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STUDY ON THE INTERNAL COORDINATION COUPLING DEGREE AND KEY INFLUENCING FACTORS OF REGIONAL ENTREPRENEURIAL ECOSYSTEM -- A CASE STUDY OF URBAN AGGLOMERATION IN THE MIDDLE REACHES OF THE YANGTZE RIVER

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ABSTRACT

Entrepreneurial activity is the original driving force of urban economic development. The measurement of its internal coordination coupling degree is helpful to judge the overall quality of the Regional Entrepreneurial ecosystem and identify its key influencing factors. In order to reduce the subjective bias in the selection of evaluation indicators, this study abstracts and selects the collaborative coupling measurement system of the Regional Entrepreneurial ecosystem composed of three levels and 17 indicators from the existing research results at home and abroad, and uses this system to complete the quantitative analysis of the panel data of 28 cities in the urban agglomeration in the middle reaches of the Yangtze River in recent 10 years. The results show that the collaborative coupling measurement evolution of the Regional Entrepreneurial ecosystem presents the characteristics of heterogeneity, ladder, and coordination. The formulation of entrepreneurship incentive policy needs long-term layout and reality, and the implementation of the policy needs to follow the law and make good use of the situation.

KEYWORDS: Entrepreneurship ecosystem; Coordination coupling degree; Urban agglomeration in the middle reaches of the Yangtze River

1. INTRODUCTION

As a systematic activity of creative destruction (Schumpeter et al. 1934), entrepreneurship is the original driving force to promote regional economic development and transformation. One of the themes that has received much attention in entrepreneurship research is the systemic nature of its activities, and the concept of "entrepreneurial ecosystem", as the sum total of the systemic nature, has been widely recognized and continuously studied by scholars. It is generally believed that it not only has an ecological metaphorical significance but also reveals the complex relationship and interaction

among various actors in entrepreneurial activities (Acs et al. 2017). The research on entrepreneurial activities based on time series in specific regions helps to comprehensively reveal the evolution characteristics of interdependence and interaction among participants and can provide the basis for policy makers' policy design and implementation (Evans et al. 1989). This study will systematically review the framework, dimensions, and measurement indicators of the Regional Entrepreneurial ecosystem proposed by various international institutions and scholars. Taking 28 cities in the middle reaches of the Yangtze River urban agglomeration as the research object, the panel data in the recent 10 years has been collected, and the data processing and analysis have been completed according to the coordination coupling degree calculation model. Through multi-dimensional analysis of the result data, this paper summarizes the characteristics of universality and obtains the corresponding policy enlightenment.

2. LITERATURE REVIEW

The measurement of entrepreneurial activities can be traced back to the enterprise positioning theory proposed by Covin in 1986(Acs et al. 1993). With the increasing impact of the regional environment on enterprise business activities, scholars gradually learn from the research results of industrial economics and econometrics to study the evaluation dimensions and indicators that can reflect the overall entrepreneurial quality in the region, including self-employment ratio, enterprise ownership ratio Enterprise import and export ratio (Caves 1997). After 2000, information and networking made the participants of entrepreneurial activities form a relationship of mutual connection, interdependence, and influence, which objectively requires a more systematic perspective on the quality of regional entrepreneurial activities. Especially in addition to traditional influencing factors such as economic development and infrastructure, non-traditional factors such as social culture should be more considered (Audretsch et al. 2015; Zahra et al. 2014). In 2019, Stam summarized the above views, emphasized that entrepreneurial activities should be examined under the multi-dimensional background of time, space, society, organization, and market, and proposed that the quality of a regional entrepreneurial system should be evaluated from three levels: basic framework, resource pool and new value creation (Stam et al. 2019).

Under the guidance of the above academic consensus, major international organizations and academic institutions have successively launched the quality evaluation index system of entrepreneurship system at the national and regional levels. Among them, the most widely recognized and participating countries and regions are the Global Entrepreneurship Monitor (GEM) project, which constructs a measurement index system composed of 12 dimensions such as entrepreneurial financial support, supportive policies, and tax policies (gem2019 / 2020 report) (Bosma et al. 2019). The global entrepreneurship index (GEI) project derived from gem emphasizes the evaluation of the entrepreneurship system from the perspective of entrepreneurs. It establishes three levels: social entrepreneurial attitude, entrepreneurial ability, and personal entrepreneurial ambition, opportunity perception, entrepreneurial technology, risk tolerance, network collaboration, entrepreneurial culture,

