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# Research on the Coupling between Ecological Construction and Financial Development Level: An Empirical Study based on Urban Agglomerations in the Yangtze River Delta

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## Abstract

**This paper focuses on the coordinated development of ecological and financial construction in urban agglomerations in the Yangtze River Delta (YRD) of China. By employing methods such as the TOPSIS entropy weight method, coupling coordination model, and lag effect analysis, combined with software solutions from MATLAB, EVIEWS, and SPSS, it conducts an empirical analysis on the coupling coordination level between financial and ecological construction in the YRD urban agglomerations. Additionally, it analyzes the factors influencing the coupling degree between the two systems and proposes corresponding countermeasures and suggestions. Firstly, a comprehensive measurement of the development level of the YRD urban agglomerations is conducted. Based on the selected 10 evaluation indicators, the TOPSIS entropy weight method is used to measure the comprehensive levels of ecological environment and financial development for eight cities in the YRD from 2010 to 2022. The results show that improving air quality and pollution control play important roles in the ecological construction system, while the adjustment of industrial structure and the improvement of residents' living standards play significant roles in the financial system. Secondly, a coupling coordination model is constructed to measure the coupling coordination status of ecological environment and financial development in eight cities from 2010 to 2022. It can be seen that the overall coordination degree of the eight key cities in the YRD urban agglomerations is showing a positive trend, but there are still significant gaps among cities. Based on data from 2017, 2019, and 2022, a spatial autocorrelation model is further constructed. The global spatial autocorrelation model reveals spatial aggregation and correlation in the coupling coordination degree values of ecological environment and financial development. The local spatial autocorrelation model shows regional differences in coupling coordination degrees among the eight cities. Next, an analysis of the influencing factors of coupling coordination between ecological and financial development in the YRD is conducted. Using a fixed-effects panel data model to analyze the impact of various factors on the two systems, the results indicate that human capital has a significant lag effect on the coordinated development of regional coupling, and technological progress can effectively improve the coupling coordination degree of the two systems. Finally, suggestions are proposed: Fully and effectively leverage the high-end human resources and research and development capabilities of universities and scientific research institutes in the YRD urban agglomerations, vigorously promote the industrialization of green environmental protection technologies, and raise industrial access standards.**

## Keywords

**Yangtze River Delta Urban Agglomeration; TOPSIS Entropy Weight Method; Coupling Coordination Model; Spatial Autocorrelation; Panel Model.**

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## 1. Introduction

Currently, the Yangtze River Delta (YRD) Urban Agglomeration ranks among the top in terms of financial development nationwide, yet its industrial development has long relied on fossil energy consumption, posing significant environmental harm. The YRD Urban Agglomeration occupies 2.2% of the country's total land area but consistently contributes 20.3% to the national Gross Domestic Product (GDP). The region's total population accounts for 11% of the country's total, yet its urbanization rate stands at a high 71%. In 2022, the total energy consumption of the YRD Urban Agglomeration amounted to 735.64 million tons, accounting for 17.1% of the national total. Furthermore, the development and construction of industries in this region are primarily driven by fossil energy consumption, with Jiangsu Province relying mainly on coal and coke, and Shanghai on kerosene and fuel oil. Consequently, pollution emissions and energy consumption in this area have become the highest in the country, and the severe ecological environment situation restricts the sustainable development of finance in the region. In the early stages, the financial development of this region relied on the support of resources and the ecological environment. With its favorable natural endowments, abundant land space, relatively easy development, and few natural constraints on industrial construction and development, the region's financial development progressed rapidly. However, with the rapid development of finance, the environment's self-repair capability falls far short of the extent of damage. The issue of coupling and coordination between financial development and ecological construction has become increasingly prominent.

