. Conversely, KIBS policies became a hot topic, accounting for 23.6 percent of all policies. Overall, the priorities in relation to local innovation policies shifted from innovation subjects to talents, and then to KIBS policies during the period 2000-2015, indicating that the core competitive elements of regional development were shifting from innovation resources to an innovation milieu.

Specifically, policies such as an urban innovation strategy, highly skilled talents, a science and technology service industry, and entrepreneurial space became hot topics in the second-class policies (see Fig. 8). Of the total number of policies in the second class, the following features are noteworthy: (1) There were 276 talent-related policies, in which policy priorities shifted from high-level talents to highly skilled talents, with the former rising at first and then falling (25 percent→60 percent→31.6 percent), and the latter doing the opposite (45.8 percent→30 percent→44.1 percent). (2) The innovation service environment

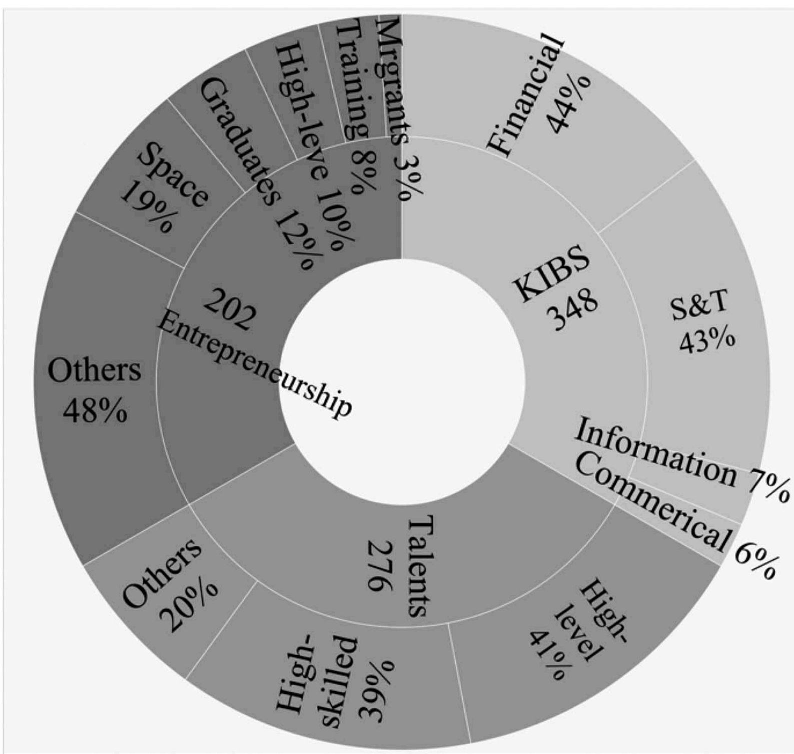

FIG. 8—Hot points of second class of local innovation policies, 2000–2015.

has evolved from science and technology services to financial services. Financial services–related policies accounted for the largest share among the four types of KIBS policies by the third stage, having increased by 25.7 percent from the first stage. (3) The focus of entrepreneurship policies shifted from high-level talents to innovation spaces. Specifically, the proportion of high-level talent entrepreneurship policies gradually declined from 20.3 percent in the second stage to 5.8 percent in the third stage. In contrast, the proportion of innovation space policies increased from 13.6 percent to 20.9 percent. (4) Comprehensive policies accounted for 14.4 percent of the total number of policies. Urban innovation strategy was the central issue in all three stages, and the share of comprehensive planning policies increased from 41.8 percent to 57.1 percent over the three stages.