opportunity capture ability, technology absorption ability An index system composed of 14 dimensions: human resource capability, competitiveness, product innovation, process innovation, high growth, international operation and venture capital (Szerb et al. 2020). The asset mapping roadmap (AMR) report prepared by the global competitiveness Committee puts forward an evaluation system composed of 8 dimensions: human capital, R & D capability, financial capital, industrial base, connecting organization, legal and regulatory environment, infrastructure, and quality of life, and 44 indicators such as available labor force, venture capital company and tax (Kempner et al. 2008). The entrepreneurship measurement framework (EMF) proposed by the organization for economic cooperation and development emphasizes the establishment of a measurement index system based on the business process of enterprise entrepreneurial activities and selects 31 measurement indicators such as employment opportunity, poverty reduction, gazelle enterprise growth rate and entrepreneurial culture from the three dimensions of entrepreneurial impact, entrepreneurial performance and entrepreneurial determinants(OECD 2017). The doing business2020 report released by the World Bank (WB) evaluates the regional business environment from 12 dimensions, including tax payment, cross-border transactions, and employment of workers, which has reference significance for the evaluation of regional entrepreneurial activities (Bank 2020). The World Economic Forum (WEF), especially from the perspective of the difficulty of undertaking entrepreneurial activities and the availability of all kinds of support, has established a measurement system composed of 8 dimensions such as barrier-free market, capital and financing, government and regulatory framework, universities, and 38 indicators such as domestic market, entrepreneurial culture and entrepreneurial training (World 2014). The "China Youth Entrepreneurship report" (CyeR) prepared by the Chinese Academy of labor and social security takes Chinese provincial units as the research object and evaluates 11 indicators such as entrepreneurs' psychological characteristics, policy environment, opportunity identification, and individual happiness from four aspects: Entrepreneurs' characteristics, entrepreneurial ability, entrepreneurial environment and entrepreneurial performance (CFYEE 2018). The "China regional innovation capability evaluation report 2019" prepared by the China Science and technology development strategy research group and the China Entrepreneurship Management Research Center of the University of Chinese Academy of Sciences has constructed a number of 138 regional innovation capability evaluation index systems around five aspects: knowledge creation, acquisition, enterprise innovation, innovation environment and innovation performance (Group et al. 2019).

In addition to the entrepreneurship evaluation system constructed by the above organizations and institutions, scholars have also made some achievements in regional and urban research. Cunningham et al. (2017) theoretically proposed the governance and evaluation framework of an entrepreneurial ecosystem from five dimensions: public policy, industrialization, public capital supply, private capital supply, and research institutions. Stam and Andrew (2019) took 12 provinces in the Netherlands as the research object and constructed a lightweight evaluation system composed of three dimensions of institutions, resources, and new value creation, and 10 indicators such as entrepreneurial culture, market demand, and networking. Hemmert et al. (2019) analyzed the differences of entrepreneurial

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ecosystems between eastern and western cities from six dimensions: policy support, culture, and human capital, and further explained the profound impact of cultural traditions on entrepreneurs' behavior patterns.

3. Evaluation system construction and measurement

This study follows the division dimension of Stam et al. (2019) and sets the basic layer, performance layer, and output layer of the Regional Entrepreneurial ecosystem as three dimensions of the evaluation index system according to the characteristics of China's situation, as shown in Figure 1. Finance and finance provide financial support for entrepreneurship. Technical talents are always the most important subject of entrepreneurship. They together with the natural and living environment of the city, constitute the basis of Urban Entrepreneurship; On this basis, companies, scientific research institutes, or individuals continuously enhance the vitality of the urban economy through the R & D and marketization process of innovative technologies, and promote the accelerated flow of human, property and other factors; Finally, the increasingly active urban market economy will stimulate the demand for talents in more vigorous regions, provide more jobs, increase residents' income and promote sustainable economic growth.

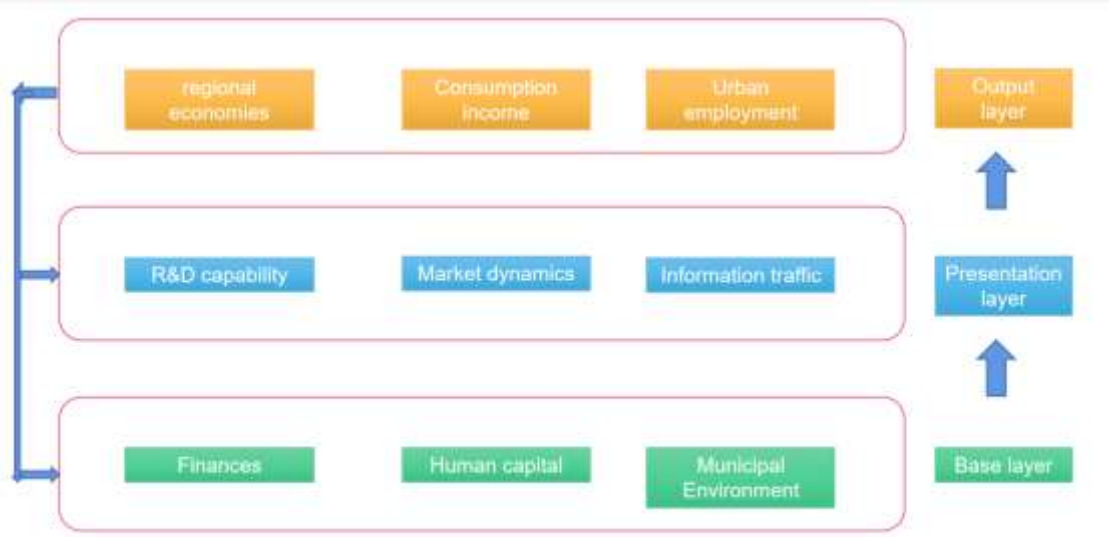

Figure 1 Evaluation dimension block diagram

The coordinated coupling measurement index system of regional entrepreneurship ecosystem is shown in Table 1.