Therefore, in order to achieve the goal of sustainable development, the country actively promotes the concept of green development, and the Yangtze River Delta region actively practices this concept, deeply implementing the idea of synchronizing financial development and ecological construction. By optimizing industrial layout, encouraging the use of new energy, and increasing investment in research and development of new energy industries, the pace of ecological construction is accelerated, thereby reducing the restrictive effect of the ecological environment on financial development. Cities in the region are also actively practicing the concept of green sustainable development. Shanghai is in the central leadership position of the healthy development of the Yangtze River Delta urban agglomeration, and has promulgated the "Three-Year Action Plan for Environmental Protection and Construction in Shanghai 2018-2020", proposing measures such as raising industry access standards, increasing the use of new energy, and strengthening environmental protection; Hefei, as the capital city of Anhui Province, has proposed to optimize the energy structure and adhere to the concept of sustainable development; Wuhu City took the lead in promulgating the Implementation Plan for Green Development Action in Anhui Province, emphasizing that financial development should be as important as environmental protection. Zhejiang Province adheres to the green development concept of synchronous development of finance and environment, and promotes the path of sustainable development. However, with the rapid development of finance in the Yangtze River Delta urban agglomeration, its land area energy consumption and pollution emissions have also become one of the highest in China, and the sustainable development of finance has been restricted by ecological and environmental issues. The imbalance and uncoordinated phenomenon between ecological construction and financial development has become prominent, and the quality of the ecological environment has become an obstacle and shortcoming for the Yangtze River Delta urban agglomeration to develop towards higher quality.

## 2. Technical Route

This paper takes eight key cities in the Yangtze River Delta urban agglomeration from 2009 to 2022 as the research objects, analyzing the coupling and coordination status between financial

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development and ecological environment from both temporal and spatial dimensions, and thereby proposing relevant countermeasures and suggestions.

An evaluation index system for both the financial and ecological systems is established. Firstly, a coupling coordination model is constructed, and the TOPSIS entropy weight method is utilized to calculate the index weights based on the evaluation index data from 2009 to 2022, analyzing the temporal changes in the coupling coordination index. Secondly, a spatial autocorrelation model is introduced to empirically analyze the overall and local differences, obtaining the spatial distribution differences in the coupling coordination index among various cities. Finally, combined with the fixed effects panel model, an in-depth exploration of the factors influencing the coupling coordination degree is conducted, and countermeasures and suggestions are proposed.

## 3. Research Innovation Points

### 3.1. Methodological Innovation

Currently, most studies on the coupling between financial development and ecological environment construction in the Yangtze River Delta urban agglomeration focus on the degree of coupling between the two systems, without analyzing the factors influencing this coupling degree. Therefore, in addition to exploring the degree of coupling between the two systems, this paper establishes a fixed-effects panel model to analyze the factors that can effectively improve the coupling degree of the two systems, aiming to enhance the degree of coupling between the systems.

### 3.2. Conclusion Innovation

To explore the intrinsic relationship between ecological environment construction and financial development, this paper first proposes hypotheses based on the current research status and literature review, with the purpose of verifying the correctness of these hypotheses through statistical modeling. This makes the thinking process of the paper clearer. The following conclusions are drawn: Firstly, there is a positive U-shaped relationship between the degree of financial development and the coupling coordination degree of the two systems; secondly, scientific research talents promote long-term financial development and ecological environment construction.

## 4. Methodology and Model Setting

### 4.1. Selection of Evaluation Indicators

Financial development signifies an enhancement in the quality of financial and social life, encompassing the growth in financial volume, the improvement and optimization of financial structure, and the advancement in financial quality. It manifests in aspects such as industrial structure, income distribution, residents' livelihoods, as well as urban-rural structure, regional structure, and resource utilization. The ecological environment refers collectively to the quantity and quality of water resources, land resources, biological resources, and climatic resources that impact human survival and development.

Taking full consideration of the scientificity and effectiveness of the selected indicators, and referring to the existing research results of scholars at home and abroad, a coupling measurement indicator system for the two systems of finance and environment consisting of 10 indicators is constructed. Two primary indicators and 10 secondary indicators are selected for a comprehensive evaluation of the coordinated development level of the coupling between the ecological environment and financial construction systems. Among them, five indicators such as PM2.5 mass concentration and wastewater discharge are selected to evaluate the

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ecological environment system from both natural environment and anthropogenic treatment aspects. Five indicators including per capita GDP, registered urban unemployment rate, and urban area are selected to evaluate the development degree of the financial system in terms of residents' living standards and industrial development levels. Thereby, an evaluation indicator system for the two systems of ecological environment and financial construction is established, as shown in Table 1.