VARIATIONS IN LOCAL INNOVATION POLICIES

The spatial distribution of policies presented dynamic characteristics from concentration to decentralization (see Fig. 9). (1) From 2000 to 2005, policies were mainly concentrated in five cities in the Sunan region, accounting for 62.7 percent of the total number of policies in this stage. The Changzhou government was the most active agency, introducing thirty-five policies. Meanwhile, the Subei region only introduced fourteen policies, and cities such as Huai'an, Lianyungang, and Suqian had not yet begun to implement innovation policies. (2) From 2006 to 2010, the number of policies in the Sunan region rose sharply to 283, but the proportion of the total number of policies in the province decreased by 8 percent. Meanwhile, the status of Changzhou dropped significantly, with a fall of 10.5 percent in the total number of policies, while the Subei region began to implement innovation policies, especially in cities such as Huai'an and Xuzhou, such that its total number of policies increased by 5.2 percent from the previous period. Furthermore, the number of policies in the

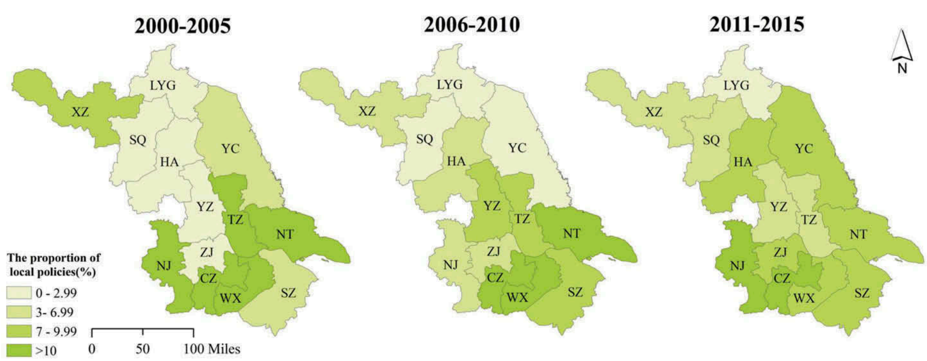

FIG. 9—Spatial distribution of local policies, 2000–2015.

Suzhong region also increased slightly (25.4 percent→28.2 percent). (3) From 2011 to 2015, the number of policies in the Sunan region continued to fall (48.9 percent), while that in the Subei region continued to rise, reaching 30.7 percent in 2015. Apart from Nanjing (13.6 percent) and Changzhou (10.8 percent), the proportion of the total number of policies in the cities was 3.4 percent–8.8 percent. In short, the spatial inequality among the cities was declining.

Based on the first-level policy classification, the evolution of each city's core policies presented the following rules: innovation subjects→talents→KIBS. To clarify the hot topics in local policies, the concept of concentration was introduced to analyze the secondary policies, which was represented by the proportion of the top three policies in the secondary classification to the total policies of the city. The higher the value, the more significant the hierarchical characteristics of policies. The results can be summarized as follows.

1) The five cities in the Sunan region showed a dynamic evolution from concentration to decentralization, the policy system was gradually improved, and the complementarity of policies was continuously improved. In the 2000–2005 period, with the exception of Changzhou, where the concentration of policies was low (34.3 percent), the concentration of policies in all cities was more than 50 percent. The hot topics in these policies focused on innovation subjects and highly skilled talents. From 2006 to 2010, the concentrations in Suzhou (100 percent→65.9 percent), Nanjing (60 percent→50 percent), and Wuxi (52.9 percent→40.2 percent) fell, and high-level talents and intellectual property rights became policy priorities. During the period 2011–2015, the concentration continued to decline in all five cities, and financial services, S&T services, and entrepreneurship became mainstream topics.
2) The three cities in the Suzhong region mainly introduced resource-based policies, with varying emphases in each city. The concentration in Nantong fell from 60 percent in the first stage to 50 percent in the third stage. In addition, S&T service was the main focus in all three stages, with a shift from achievements transformation and high-level talents to intellectual property rights. However, the emphasis in Taizhou was on attracting highly skilled workers and cultivating innovative enterprises, with a concentration of 44.4 percent–50.0 percent. The city of Yangzhou did not rank innovation subjects in the same way as Taizhou, attaching more importance to high-level talents and entrepreneurship-related policies. Meanwhile, its concentration decreased significantly over the three stages (100 percent→54.4 percent→40.4 percent).
3) The innovation strategy in five cities in the Subei region began with an urban innovation strategy and innovation subject policies. In the first stage, the cities of Xuzhou and Yancheng had ten and four policies, respectively, while the other three cities had not yet started to introduce

innovation policies. During the second stage, these cities started to promulgate innovation policies, with a focus on urban innovation strategy, the cultivation of innovation subjects, and the guidance of high-tech industries. For example, 75 percent of the policies in Suqian were concentrated on innovation plans, financial services, and industry guidance. In the third stage, S&T services and intellectual property policies started to gain prominence, for example, in Yancheng, 43.2 percent of policies were concentrated on innovation subjects, S&T services, and intellectual property.