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Table 1 Coordination and Coupling Measurement Index Table of Regional Entrepreneurship Ecosystem

First index	Secondary index	Tertiary index	Index nature
Entrepreneurial foundation	Finances	Science and technology expenditure (ten thousand yuan)	+
		Education expenditure (ten thousand yuan)	+
	Human capital	Natural population growth rate (%)	+
		Number of students in universities and vocational education institutions (person)	+
	Municipal Environment	Industrial waste gas + smoke emission (ton)	-
		The city's completed residential investment (ten thousand yuan)	+
	R&D Capacity	Number of R&d Staff (person)	+
		Annual number of patents granted (pieces)	+
Entrepreneurial performance	Market Dynamics	Foreign direct investment contract projects (a)	+
		Total annual profit of industrial enterprises above designated size (ten thousand yuan)	+
	Information traffic	Annual passenger traffic (10,000 people)	+
		Annual freight volume (10,000 tons)	+
	Regional economics	Regional GDP (ten thousand yuan)	+
Entrepreneurial output	Consumption income	Number of employees (10,000 people)	+
		Average salary of on-the-job employees (yuan)	+
	Urban employment	Number of employed persons in urban units (10,000 people)	+
		Proportion of employment in the tertiary industry (%)	+

Data source: compiled by the author

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According to the indicators listed in Table 1, 28 cities out of a total of 31 cities in the urban agglomeration in the middle reaches of the Yangtze River are taken as the research object (Xiantao, Tianmen, and Qianjiang are not included in this study due to the lack of data). Specifically, it includes 10 cities in Hubei Province: Wuhan, Ezhou, Huangshi, Huanggang, Xiaogan, Xianning, Xiangyang, Yichang, Jingzhou and Jingmen; Eight cities in Hunan Province: Changsha, Zhuzhou, Xiangtan, Yueyang, Changde, Yiyang, Loudi, and Hengyang; There are 10 cities in Jiangxi Province: Nanchang, Jiujiang, Yichun, Xinyu, Pingxiang, Fuzhou, Shangrao, Yingtan, Jingdezhen and Ji'an. Collect various statistical data of the above 28 cities in 2009-2018. The data is mainly from China Urban Statistical Yearbook (2010-2019), and the rest of the data is from the Hubei statistical yearbook, Hunan statistical yearbook, Jiangxi statistical yearbook, China Statistical Yearbook, China high-tech industry statistical yearbook of the corresponding year, and the "statistical bulletin of national economic and social development" of the corresponding year published on the websites of the municipal governments.

SPSS (20.0) software is used to complete the processing and calculation of the collected original data, and the steps are as follows：

The first step is to complete the forward processing of data. Except that the fifth indicator "industrial waste gas and smoke emission" is a reverse indicator, the rest are positive indicators, and the forward processing is completed by counting the reciprocal.

The second is to standardize the forward data obtained in the first step and standardize it with the normalization square.

The third is to obtain the entropy method weight of 17 indexes of each city, as shown in Table 2. Table 2 index weight values of each city

Table 2 Table of index weight values of each city

City	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Nanchang	0.0906	0.0303	0.0319	0.0241	0.0719	0.0616	0.1201	0.0626	0.0534	0.0309	0.0557	0.1595	0.0317	0.034	0.0397	0.0328	0.0693
JingDezhen	0.0656	0.0373	0.1038	0.0223	0.1095	0.0859	0.0994	0.1064	0.0412	0.0281	0.0384	0.0605	0.0436	0.0346	0.0445	0.0328	0.0462
Pingxiang	0.0476	0.0398	0.0629	0.048	0.0834	0.0641	0.0947	0.0998	0.066	0.0334	0.0363	0.0609	0.0321	0.0724	0.0453	0.0614	0.0518
Jiujiang	0.0751	0.049	0.026	0.0711	0.096	0.0703	0.0731	0.0911	0.0778	0.0523	0.0455	0.0364	0.0533	0.0387	0.0515	0.0348	0.0581
Xinyu	0.0368	0.0391	0.0379	0.0763	0.0692	0.0377	0.0901	0.0758	0.064	0.0482	0.075	0.0494	0.0329	0.0678	0.0645	0.0675	0.0679
Yingtan	0.0764	0.0413	0.0259	0.0553	0.0678	0.0469	0.1474	0.144	0.0626	0.0185	0.0469	0.0654	0.0414	0.0459	0.043	0.0357	0.0356
Ji’an	0.0643	0.0385	0.0973	0.0257	0.065	0.0596	0.0487	0.0895	0.0195	0.0306	0.0632	0.1242	0.0267	0.0555	0.0406	0.0528	0.0982