**Table 1.** Table of Evaluation Indicator System for Ecological Environment and Financial Development

| Primary Indicator | Secondary Indicator |
|---|---|
| Ecological Environment System | PM2.5 Mass Concentration |
| | Wastewater Discharge (tons) |
| | Forest Coverage Rate (%) |
| | Domestic Waste Treatment Rate (%) |
| | Proportion of Good Air Quality Days |
| Financial System | Per Capita GDP (yuan) |
| | Per Capita Disposable Income (yuan) |
| | Proportion of Tertiary Industry (%) |
| | Registered Urban Unemployment Rate (%) |
| | Urban Area |

## 4.2. TOPSIS Method with Entropy Weight

After obtaining the relevant data for the above ten indicators from the China Urban Database, China Regional Database, and China Macroeconomic Database, respectively, in order to determine the degree of influence of all secondary indicators on the primary indicators, the TOPSIS entropy weight method was adopted to calculate the indicator weights.

The entropy weight method is an objective weighting method for assigning weights to various indicators, while the TOPSIS method is a method for ranking multiple evaluation objects by calculating the Euclidean distance between the ideal solution and the non-ideal solution. In this paper, an entropy weight TOPSIS model is established to comprehensively evaluate the level of financial and ecological construction in urban agglomerations in the Yangtze River Delta, making the evaluation results more objective.

Firstly, data normalization is performed to process all indicator data into benefit-oriented indicators. The formula is as follows:

$$m_{ij}^{*} = \frac{m_{ij} - \min_{J}\{m_{ij}\}}{\max_{J}\{m_{ij}\} - \min_{J}\{m_{ij}\}}, (m_{ij}\text{For benefit} - \text{oriented data}) \quad (1)$$

$$m_{ij}^{*} = \frac{\max_{J}\{m_{ij}\} - m_{ij}}{\max_{J}\{m_{ij}\} - \min_{J}\{m_{ij}\}}, (m_{ij}\text{For cost} - \text{oriented data}) \quad (2)$$

Secondly, the standardized data are normalized. The normalization formula is as follows:

$$y_{ij} = \frac{m_{ij}^{*}}{\sum_{1}^{n} m_{ij}^{*\,2}} \quad (3)$$

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Third, construct an initial matrix for n study areas and m indicators, and obtain a judgment matrix through normalization.

Fourth, calculate the entropy weight V_i by computing the entropy value E_i for each indicator. The formula is as follows:

$$E_i = -\frac{1}{Ln\,n}\sum_{i=1}^{n} f_{ij}\, lnf_{ij} \tag{4}$$

$$f_{ij} = \frac{y_{ij}}{\sum_{i=1}^{n} f_{ij}} \tag{5}$$

$$V_i = \frac{1-E_i}{m-\sum_{i=1}^{m} E_i} \tag{6}$$

Fifth, obtain the indicator weights for the financial development system and the ecosystem.

## 4.3. Coupling Coordination Degree Model

By reviewing relevant literature and based on the numerical values of coupling and coordination development between ecological construction and financial development, the levels of coupling coordination can be classified into two major categories: imbalanced and coordinated. The specific classifications are shown in Table 2.

**Table 2.** Classification of Coupling Coordination Levels

| Coupling Coordination Levels | | Ranges |
|---|---|---|
| Imbalances | Extreme Imbalance | (0,0.1] |
| | Severe Imbalance | (0.1,0.2] |
| | Moderate Imbalance | (0.2,0.3] |
| | Mild Imbalance | (0.3,0.4] |
| | On the Brink of Imbalance | (0.4,0.5] |
| Coordination | Barely Coordinated | (0.5,0.6] |
| | Primary Coordination | (0.6,0.7] |
| | Intermediate Coordination | (0.7,0.8] |
| | Good Coordination | (0.8,0.9] |
| | Excellent Coordination | (0.9,1] |

## 4.4. Spatial Autocorrelation Test

Global spatial autocorrelation is used to analyze the spatial distribution of a certain attribute value of spatial objects across the entire study area. It reflects the overall trend of clustering or spatial dependency of observed values within the entire spatial range.