Effects of Innovation Policies on Regional Development

Findings from the Model Analysis

The unit root test results (see Table 5) showed that while the variables were not stable, the differential ones were stable, indicating that the VEC model was more suitable for this article (see Table 6, 7). In addition, the Chow test and Hausman test showed that models had one of fixed effects, such as cross-section (city) fixed, period (year) fixed, or cross-section and period fixed effect. The results from the VEC models showed that R^2 was between 0.74 and 0.96 and satisfied the regression requirements.

From the above analysis, it could be seen that the number of policies in Suzhou was much higher than that of other cities, especially the number of national policies. The same was true for its high-tech industry output value and patents, which fully demonstrated the positive effects of national and local policies on regional economic development. However, although this paper removed the calculations from Suzhou to ensure the robustness of the model, the results didn't differ significantly.

The results of Granger causality analysis indicated that local policies had no effect on economic output, but significant effect on knowledge output in the original data. Conversely, the cumulative data showed that local and national policies had a significant causal relationship with both economic and knowledge outputs at the 99 percent confidence level. The results confirmed the hypothesis of the cumulative effects of innovation policies.

Deeper analysis of the impact of various policies on different types of outputs was known. First, whether it was raw or cumulative data, policies, such as innovation subjects, intellectual property, talents as well as innovative cities and organizations, had a positive impact on knowledge and economic outputs. This showed that the stimulating effects of policies on local economic development emerge quickly and last for a long time. Second, innovation base policies, such as the national science and technology cooperation base, had an impact on knowledge output in the early stages of policy implementation, but only promoted economic output after a few years. This confirms that the establishment of a national-level innovation base provides a platform for the exchange of innovation subjects, stimulates innovation by enterprises, and accelerates the

TABLE 5—UNIT ROOT TEST RESULTS OF EACH VARIABLES USING AUGMENTED DICKEY-FULLER TEST

	Original data		Cumulative data	
Variables	Unit root test	Results	Unit root test	Results
Economic output	(5.76, 1.00, N)/[-90.87, 0.00, T]		D(1)	
Knowledge output	(-3.58, 0.01, I)		D(0)	
Resource	(-0.61, 0.45, N)/[-4.75, 0.00, T]		D(1)	
Marketization	(5.715, 1.00, N)/[-162.12, 0.00, T]		D(1)	
Local	(-14.43, 0.00, T)	D(0)	(2.24, 0.99, N)/[-4.62, 0.00, N]	D(1)
Talents	(-12.99, 0.00, T)	D(0)	(1.95, 0.99, N)/[-19.25, 0.00, I]	D(1)
Innovation subjects	(-13.24, 0.00, T)	D(0)	(1.06, 0.92, N)/[-4.06, 0.00, N]	D(1)
Hi-tech industries	(-13.11, 0.00, T)	D(0)	(1.06, 0.92, N)/[-22.41, 0.00, N]	D(1)
KIBS	(-12.37, 0.00, T)	D(0)	(0.95, 0.91, N)/[-18.60, 0.00, N]	D(1)
Intellectual property	(-12.42, 0.00, T)	D(0)	(0.93, 0.91, N)/[-17.16, 0.00, N]	D(1)
Entrepreneurship	(-12.96, 0.00, T)	D(0)	(1.94, 0.99, N)/[-26.66, 0.00, I]	D(1)
Comprehensive plans	(-12.10, 0.00, T)	D(0)	(1.55, 0.97, N)/[-25.98, 0.00, T]	D(1)
National	(-0.16, 0.63, T)/[-12.31, 0.00, T]	D(1)	(0.20, 0.74, N)/[-7.95, 0.00, N]	D(1)
Innovative cities	(-12.09, 0.00, T)	D(0)	(0.46, 0.81, N)/[-16.21, 0.00, T]	D(1)
Innovative parks	(-12.57, 0.00, T)	D(0)	(0.19, 0.74, N)/[-21.76, 0.00, N]	D(1)
Innovative bases	(-12.03, 0.00, T)	D(0)	(0.62, 0.85, N)/[-16.29, 0.00, N]	D(1)
Innovative clusters	(-6.31, 0.00, T)	D(0)	(2.07, 0.99, N)/[-3.88, 0.00, N]	D(1)
Innovative organizations	(-11.04, 0.00, T)	D(0)	(0.23, 0.75, N)/[-7.36, 0.00, N]	D(1)