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Yichun	0.0896	0.0426	0.0547	0.0495	0.0482	0.0557	0.1231	0.0907	0.0469	0.0454	0.0642	0.0415	0.0382	0.0283	0.0589	0.0398	0.0826
Fuzhou	0.0822	0.0431	0.0373	0.0827	0.0649	0.0478	0.1279	0.1341	0.0254	0.0424	0.0211	0.0338	0.0386	0.0465	0.0466	0.0503	0.0752
Shangrao	0.0783	0.0454	0.0374	0.0582	0.0679	0.069	0.0934	0.1169	0.0372	0.0387	0.0799	0.0364	0.0437	0.0423	0.0549	0.0461	0.0541
Wuhan	0.0933	0.0661	0.0448	0.0392	0.1183	0.041	0.0334	0.0502	0.1025	0.0542	0.0651	0.0348	0.0491	0.0206	0.0429	0.0462	0.0985
Huangshi	0.046	0.0588	0.0358	0.0807	0.0612	0.0564	0.0684	0.0916	0.0728	0.0458	0.0679	0.0461	0.0432	0.0228	0.0457	0.1052	0.0516
Yichang	0.0641	0.0427	0.0272	0.1444	0.064	0.0297	0.083	0.1069	0.0523	0.0507	0.0506	0.0337	0.0466	0.0406	0.0469	0.037	0.0798
Xiangyang	0.0978	0.0524	0.0686	0.0629	0.1025	0.0408	0.0458	0.0433	0.0329	0.0433	0.0859	0.0662	0.0496	0.0425	0.0725	0.0604	0.0326
Ezhou	0.0943	0.0494	0.0495	0.0583	0.0843	0.0527	0.0437	0.0435	0.1993	0.0482	0.0414	0.0441	0.0397	0.0248	0.0429	0.0284	0.0557
Jingmen	0.0801	0.0458	0.0191	0.0675	0.1102	0.0387	0.1338	0.1251	0.0356	0.042	0.0495	0.0635	0.0396	0.0382	0.0551	0.0262	0.0299
Xiaogan	0.0885	0.0517	0.0344	0.0987	0.1193	0.0501	0.0736	0.0842	0.0295	0.0455	0.0699	0.0575	0.0435	0.0247	0.0393	0.036	0.0536
Jingzhou	0.0623	0.0516	0.0261	0.047	0.1047	0.0613	0.0261	0.054	0.2424	0.0519	0.0586	0.0505	0.0377	0.0224	0.042	0.0274	0.0339
Huanggang	0.0503	0.0464	0.0215	0.0809	0.0813	0.0579	0.0318	0.0593	0.1034	0.0437	0.0344	0.0583	0.0437	0.0502	0.0399	0.0905	0.1066
Xianning	0.0574	0.0484	0.0267	0.0683	0.0656	0.0603	0.1244	0.1051	0.0563	0.0364	0.0357	0.0686	0.0378	0.0356	0.0439	0.0307	0.0989
Changsha	0.0487	0.0491	0.0232	0.11	0.0615	0.0294	0.0282	0.0357	0.0534	0.0403	0.0864	0.2033	0.0427	0.0267	0.0544	0.026	0.081
Zhuzhou	0.1582	0.0654	0.0437	0.0732	0.053	0.0593	0.0496	0.0599	0.0311	0.0358	0.0631	0.0423	0.0532	0.0456	0.0671	0.0461	0.0531
Xiangtan	0.1541	0.0525	0.0308	0.0626	0.0485	0.0621	0.0299	0.0338	0.0561	0.0696	0.0649	0.0543	0.0485	0.0392	0.0605	0.0622	0.0702
Hengyang	0.064	0.0602	0.0231	0.0643	0.133	0.0524	0.0905	0.1089	0.025	0.0353	0.0614	0.0372	0.0466	0.0552	0.0667	0.0313	0.0447
Yueyang	0.0844	0.0594	0.0266	0.0523	0.1438	0.0451	0.04	0.0422	0.1131	0.0323	0.06	0.0459	0.0513	0.044	0.0607	0.0486	0.0501
Changde	0.1232	0.0543	0.0308	0.0611	0.1269	0.0727	0.0318	0.0366	0.0582	0.0363	0.0507	0.0434	0.0528	0.0463	0.0713	0.0415	0.062
Yiyang	0.0485	0.0538	0.0223	0.0489	0.153	0.0284	0.1103	0.1031	0.0812	0.0211	0.0384	0.0331	0.0417	0.0591	0.0532	0.0356	0.0681
Loudi	0.0609	0.0446	0.0352	0.0571	0.1299	0.0635	0.0636	0.0947	0.0619	0.0449	0.0746	0.0462	0.0426	0.0426	0.0523	0.0236	0.0618

Data source: compiled by the author

The fourth step is to calculate the sequence parameters of each secondary index.

Let the variable $Z_i(i=1,2,\ldots n)$ be the order parameter of a secondary index in the Urban Entrepreneurship system, and X_{ij} be the j-th index of the i-th order parameter, and its maximum and

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minimum values are A_{ij} and B_{ij} respectively, then the efficacy function U_{ij} of the j-th index of the i-th secondary index can be expressed as:

$$U_{ij} = \begin{cases} \frac{(X_{ij}-B_{ij})}{(A_{ij}-B_{ij})}, & \text{When the j is a positive indicator;} \\ \frac{(A_{ij}-X_{ij})}{(A_{ij}-B_{ij})}, & \text{When the j}-\text{th is a reverse indicator;} \end{cases} \quad (1)$$

The order parameter Z_i of the ith second-level indicator can be expressed as

$$Z_i = \sum_{j=1}^{m} q_{ij} \times U_{ij} \quad (2)$$

Then the total entrepreneurial system coupling degree C_0 can be expressed as：

$$C_0 = n \times \left\{ \frac{(Z_1 \times Z_2 \ldots \times Z_n)}{\prod (Z_i + Z_j)} \right\}^{\frac{1}{n}} \quad (3)$$

N is the number of subsystems. In this study, n = 3. q_{ij} is the weight of the j-th index of the i-th secondary index.

The fifth step is to calculate the annual coordination coupling degree D of each city. The calculation formula is as follows:

$$\begin{cases} D = \sqrt{C_0 \times T} \\ T = \sum_{i=1}^{n} a \times U_1 + b \times U_2 + \ldots x \times U_n \end{cases} \quad (4)$$

In equation (4), a, b and c are respectively equal to the sum of the weights of all three-level indicators in U1, U2 and U3.