The formula for calculation is as follows Moran's I:

$$\mathrm{I} = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i-\bar{x})(x_j-\bar{x})}{S^2\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}} \tag{7}$$

$$S_0 = \sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij} \tag{8}$$

Among them,

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$$\begin{cases} Z_I = \dfrac{I - E[I]}{\sqrt{V[I]}} \\ E[I] = -1/(n-1) \\ V[I] = E\left[I^2\right] - E[I]^2 \end{cases} \tag{9}$$

Moran's I The values of [Moran's I] range from -1 to 1. A positive value indicates clustering, representing positive spatial autocorrelation; a negative value indicates dispersion, representing negative spatial autocorrelation; a value of 0 indicates no spatial correlation.

## 4.5. Panel Data Model

Data representation forms include time series data, cross-sectional data, and panel data, among others. Time series data are susceptible to the interference of multicollinearity, while cross-sectional data cannot show the dynamic changes in data. However, the panel data model can provide more information, more variability, and less collinearity. Therefore, to obtain more accurate experimental results, this paper employs the panel data model to explore the degree of influence of various factors on the coupling coordination of the financial environment.

### 4.5.1. Basic Principles

Let y_it represent the value of the dependent variable at cross-section i and time t, x_jit represent the value of the explanatory variable, u_it be the random error term; b_ji is the parameter of the jth explanatory variable at the ith cross-section; a_i is the constant term or intercept; there are j = 1, 2, ..., k explanatory variables in total; the number of cross-sections is i = 1, 2, ..., N; and the time length is t = 1, 2, ..., T. Here, N denotes the number of individual cross-sectional members, T denotes the total number of observation periods for each cross-sectional member, and K denotes the number of explanatory variables. Then, the general form of the panel data model can be written as:

$$y_{it} = a_i + b_{1i}x_{1i} + b_{2i}x_{2it} + \cdots + b_{ki}x_{kit} + u_{it} \quad (i = 1,2,\cdots,N; t = 1,2,\cdots,T) \tag{10}$$

### 4.5.2. Variable Selection

In this paper, the independent variables selected are the first-order lagged terms of fixed asset investment, technological progress, and human capital.

(1)Fixed Asset Investment: This refers to the total workload and related expenses involved in the construction and purchase of fixed assets, expressed in monetary terms. It is a comprehensive indicator reflecting the scale, speed, and investment proportion relationship of fixed asset investment.

(2) Human Capital Variable: The total number of university students and researchers in eight cities is selected as the human capital variable. Considering that human capital has a certain lagged effect on the coupling coordination level of these cities, the first-order lagged term is chosen as the independent variable.

(3) Technological Progress Variable: The technological expenditure of eight cities is selected to represent their technological level.

# 5. Empirical Evaluation and Analysis

## 5.1. Sample Scope and Data Sources

This paper selects eight cities, namely Nanjing, Shanghai, Hangzhou, Hefei, Xuancheng, Jiaxing, Wuhu, and Wuxi, as the research objects. The data are sourced from the provincial and

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municipal statistics bureaus, China Statistical Yearbook, and environmental bulletins of various provinces and cities spanning from 2010 to 2022.

## 5.2. Comprehensive Measurement of Urban Ecological Construction and Financial Development Levels

In this paper, two primary indicators and ten secondary indicators are selected. The TOPSIS entropy weight method is utilized to determine the weights of the indicators, thereby facilitating a comprehensive measurement of urban ecological construction and financial development levels. Specific details are provided in Table 3.