Notes: 1. Values in and represent original and differential unit root test results, the three values are t, p, and test equation, where T, I and N stand for trend and intercept, intercept, and none respectively in the third value.
2. D (0) and D (1) represent the original and 1st differential stability, respectively.

TABLE 6—GRANGER CAUSALITY/BLOCK EXOGENEITY TESTS BETWEEN INNOVATION POLICIES AND ECONOMIC OUTPUT

	MODEL 1		MODEL 2		MODEL 3		MODEL 4	
VARIABLES	ORIGINAL	CUMULATIVE	ORIGINAL	CUMULATIVE	ORIGINAL	CUMULATIVE	ORIGINAL	CUMULATIVE
Resource	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***
Marketization	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***
Local	0.15	0.00***						
National	0.24	0.00***						
Talents			0.00***	0.09*			0.00***	0.07*
Innovation subjects			0.09*	0.00***			0.01***	0.03**
Hi-tech industries			0.67	0.00***			0.30	0.02**
KIBS			0.49	0.00***			0.69	0.06*
Intellectual property			0.00***	0.06*			0.04**	0.04**
Entrepreneurship			0.00***	0.01***			0.08*	0.00***
Comprehensive plans			0.07*	0.00***			0.00***	0.02**
Innovative cities					0.53	0.00***	0.00***	0.00***
Innovative parks					0.00***	0.11	0.00***	0.32
Innovative bases					0.09*	0.00***	0.36	0.06*
Innovative clusters					0.78	0.13	0.43	0.06*
Innovative organizations					0.00***	0.00***	0.00***	0.01***
R^2	0.84	0.88	0.85	0.94	0.83	0.90	0.90	0.96
Log likelihood	67.57	90.33	72.31	137.82	62.07	100.76	101.43	164.56
Akaike AIC	-0.77	-1.09	-0.69	-1.63	-0.60	-1.15	-0.96	-1.87
Schwarz SC	-0.47	-0.80	-0.19	-1.12	-0.18	-0.73	-0.25	-1.15

Note: *, **, and *** indicates significant at 90%, 95% and 99% confidence level respectively. Hereinafter.

Table 7—Granger causality/block exogeneity tests between innovation policies and knowledge output

	Model 1		Model 2		Model 3		Model 4	
Variables	Original	Cumulative	Original	Cumulative	Original	Cumulative	Original	Cumulative
Resource	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***
Marketization	0.00***	0.02**	0.01***	0.00***	0.00***	0.00***	0.00***	0.00***
Local	0.03**	0.00***						
National	0.54	0.00***						
Talents			0.08*	0.02**			0.01***	0.02**
Innovation subjects			0.04**	0.45			0.00***	0.03**
Hi-tech industries			0.85	0.14			0.04**	0.44
KIBS			0.58	0.00***			0.45	0.02**
Intellectual property			0.00***	0.94			0.07*	0.00***
Entrepreneurship			0.01***	0.08*			0.16	0.00***
Comprehensive plans			0.08*	0.04**			0.13	0.25
Innovative cities					0.00***	0.00***	0.00***	0.04**
Innovative parks					0.00***	0.08*	0.00***	0.02**
Innovative bases					0.00***	0.00***	0.02**	0.14
Innovative clusters					0.97	0.57	0.07*	0.53
Innovative organizations					0.00***	0.00***	0.00***	0.01***
R^2	0.76	0.81	0.74	0.92	0.78	0.81	0.84	0.93
Log likelihood	34.94	53.64	29.85	108.85	41.45	53.92	64.86	126.78
Akaike AIC	-0.30	-0.57	-0.08	-1.21	-0.31	-0.48	-0.44	-1.33
Schwarz SC	0.00	-0.27	0.42	-0.71	0.11	-0.06	0.27	-0.61