According to equations (1) - (4), the scores of coordination and coupling degree of Urban Entrepreneurship ecosystem of 28 cities in the urban agglomeration in the middle reaches of the Yangtze River from 2009 to 2018 are calculated one by one. The calculation results are shown in Table 3.

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Table 3 Calculation results of coordination coupling degree of Yangtze River urban agglomeration

City	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Nanchang	0.1584	0.3712	0.2032	0.2344	0.4048	0.4992	0.5200	0.6128	0.6848	0.7960
Jingdezhen	0.1617	0.3024	0.1736	0.3066	0.2793	0.2240	0.4109	0.4452	0.5369	0.6804
Pingxiang	0.1176	0.2765	0.2177	0.2065	0.3227	0.4613	0.3675	0.5215	0.5803	0.6846
Jiujiang	0.1169	0.2569	0.2520	0.1862	0.4795	0.4634	0.4466	0.4795	0.5236	0.6245
Xinyu	0.1780	0.6320	0.6370	0.6040	0.8880	0.5870	0.6470	0.7970	0.7370	0.4620
Yingtan	0.0763	0.0581	0.2926	0.3556	0.5180	0.5089	0.5096	0.5481	0.5761	0.6665
Ji’an	0.0700	0.2156	0.3640	0.3528	0.4172	0.5642	0.5201	0.5908	0.5929	0.6765
Yichun	0.2170	0.1260	0.1729	0.1799	0.2758	0.3920	0.3913	0.4739	0.5747	0.6895
Fuzhou	0.1043	0.2751	0.3451	0.1778	0.2863	0.4130	0.4641	0.4662	0.5439	0.6867
Shangrao	0.1232	0.3220	0.2821	0.3164	0.2534	0.4053	0.4193	0.5257	0.5075	0.6750
Wuhan	0.1000	0.3560	0.3800	0.4730	0.5880	0.6600	0.6730	0.7660	0.7860	0.9950
Huangshi	0.1258	0.4531	0.2856	0.4820	0.5032	0.5449	0.5508	0.7650	0.7888	0.8458
Yichang	0.2644	0.1131	0.3800	0.4939	0.6069	0.6086	0.6894	0.6979	0.6596	0.8186
Xiangyang	0.1054	0.2856	0.4378	0.3137	0.4922	0.5661	0.6486	0.6511	0.7072	0.8441
Ezhou	0.2448	0.2882	0.3001	0.2491	0.3392	0.3698	0.2686	0.6001	0.5211	0.6452
Jingmen	0.0978	0.2049	0.2610	0.3281	0.3987	0.3800	0.5874	0.7098	0.7429	0.8678
Xiaogan	0.3069	0.2295	0.2236	0.3698	0.4981	0.5474	0.6486	0.6613	0.7727	0.8788
Jingzhou	0.1632	0.1471	0.5313	0.3910	0.4760	0.5381	0.5321	0.6018	0.6316	0.7378
Huanggang	0.2295	0.3154	0.1947	0.2712	0.3978	0.5330	0.6078	0.6953	0.7565	0.8339
Xianning	0.1190	0.2635	0.1947	0.2797	0.4106	0.5449	0.5398	0.5925	0.6486	0.8458
Changsha	0.1200	0.3312	0.4884	0.5892	0.8832	0.5280	0.5616	0.6912	0.7188	0.8364

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Zhuzhou	0.1632	0.2202	0.6358	0.6129	0.6902	0.7625	0.7157	0.7667	0.7370	0.8075
Xiangtan	0.0850	0.3485	0.4930	0.5483	0.5882	0.4845	0.5134	0.6103	0.6171	0.7667
Hengyang	0.0850	0.2805	0.2865	0.5177	0.4828	0.4794	0.5848	0.6520	0.7472	0.8288
Yueyang	0.1267	0.4012	0.3307	0.2652	0.5389	0.6052	0.5874	0.7276	0.6724	0.7795
Changde	0.0850	0.2882	0.4327	0.4956	0.5262	0.5287	0.5602	0.6324	0.6860	0.8194
Yiyang	0.1624	0.1862	0.1972	0.2508	0.3366	0.4386	0.5211	0.6137	0.7038	0.8454
Loudi	0.2236	0.2992	0.7285	0.7098	0.4624	0.4276	0.4446	0.5066	0.5474	0.8234

Data source: compiled by the author

According to the measured values, the coordinated coupling degree of entrepreneurial ecosystem in 28 cities is classified. Referring to the classification standards in relevant literature and combined with the specific situation of this study, the scores of coupling degrees at all levels are defined as: 0-0.4 is low coupling degree, 0.4-0.6 is general coupling degree, 0.6-0.8 is medium coupling degree, 0.8-0.9 is high coupling degree and 0.9-1.0 is high coupling degree. The cities in the above different stages in each year are shown in Table 4:

Table 4 Summary of urban coupling level in each year

Year	Low coupling	General coupling	Medium coupling	Higher coupling	High coupling
2009	All 28 cities	/	/	/	/
2010	The remaining 25 cities	Xinhyu, Huangshi, Yueyang	/	/	/
2011	The remaining 20 cities	Xiangyang, Jingzhou, Changsha, Xiangtan, Changde	Xinyu, Zhuzhou, Loudi	/	/
2012	The remaining 18 cities	Wuhan, Huangshi, Yichang, Changsha, Xiangtan, Hengyang,	Xinyu, Zhuzhou, Loudi	/	/