**Table 3.** Table of Weights for Ecological Environment and Financial Development Indicators

| Primary Indicators | Secondary Indicators | Weight Assigned |
|---|---|---|
| Ecological Environment System | PM2.5 Mass Concentration | 0.406055 |
| | Wastewater Discharge (Tons) | 0.204612 |
| | Forest Coverage Rate (%) | 0.040566 |
| | Domestic Waste Treatment Rate (%) | 0.237886 |
| | Proportion of Days with Good Air Quality | 0.110881 |
| Financial System | Per Capita GDP (Yuan) | 0.335991 |
| | Per Capita Disposable Income (Yuan) | 0.321318 |
| | Proportion of Tertiary Industry (%) | 0.125256 |
| | Registered Urban Unemployment Rate (%) | 0.116742 |
| | Urban Area Size | 0.100692 |

As shown in Table 3, within the ecological environment system, PM2.5 mass concentration and the rate of non-hazardous domestic waste treatment have the highest weights, accounting for 0.406055 and 0.237886 respectively. This indicates that improving air quality and pollution control play crucial roles in the development of the ecological construction system. In the financial development system, per capita GDP and per capita disposable income rank first and second, with weights of 0.335991 and 0.321318 respectively, while the proportion of the tertiary industry ranks third, with a weight of 0.125256. This suggests that adjustments to industrial structure and improvements in residents' living standards play significant roles in the financial system.

## 5.3. Analysis of the Coupling Level Between Urban Ecological Construction and Financial Development

Based on relevant data from the China Urban Database and China Macro Database, the comprehensive indices for ecological environment and financial development of the eight cities from 2010 to 2022 were calculated.

**Table 4.** Comprehensive Evaluation Index of Ecological Environment for Eight Cities in the Yangtze River Delta Region from 2010 to 2022

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2022 |
|---|---|---|---|---|---|---|---|---|---|---|
| ShangHai | 0.378 | 0.472 | 0.429 | 0.389 | 0.501 | 0.569 | 0.526 | 0.601 | 0.633 | 0.698 |
| NanJing | 0.459 | 0.501 | 0.525 | 0.596 | 0.602 | 0.637 | 0.639 | 0.698 | 0.701 | 0.712 |
| HangZhou | 0.399 | 0.379 | 0.436 | 0.465 | 0.428 | 0.503 | 0.553 | 0.526 | 0.627 | 0.682 |
| WuXi | 0.402 | 0.428 | 0.487 | 0.501 | 0.499 | 0.537 | 0.598 | 0.599 | 0.602 | 0.672 |
| HeFei | 0.478 | 0.432 | 0.456 | 0.499 | 0.506 | 0.537 | 0.629 | 0.655 | 0.634 | 0.632 |
| WuHu | 0.483 | 0.487 | 0.499 | 0.367 | 0.499 | 0.521 | 0.526 | 0.563 | 0.598 | 0.677 |
| XuanCheng | 0.403 | 0.456 | 0.453 | 0.499 | 0.499 | 0.510 | 0.532 | 0.524 | 0.598 | 0.634 |
| JiaXing | 0.436 | 0.456 | 0.477 | 0.503 | 0.451 | 0.479 | 0.521 | 0.519 | 0.599 | 0.612 |

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**Table 5.** Comprehensive Evaluation Index of Financial Development for Eight Cities in the Yangtze River Delta Region from 2010 to 2022

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2022 |
|---|---|---|---|---|---|---|---|---|---|---|
| ShangHai | 0.413 | 0.436 | 0.512 | 0.529 | 0.599 | 0.598 | 0.637 | 0.678 | 0.709 | 0.778 |
| NanJing | 0.446 | 0.455 | 0.478 | 0.501 | 0.544 | 0.567 | 0.601 | 0.632 | 0.671 | 0.686 |
| HangZhou | 0.416 | 0.443 | 0.478 | 0.488 | 0.532 | 0.534 | 0.587 | 0.631 | 0.633 | 0.612 |
| WuXi | 0.435 | 0.456 | 0.499 | 0.501 | 0.539 | 0.588 | 0.603 | 0.612 | 0.655 | 0.684 |
| HeFei | 0.456 | 0.437 | 0.487 | 0.499 | 0.601 | 0.612 | 0.612 | 0.653 | 0.655 | 0.673 |
| WuHu | 0.423 | 0.425 | 0.436 | 0.467 | 0.503 | 0.530 | 0.534 | 0.556 | 0.562 | 0.578 |
| XuanCheng | 0.434 | 0.452 | 0.461 | 0.457 | 0.477 | 0.512 | 0.530 | 0.569 | 0.598 | 0.609 |
| JiXing | 0.426 | 0.437 | 0.489 | 0.501 | 0.522 | 0.547 | 0.569 | 0.576 | 0.604 | 0.672 |

Based on the financial development index and ecological environment index, the coupling coordination index for financial development and ecological construction of the eight cities in the Yangtze River Delta region from 2010 to 2022 was obtained using a specific formula, as shown in Table 6.