production of high-level knowledge outputs, although the economic benefits take a few years to eventuate, which means that local governments need to have a long-term strategy in relation to formulating innovation policies. Third, KIBS policies only had an impact on knowledge and economic outputs in the cumulative data. This can be attributed to the fact that KIBS policies only began to attract attention from local governments after 2010, and thus financial centers, transformation platforms, and R&D centers are just beginning to emerge, so the contribution of policies to economic development remains limited at this stage.

In addition, although the effects of some policies, such as innovation cities, were insignificant when the impact of national policies on outputs was analyzed, results were opposite when they are combined with the overall policy system. Therefore, although targeted policies are necessary, programmatic and comprehensive policies are also indispensable, and inclusive and preferential policies need to be combined to promote economic development throughout the policy system. Similarly, high-tech industry development policies will not bring about knowledge innovation without considering the impact of talent policies and existing industry conditions, thus it is necessary to consider the convergence of old and new policies when formulating policies.

In analyzing the time lag regarding the effects of the various policies, the raw data are more convincing than the cumulative data. Using the variance decomposition method in conjunction with VEC model analysis, we analyzed the variables that showed significant results in Granger causality testing, calculating their lag periods when the policy contribution rate reached its highest value (see Table 8). The findings are as follows:

First, the contribution rate of innovation resource to knowledge and economic outputs was maximized in the third and fifth periods, respectively. The market's contribution to economic output was maximized in the fourth period, while its influence on knowledge output continued to increase before reaching a peak in the tenth period.

Second, in relation to local policies, the contribution rates of innovation subjects and comprehensive policies to economic and knowledge outputs were maximized in the 7th and 6th periods, respectively, while the contribution rate of intellectual property protection policies was maximized in the 5th and 7th periods for knowledge and economic outputs, respectively. The two-year lag indicates the time it took for knowledge achievements to be converted into economic output.

Third, national base and organization policies increased local knowledge output in three to four years, while it took more than six years for the associated economic benefits to appear. Moreover, summing the maximum contribution rates of local and national policies showed that the contribution rate of local policies to economic and knowledge outputs was 22.0 percent and 8.4 percent,

TABLE 8—THE MAXIMUM CONTRIBUTION RATE (%) AND TIME LAG BY THE VARIANCE DECOMPOSITION OF VEC

VARIABLES	ECONOMIC OUTPUT				KNOWLEDGE OUTPUT			
Resource	13.74(5)	9.72(5)	9.12(5)	16.31(5)	15.65(3)	10.69(3)	3.68(3)	12.23(3)
Marketization	9.14(4)	13.70(10)	9.57(4)	12.12(4)	32.52(10)	11.08(10)	24.57(10)	19.03(10)
Local	Null				2.78(7)			
National	Null				Null			
Talents		5.89(7)		7.05(9)		3.69(9)		0.97(8)
Innovation subjects		2.04(5)		8.40(7)		2.66(10)		4.57(7)
Hi-tech industries		Null		Null		Null		0.73(6)
KIBS		Null		Null		Null		Null
Intellectual property		2.22(6)		4.28(7)		2.31(5)		2.16(5)
Entrepreneurship		0.65(6)		0.65(6)		1.98(9)		Null
Comprehensive plans		2.51(4)		1.57(6)		4.13(6)		Null
Innovative cities			Null	1.31(10)			4.55(6)	4.08(6)
Innovative parks			5.99(10)	6.40(7)			4.46(10)	5.41(10)
Innovative bases			7.69(10)	Null			9.72(10)	2.47(4)
Innovative clusters			Null	Null			Null	4.02(4)
Innovative organizations			6.45(6)	3.11(7)			4.31(4)	4.21(3)

Note: The data is original data. Null indicates an indicator that is not significant in granger causality test. The value in parentheses is the time lag period when the policy contribution rate reaches the highest value.

The value of Modulus is less than 1, which indicates the robustness of the models and the city or year fixed effects have been test by the Chow and Hausman test.

respectively, while that of national policies was 10.8 percent and 20.2 percent, respectively.