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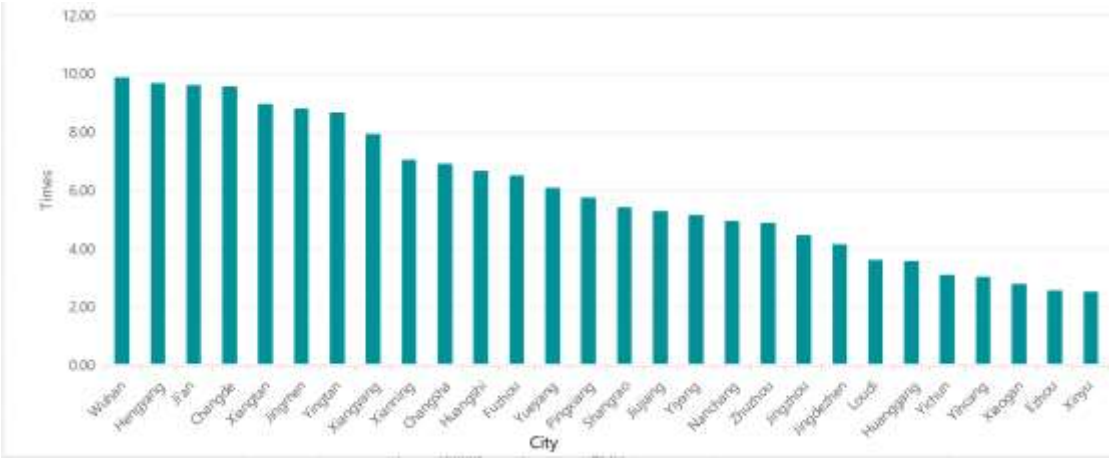
2013	The remaining 9 cities	Nanchang, Jiujiang, Yingtan, Ji'an, Wuhan, Huangshi, Xiangyang, Xiaogan, Jingzhou, Xianning, Xiangtan,	Yichang, Zhuzhou	Xinyu, Changsha	/
2014	Jingdezhen, Yichun, Ezhou, Jingmen	The remaining 20 cities	Wuhan, Yichang, Zhuzhou, Yueyang	/	/
2015	Pingxiang, Yichun, Ezhou	The remaining 18 cities	Xinyu, Wuhan, Yichang, Xiangyang,	/	/
2016	/	Jingdezhen, Pingxiang, Jiujiang, Yingtan, Ji'an, Yichun, Fuzhou,	The remaining 18cities	/	/
2017	/	Jingdezhen, Pingxiang, Jiujiang, Yingtan, Ji'an, Yichun, Fuzhou,	The remaining 18cities	/	/
2018	/	Xinyu	The remaining 13cities	Huangshi, Yichang, Xiangyang, Jingmen, Xiaogan, Huanggang, Xianning, Changsha, Zhuzhou, Hengyang, Changde, Yiyang, Loudi	Wuhan

It can be seen from table 4 that the coupling degree of entrepreneurial ecosystem of 28 cities in the urban agglomeration in the middle reaches of the Yangtze River has significantly improved from 2009 to 2018, with an increase of 2.6-9.9 times, and the improvement multiple from high to low, as shown in Figure 1.



Data source: author statistics

Figure 1 List of coupling improvement of each city

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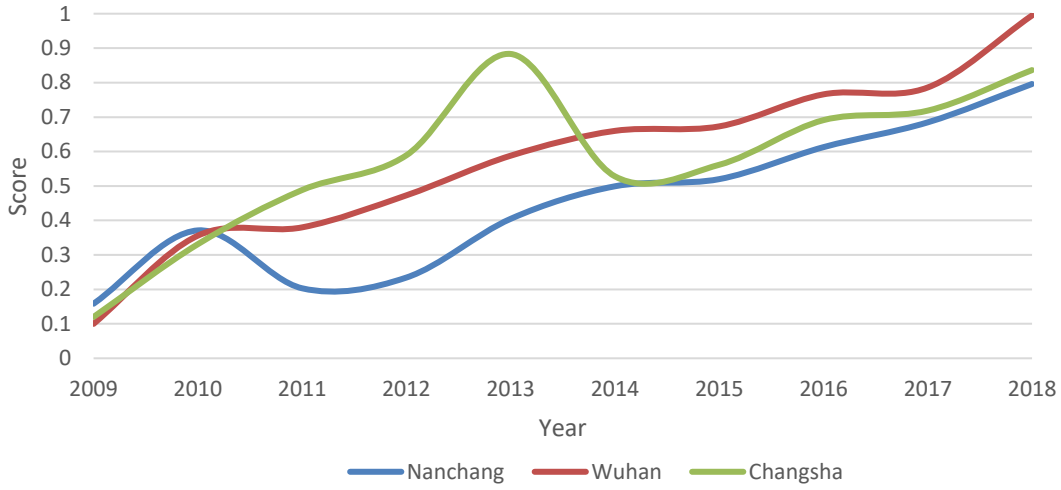
As can be seen from Figure 1, there are significant differences among cities. The coupling degree of Wuhan, Hengyang, Ji'an and other cities has improved significantly; The coupling degree of most cities such as Huangshi and Yueyang has improved well; A few cities, such as Ezhou and Xinyu, need to further improve their coordination and coupling degree.