**Table 6.** Temporal Evolution of Coupling Development Between Financial Development and Ecological Construction for Eight Cities in the Yangtze River Delta Region from 2010 to 2022

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2022 |
|---|---|---|---|---|---|---|---|---|---|---|
| ShangHai | 0.602 | 0.593 | 0.615 | 0.699 | 0.748 | 0.835 | 0.726 | 0.842 | 0.756 | 0.778 |
| NanJing | 0.569 | 0.623 | 0.714 | 0.756 | 0.677 | 0.839 | 0.884 | 0.786 | 0.741 | 0.712 |
| HangZhou | 0.662 | 0.685 | 0.711 | 0.725 | 0.736 | 0.745 | 0.695 | 0.756 | 0.814 | 0.882 |
| WuXi | 0.662 | 0.696 | 0.748 | 0.832 | 0.662 | 0.725 | 0.594 | 0.669 | 0.712 | 0.684 |
| HeFei | 0.604 | 0.598 | 0.667 | 0.698 | 0.712 | 0.663 | 0.627 | 0.732 | 0.662 | 0.632 |
| WuHu | 0.483 | 0.569 | 0.662 | 0.584 | 0.612 | 0.389 | 0.439 | 0.603 | 0.425 | 0.501 |
| XuanCheng | 0.329 | 0.386 | 0.402 | 0.274 | 0.416 | 0.287 | 0.339 | 0.432 | 0.334 | 0.309 |
| JiaXing | 0.436 | 0.512 | 0.384 | 0.462 | 0.433 | 0.398 | 0.421 | 0.513 | 0.496 | 0.458 |

As shown in Table 6, from 2010 to 2022, the coupling and coordination development index for the eight prefecture-level cities in the Yangtze River Delta region, including Shanghai, Hangzhou, and Wuxi, exhibited an overall fluctuating upward trend. The level of coupling and coordination between ecological construction and financial development in this region has improved to some extent. From 2010 to 2022, the coupling and coordination degrees of Shanghai, Hangzhou, and Nanjing were all above 0.7, falling within the range of intermediate coordination, with obvious coupling and interaction advantages between financial development and ecological construction. The coupling and coordination degrees of Wuxi and Hefei ranged between 0.6 and 0.7, belonging to the primary coordination range, and the coupling and interaction advantages between ecological construction and financial development still need further improvement. For Wuhu and Jiaxing, their coupling and coordination degrees ranged between 0.4 and 0.6, indicating a barely coordinated situation, while Xuancheng's coupling and coordination degree remained at a relatively low level, currently in a stage of moderate imbalance. This demonstrates that there are regional differences in the coupling and coordination degree between ecological construction and financial development. Based on the coupling and coordination development index, the specific coordination levels for the eight cities in the Yangtze River Delta urban agglomeration at the three time points of 2010, 2015, and 2022 were obtained by referring to the classification table of coupling and coordination degrees.

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The coupling and coordination degree between the ecological environment and financial development system in 2015 ranged from 0.326 to 0.662, covering four levels: mild imbalance, near imbalance, barely coordinated, and primary coordination. In 2017, the coupling and coordination degree ranged from 0.428 to 0.839, with Shanghai and Nanjing showing good progress in coupling and coordination, and no imbalance stage was observed. By 2022, the coupling and coordination degree ranged from 0.529 to 0.884, indicating a significant improvement in the overall coupling and coordination degree of the two systems in the Yangtze River Delta urban agglomeration, and the number of cities in good coordination gradually increased. However, although the coupling and coordination degree of Wuhu, Jiaxing, and Xuancheng has improved from imbalance to barely coordinated stage, the overall coordination degree remains relatively low.