Overall, the lag time for maximizing the efficiency of innovation resource was three to five years, and the role of the market in resource allocation became increasingly important over time. In addition, local policies were more useful than national policies in economic output, and national policies were more beneficial to knowledge output, which affirmed the positive role of governments in regional innovation development.

FINDINGS FROM THE QUESTIONNAIRE SURVEY

First, most of the interviewees were unfamiliar with the policies. Of the twelve policies presented, ten of them were dominated by "heard, but not familiar" with accounting for about 40 percent of the total. The other two policies, which were related to these two policies—undergraduate entrepreneurship and high-tech enterprise support—were more familiar to respondents than the other policies with 7.7 percent and 5.9 percent for "know well," respectively, and the other ten policies are less than 5 percent. However, they had the least knowledge of R&D cost deduction (29.0 percent) and achievements transformation profit (27.0 percent) policies (see Table 9).

Second, the core status of firms had basically been established in innovation system, but the unwillingness to transform achievements of universities and research institutes impeded regional innovation. Over 60 percent of enterprises launched a collaborative innovation involving production, learning, and research, and more than half of the interviewees affirmed the dominant position of enterprises during the progress. In addition, nearly half of the enterprises

Table 9—S&T workers' familiarity of innovation policies (%)

LISTS	NEVER HEARD	HEARD, BUT NOT FAMILIAR	KNOW A LITTLE	KNOW WELL
R&D costs deduction	29.03	35.25	31.10	4.62
Decentralization of S&T achievements	26.96	41.00	29.59	2.45
Investment and financing channels	23.09	46.65	29.03	1.23
Entrepreneurs of technical personnel	21.49	38.26	36.48	3.77
Research equipment openness	21.40	40.43	35.34	2.83
Achievement transformation	19.98	40.53	36.00	3.49
S&T service industry	19.60	41.56	34.97	3.87
Guaranteed loan	17.90	47.41	32.99	1.70
Incubators	17.44	41.09	37.61	3.86
Entrepreneurs of migrant workers	13.38	42.41	40.53	3.68
High-tech enterprise supporting	8.58	40.71	44.77	5.94
Entrepreneurs of college students	6.41	34.21	51.65	7.73

Table 10—Problems affecting S&T achievements (%)

LISTS	VALUE
Mismatch between S&T and products	66.14
Unreasonable scientific evaluation system	37.30
Imperfection for KIBS	31.97
Insufficient benefits for S&T personnel	30.41
Hard to value S&T achievements	30.09
Information asymmetry among supply chains	29.78
Insufficient enterprise demands	14.11
Lack of credibility	12.54
Others	0.31

increased their R&D spending, resulting in a corresponding increase in the number of patents. The implementation of policies on innovation inputs and achievement transformation ranked highest among enterprises, accounting for 58.0 percent and 52.0 percent of the total number of policies, respectively, while only one-third of enterprises adopted policies relating to the reform of achievements transformation and provision of financial services.

A question on the factors hindering scientific and technological achievements revealed that a disconnection between research results and market demand was the primary factor (66.1 percent), followed by unreasonable scientific research evaluation systems (37.3 percent), unsound professional service systems (32.0 percent), and insufficient benefits for researchers (30.4 percent) (see Table 10).

Finally, the reform of the science and technology system was struggling, and two major bottlenecks—namely, funding and the ecological environment—had restricted innovation outputs. Of the interviewees, 45.3 percent considered that the policy effects were not obvious, and only 24.7 percent reported that the policies had achieved significant results. Half of the respondents stated that they were unsure whether there had been any system reform. As for the reasons for the low impact of innovation policies, insufficient financial support (50.4 percent), imperfect innovation and entrepreneurial ecological environment (49.7 percent), and missing supporting policies (37.6 percent) had become the main obstacles to policy implementation.

Conclusions and Implications

Given that the driving force behind China's economic development is shifting from element-driven and investment-driven policies to innovation-driven policies, this study focuses on the spatial relationships between innovation policies and regional innovation of Jiangsu, China and constructs a policy classification system based on Chinese characteristics. Additionally, using spatial analysis and economic statistical analysis, the study verifies the mechanisms driving the spatial interaction between local and national policies and economic and knowledge outputs. A questionnaire survey is also used to supplement the model analyses. The findings of the study are as follows.