Data source: author statistics

Figure 2 score map of three provincial capitals

The evolution of the coupling degree of the three large provincial capitals is shown in Figure 2 above. From 2009 to 2010, the three cities were basically in the same starting line, and the difference of the coupling degree values was very small. After that, Changsha took the lead in achieving significant improvement, while Nanchang experienced a serious decline. After four years of shock adjustment, the coupling degree of the two cities returned to almost the same value, and then improved at a close rate. It should be noted that during this period, Wuhan has always maintained steady improvement, and its final score of coordination coupling degree is the highest. It is also the only city in the 28 cities that has reached the state of high coupling degree.

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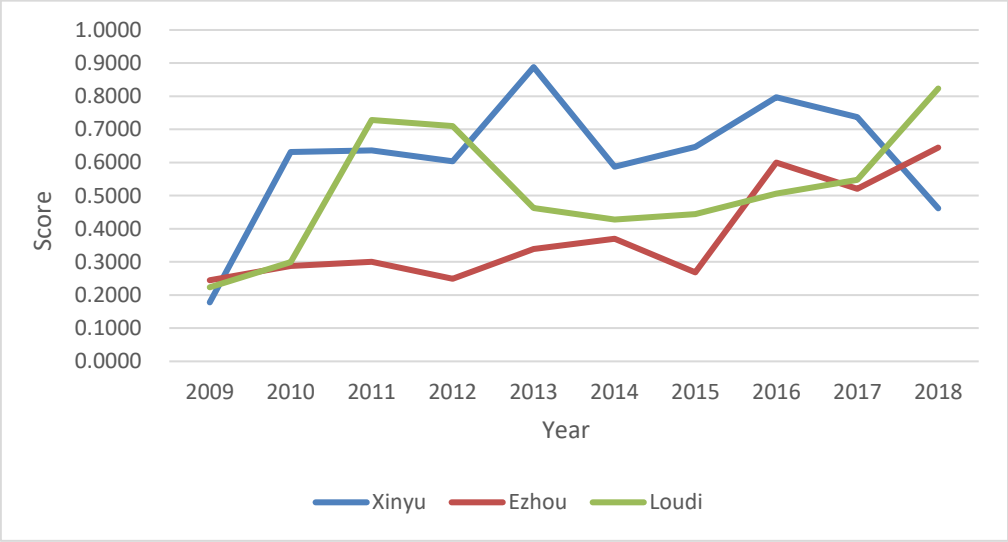
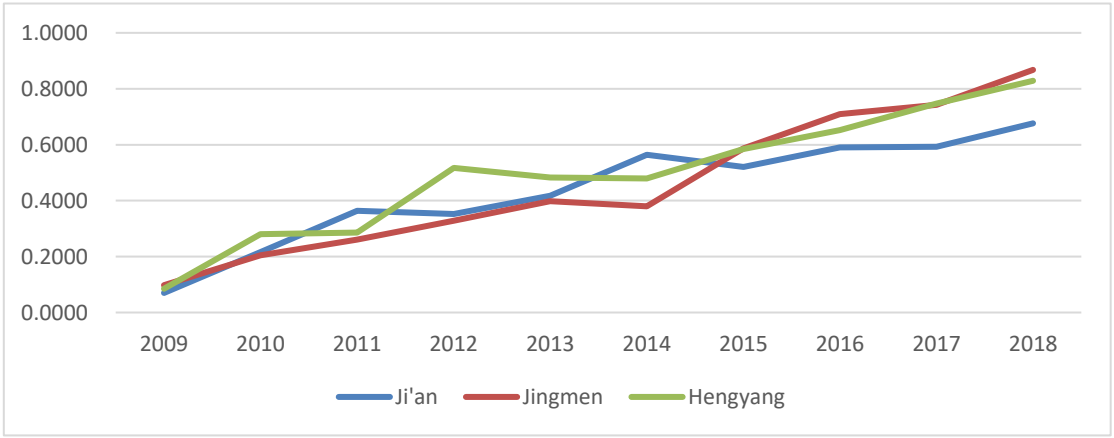


Data source: author statistics

Figure 3 score map of three cities

Except for a few cities, the coordination and coupling degree of most cities shows a trend of continuous improvement, while the coupling degree of Xinyu, Zhuzhou and Loudi, which increases rapidly in the initial stage, has little improvement or even obvious regression in the later stage (Xinyu). As shown in Figure 3 above, the growth of the three cities in the basic dimension is relatively slow, and the scores in the performance and output dimensions are also low for a long time. In addition to the above six cities, the coupling degree evolution of 22 cities shows a steady improvement trend as a whole, among which Hengyang, Ji'an and Jingmen are the most ideal, as shown in Figure 4.



数据来源：作者统计

Figure 4 score map of Ji'an, Jingmen, and Hengyang

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4. Policy implications

Through the above positive and negative development trends, we can get the following three policy enlightenments:

First, the heterogeneity of the coordinated coupling degree evolution of Regional Entrepreneurial ecosystem is very obvious, and the key influencing factors are also different for cities with different coupling degrees in different development stages. For example, for Yueyang with medium coupling degree, foreign direct investment projects and science and technology expenditure are indicators with high influence weight; For Hengyang, which is in a high coupling degree, the number of R & D personnel and the number of annual patent authorizations are the main impact indicators; For Wuhan, which is in a high degree of coupling, indicators such as industrial waste gas and smoke emission and the proportion of employment in the tertiary industry are the main driving factors. Therefore, the design and implementation of relevant industrial development planning, incentive policies and fiscal and tax preferential policies in each city must take into account the actual situation of local natural endowment, scientific research and innovation potential, industrial structure and human resources, especially the differences in institutional environment and governance capacity among different cities, and the existing policies of other cities cannot be applied rigidly. Hengyang, Ji'an, Jingmen and other cities have done a better job in this regard. Led by local government departments, they have formulated policies and measures that can reflect the historical traditions and economic geography of the region and the city. For example, Hengyang is located in the central city of southern Hunan, and its development plan is approved by the State Council and supervised and implemented by provincial departments. Based on the actual situation and development stage of Hengyang, this long-term strategic planning has made strict and detailed provisions on urban scale, scientific and technological investment, industrial layout and environmental protection, and made advance planning and preparation for the specific implementation details of the policy, which can effectively avoid the uncertainty of policy implementation caused by personnel change.