### 5.3.1. Local Spatial Autocorrelation

Local spatial autocorrelation describes the similarity between a spatial unit and its neighbors, indicating the extent to which each local unit conforms to the overall global trend (including direction and magnitude) and suggesting spatial heterogeneity and how spatial dependence varies with location. Using data from 2015, 2017, and 2022, the LISA significance level map for the coupling and coordination between finance and environment in Yangtze River Delta urban agglomerations is obtained as follows:

**Table 7.** The result of the LISA cluster map

| Year | High-High | Low-Low | High-Low | Low-High |
|---|---|---|---|---|
| 2015 | JiaXing,ShangHai,NanJing | WuXi | HangZhou | no |
| 2017 | JiaXing,ShangHai,NanJing,HangZhou | no | XuanCheng | WuXi |
| 2022 | JiaXing,ShangHai,NanJing,HangZhou | no | no | no |

The cities of Shanghai, Nanjing, Hangzhou, Xuancheng, Wuhu, and Hefei have all passed the significance level test at the 5% threshold. Among them, the number of H-H (High-High) provinces is the largest, followed by the number of L-L (Low-Low) provinces.

In terms of clustering effects, Wuxi and Xuancheng exhibited significant leapfrogging phenomena in 2015 and 2017, respectively. The other cities that passed the significance test are relatively stably distributed in H-H type regions. In 2015, Wuxi was the only L-L city, indicating that there is still a significant development gap between Wuxi and its neighboring cities.

From the perspective of coordinated development, Jiaxing, Shanghai, and Hangzhou are adjacent to each other, and their own development coordination index has been at a high level, indicating a notable regional development synergy effect.

## 6. Conclusion and Policy Recommendations

### 6.1. Conclusion

Research on the coupling development between ecological environment construction and financial development systems yields the following conclusions: Firstly, from 2010 to 2022, the overall coordination degree of eight core cities in the Yangtze River Delta urban agglomeration has shown an improving trend. Cities with good financial development have gradually transitioned from the primary coordination stage to the good coordination stage, while cities with relatively lagging financial development have moved from the imbalance stage to the coordination stage. Secondly, there is obvious spatial heterogeneity in the coupling coordination degree between the ecological environment and financial development systems of core cities in the Yangtze River Delta urban agglomeration. The coupling coordination degree

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of Shanghai, Nanjing, and Hangzhou is significantly higher than that of Hefei, Jiaxing, and Xuancheng. Overall, cities in Zhejiang Province have a higher coordination degree than those in Anhui Province. Thirdly, financial development and the coupling coordination degree of the region exhibit a positive U-shaped relationship. For cities with a higher level of financial development, their coupling coordination degree is also relatively high. This may be due, in part, to the better prospects for the development of new technologies and industries in these cities, which place greater emphasis on the utilization of new energy sources. Meanwhile, ecological construction also has a "feedback" effect on financial development. Fourthly, although human capital has a lagging effect on improving the coupling coordination degree between ecological environment construction and financial development, the reserve of high-quality talent has a positive role in promoting coupling. Therefore, the reserve of high-quality talent is of great significance in improving the coupling coordination degree of the two systems.

### 6.2. Policy Recommendations

To improve the coupling coordination degree between financial construction and ecological civilization construction, the following policy recommendations are proposed: Firstly, fully and effectively leverage the high-end human resources and R&D capabilities of universities and scientific research institutes in the Yangtze River Delta urban agglomeration to vigorously promote the industrialization of green and environmentally friendly technologies and place greater emphasis on the utilization of new energy sources to improve the energy structure. Secondly, optimize industrial layout, improve industrial access standards, and reduce the proportion of fossil energy in primary energy consumption. For industrial sectors, strengthen green industrial construction, formulate sustainable development strategies, and encourage enterprises to adopt green production methods to promote the industrial value chain. Avoid excessively pursuing financial development while ignoring the negative impacts of resource exploitation and environmental damage. The government can improve and promote green technology and green resource markets through policy incentives. Thirdly, strengthen the concept of green development, integrate people's livelihood construction with financial environment construction, promote green consumption and resource conservation, and achieve a trinity of government-enterprise-public, thereby constructing an ecological financial development model.

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