1) From the perspective of the entire process from innovation inputs to outputs, local innovation policies can be divided into seven major categories and twenty-one subcategories. In the meantime, national policies mainly rely on identifying various types of national-level innovation cities, parks, bases, and organizations to promote local innovation and development. However, Jiangsu's response to national policies has been very fast, which is aligning the phases of local policies with the time frame of the national innovation strategy.
2) The focus of local policies had shifted from innovation subjects to talents- and KIBS-related policies, which was related to the economic development level of the three regions. However, the national policies approved by the cities in Jiangsu were mainly concentrated on three aspects: innovation cities, parks, and bases. Further, national policies showed significant spatial inequality, and were mainly clustered in the more developed Sunan region.
3) We used a vector error correct model to verify the cumulative and lagged effects of innovation policies. Cumulative local policies, such as those related to talents, innovation subjects, and KIBS, had a significant impact on outputs. In short, the role of local policies was more significant than that of national policies in terms of regional economic development.
4) In addition, the responses to the questionnaire survey confirmed the positive effects of innovation policies on outputs. Moreover, the major obstacles to the implementation of innovation policies were the low level of policy awareness, insufficient financial support, imperfect innovation, and the entrepreneurial ecological environment, as well as missing support policies.

For the theoretical contribution, on the one hand, the neoliberalism school opposes government intervention and emphasizes the role of market in economic development. However, China's economy has been turning from a planned economy to a market economy since the 1980s. During the transformation process, the government's participation has formed a socialist market economy system with Chinese characteristics. As discovered in this paper, the entire innovation process is supported by innovation policies. Moreover, the above conclusions also confirm the role of innovation policies (governments) in regional innovation. On the other hand, although the new Keynesian school stresses the government's behavior in the event of market failure, there are relatively few studies on hierarchical policies and regional development, not to mention the study of China. This paper not only classifies the hierarchical policies into national and local policies, but also subdivides the policies and analyzes the cumulative and lag effects of different policies on different outputs, which is small step for regional policies study. In addition to perfecting the institutional environment for innovation, it is also a vital function of the government to coordinate regional development and narrow the gaps between the rich and the poor. It is noteworthy that the innovation policies and the reward mechanism behind it will help this goal. Nevertheless, there are still a few issues to be aware of when implementing the innovation policies.

Paying attention to the relevance of various policies and building a networked policy system. The mismatch between innovation policies and development policies has resulted in barely satisfactory performance in terms of the effects of innovation policies on regional development, for example, the contradiction between long-term effects of innovation policies and government's short-term assessment mechanism. Further, policies aimed at encouraging teachers and students' entrepreneurship conflict with the existing education and teaching tasks of universities. Furthermore, the numbers of published papers, books, and patents are still the main indicators of professional achievement, and the negative attitudes of universities toward innovation and entrepreneurship policies will hinder the formation of innovation environment.

Making an effort to build a service-oriented government and highlight the role of the market in the allocation of innovation resources. Existing policies had focused too much on the construction of hard environments such as incubators, platforms, etc., and ignored follow-up supportive public service soft environment, a mismatch between implement policies and requirements policies that hinders regional innovation. In particular, "nanny-style" government behavior has reduced the incentives for companies to carry out innovation activities and bear the risk of innovation. Consequently, the role of the market in the allocation of innovation resources has not yet been fully played.

Accelerating the reform of institutional mechanisms and breaking down barriers for the transformation of scientific and technological achievements. Although more than 60 percent of companies, universities, and research institutes had carried out collaborative innovation projects, the platforms for communication between scientists and entrepreneurs were missing. Further, KIBS that helps to move innovation along the pathway from basic research→applied research→transformation of results→industrialization→marketing, is insufficient. In short, the macrochannel and microcirculation of the transformation from scientific and technological knowledge to economic output have been sluggish, which are shelving of numerous scientific and technological achievements and impeding the role of innovation policies in regional development.

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