Second, the evolution of coordination and coupling degree of Regional Entrepreneurial ecosystem is not linear, but presents a ladder development law, and the average period is about 5 years. To achieve a breakthrough in the development stage, we must get rid of the excessive "path dependence" on one or two industries and realize the transformation of old and new kinetic energy through continuous "new path creation". Only in this way can we finally make a sustainable leap to the next stage. For example, Xinyu, Ezhou and Loudi all rely on the development of large iron and steel enterprises and supporting industries for a long time. Under the dual influence of the national policy of removing iron and steel production capacity and the changes in the international iron and steel market, the uncertainty of the industrial economic situation is strong, which makes the overall coupling degree change more violently. It should be emphasized that "path dependence" has its historical inevitability and can not be denied, and the new "path creation" is not achieved in a day. For a considerable period of time, the dependence of the old path and the creation of the new path coexist in parallel, and there is no complete

replacement, but the proportion of the two is changing. That is, the proportion of the old path is decreasing and the proportion of the new path is increasing. In this process, the key influencing factors are also changing, and the corresponding financial investment and policy-making also need to be adjusted accordingly. In this regard, Loudi is commendable. While maintaining the technical advantages and economic benefits of the iron and steel industry, it actively explores new development paths. It not only actively explores the new effects of the old paths through the construction of "new iron and steel city", but also gives full play to the regional advantages of its transportation geographical center through the construction of a large-scale intelligent logistics park, and has successfully embarked on the road of continuous improvement.

Third, the three dimensions of the foundation, performance and output of the Regional Entrepreneurial ecosystem need to achieve synchronous and coordinated development. The significant progress or regression of a dimension is unfavorable to the improvement of the overall coupling degree, and even in the long run, the disadvantages outweigh the advantages. It can be seen from the change of scores in all dimensions of Wuhan, which has the best improvement trend of coupling degree, that the continuous and steady improvement at all levels is the best model for the evolution of urban entrepreneurial coupling degree, and the improvement of basic dimensions is the precursor and prerequisite for the improvement of overall coupling degree. Its experience shows that the continuous investment in science, technology and education, the governance of the natural environment and the improvement of the convenience of urban life are the cornerstone of entrepreneurial activities. In addition, for large provincial capitals such as Wuhan, Changsha and Nanchang, they should not only undertake the task of social and economic development in their own urban areas, but also undertake the important task of radiating the surrounding areas and driving the development of the whole province. Therefore, the requirements for their entrepreneurial performance are higher. Internally, we should tap the industrial collection of enriching the people and rejuvenating the city based on the accumulation of existing technology, and look for endogenous growth power in the region; Externally, we should seek appropriate technological cooperation and innovation, and look for exogenous growth power from outside the region.

5. CONCLUSIONS

The construction of a coordinated coupling measurement system of regional entrepreneurship ecosystem linked to the statistical yearbook data can more quickly and intuitively grasp the stage and key influencing factors of urban entrepreneurship development, so as to help formulate more targeted incentive policies to improve the power and potential of urban economic development. In order to avoid the rationality of index selection that may exist in similar studies, this study first systematically reviews the establishment principles and selection of specific indicators of entrepreneurial activities at the regional (urban) level in major international organizations or institutions, well-known scholars and Chinese high-level journals. Thus, the measurement index system of coordination and coupling degree of regional entrepreneurship ecosystem is constructed, which is composed of three primary indicators

of foundation layer, performance layer and output layer, nine secondary indicators such as finance and urban employment, and 17 tertiary indicators such as science and technology expenditure, annual number of patent authorizations and proportion of tertiary industry employment.

Taking 28 cities in the urban agglomeration in the middle reaches of the Yangtze River as the research object, by collecting and sorting out the statistical panel data of the above 17 indicators from 2009 to 2018, and standardizing and quantifying the data according to the coordination coupling degree calculation model, the numerical change law and characteristics of entrepreneurship coordination coupling degree of 28 cities in 10 years are obtained. The results of empirical analysis show that the key influencing factors of cities in different development stages are different, and it is very important to formulate practical and long-term sustainable development planning; In addition, the evolution of urban entrepreneurial coupling presents significant nonlinear and ladder characteristics, and the key to realize stage transition and promotion is to avoid excessive path dependence. We must actively explore new paths and explore new development models. Finally, the synchronous improvement of the three dimensions of Urban Entrepreneurship is far more favorable than the significant change of only one dimension. Continuous investment in the basic dimension is very important. Through the continuous accumulation of basic investment, it can promote the transformation of entrepreneurial performance from quantitative change to qualitative change, and finally realize the sustainable improvement of performance output.

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