A Study on the Coupling and Coordinated Development of Urban Resilience and Technological Innovation

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Abstract. Under the background that Hangzhou is committed to building an international metropolis, in order to identify the status quo of Hangzhou's urban resilience and technological innovation level, as well as the development logic and relationship between the two, this article constructs an evaluation index system related to the two. This paper uses the entropy weight method and the coupling coordination degree model to analyze and compare the coupling coordination degree from the time development process.

Keywords: Urban resilience; Coupling coordination degree; Technological innovation

1 Introduction

Urban resilience means the capability of a city to maintain various systems in working order after external interference [1]. Innovation is central to the process of urban development. High - tech industry plays a strategic role in furthering urban development. Scientific and technological innovation and urban resilience promote and restrict each other. [2] In the new phase of development, scientific and technological innovation will be included in the scope of urban resilience research and play a strategic role.

2 Methodology

2.1 Research framework

In order to scientifically and reasonably measure the coupling coordination concerning urban resilience and technological innovation level[3], this paper uses the index of Hangzhou from 2006 to 2020.

2.2 Measurement of Urban resilience and the level of technological Innovation.

In this paper, the entropy method is devoted to weight the index and calculate its comprehensive index.

Step1. Suppose the selection evaluation system contains m cities and n indicators. The original matrix is denoted as$X = \left(x_{ij}\right)_{m\times n}$.$x_{ij}$ is the value of the i indicator for the j city[4].

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Step2.Normalization of Indicators. In this paper, the standardized result is denoted as y_{ij}.

Step3.Normalization of judgment matrix

$$R' = \left(y'_{ij}\right)_{m\times n} = {y_{ij}}\Big/{\sum_{i=1}^{m} y_{ij}} \ (i = 1,2,\ldots,n; j = 1,2,\ldots,m) \tag{1}$$

Step4.Calculate the entropy value of each indicator

$$E_j = -\frac{1}{lnm}\sum_{i=1}^{m} y'_{ij}\, ln\left(y'_{ij}\right) \tag{2}$$

Step5.Calculate comprehensive score

$$g_i = \sum_{j=1}^{n} W_j \times x_{ij} \text{(i=1,2,...,n)} \tag{3}$$

2.3 Coupling coordination model

The coupling coordination degree model is selected to avoid interference of human subjective factors to the greatest extent. [5].

$$C = \frac{\sqrt{g_1 \times g_2}}{g_1 + g_2} \tag{4}$$

$$T = \alpha g_1 + \beta g_2 \tag{5}$$

$$D = \sqrt{C \times T} \tag{6}$$

D stands for the degree of coordination; T on behalf of the coordination index between urban resilience and technological innovation level; C is the degree of coupling. α and β explain the significance of urban resilience and innovation level [6]. This paper considers the values of both are 0.5.

3 Case Study

3.1 Case Profile and the Evaluation Indicators Construction

The selection of urban resilience and technological innovation indicators for Hangzhou in this paper is shown in the table 1 below.

Table 1. Evaluation Index system of Urban resilience and technological Innovation level

Index	Indicators	+/-	Weight
Economic resilience	Per capita GDP	+	0.081876
	Financial self-sufficiency rate	+	0.069401
	Per capita disposable income of urban residents	+	0.065673

	GDP growth rate	+	0.070928
Ecological resilience	Green coverage rate in built-up area	+	0.063428
	Sulfur dioxide emissions	-	0.059487
	Industrial dust emission	-	0.058346
Infrastructure resilience	Electricity consumption of the whole society	+	0.068378
	Total gas supply	+	0.061816
	urban roads per capita	+	0.061819
	Highway freight volume	+	0.054957
Social resilience	Total retail sales of consumer goods	+	0.069084
	Urban unemployment rate	-	0.058276
	Urbanization rate	+	0.057356
Innovative resources	Proportion of R&D expenditure to GDP	+	0.275325
	Number of R&D researchers	+	0.148365
	Number of students in colleges	+	0.082528
Innovation environment	Number of Internet Broadband access users	+	0.169245
Innovative ability	Number of patents granted	+	0.324537

3.2 Coupling coordination analysis

By comparing the types of coupling coordination, it can be seen that the coupling coordination between Hangzhou's urban resilience and technological innovation level went through three stages from 2006 to 2020. Relevant information is shown in figure 1.

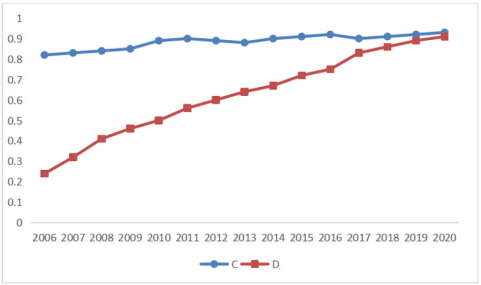

Fig. 1. Coupling coordination degree of urban resilience and technological innovation level

(1) A incongruous stage (2006-2009)

At this stage, the proportion of high-tech industries is not high, and the leading role of the industry is not strong. The phenomenon of difficulty in entrepreneurship caused by the lack of initial capital investment in start-up enterprises is still prominent, which to varying degrees affects the growth and growth of small and medium-sized high-tech enterprises [7].

(2) A basic coordination stage (2010-2015)

During this period, coupling coordination degree steadily increased, and there was no lag in any particular system. The development trend of two systems is good. Hangzhou fully leverages the foundation and potential advantages of the development of high-tech industries, ac-

tively guiding resource elements such as talent, technology, capital, and land towards the new generation of information technology industry.[8]

(3) A high coordination stage (2016-2020)

At this stage, the coupling and coordination relationship between Hangzhou's urban resilience and technological innovation level has entered a highly coordinated stage. Around 2013, Hangzhou accelerated the construction of urban resilience to create a good business environment. At the same time, the development of well-known Internet companies such as Alibaba and NetEase has enhanced Hangzhou's innovation ability and economic vitality.

4 Conclusion

The principal research findings of this article are as follows:

(1) The urban resilience of Hangzhou has shown an upward trend during this period, with social resilience contributing the most to the overall development of urban resilience. The most significant fluctuations in economic resilience reflect that economic resilience is a sensitive dimension in urban resilience.

(2) The level of technological innovation in Hangzhou has shown an upward trend during this period, with innovative resources having a higher weight. With the development of Hangzhou's e-commerce and digital economy, [10] its technological innovation level has shown a greater upward trend in the later stage.

(3) The coupling coordination concerning Hangzhou's urban resilience and technological innovation level has steadily increased. Hangzhou should seize the development opportunities, establish a multi-level management system in urban planning, [11] improve the plan for high-level talent introduction, and enhance Hangzhou's innovative ability in urban construction management, combining modern information technology with urban management services.

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