How Synergistic Network Influence "Standards + Certification" Regional Quality Brand: A Spatial Spillover Effect Perspective

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Abstract. The "Standards + Certification" regional quality brand has become a significant practice in China's high-quality development in recent years. Stakeholders involved in standards and certification form complex network relationships. However, few studies have explored the crucial role of synergistic network in the construction of "Standards + Certification" regional quality brand. This study reveals the direct and spatial spillover effects of synergistic network in the construction of "Standards + Certification" regional quality brand through the Spatial Durbin Model (SDM). The findings show that both synergistic network and "Standards + Certification" regional quality brand exhibit regional clustering and fluctuating development trends. Synergistic network foster not only the growth of local "Standards + Certification" regional quality brand but also positively impact the regional quality brands in surrounding areas through spillover effects. Additionally, the attraction of foreign investment significantly bolsters the construction of regional quality brands, while excessive industrial agglomeration exerts detrimental effects. Therefore, strengthening regional coordinated development, optimizing resource allocation, improving the mechanism of synergistic network, and balancing foreign investment introduction and industrial agglomeration are essential to promote the sustainable development of "Standards + Certification" regional quality brand.

Keywords: Regional Quality Brand, Synergistic Network, Standards, Certification, Spatial Spillover.

1   Introduction

In the evolving domestic and international environment, the concept of high-quality development has emerged as a central theme for China's economic and social progress [1]. This shift marks a significant transformation in China's development paradigm, from prioritizing speed to emphasizing quality and efficiency. However, global trade tensions, supply chain restructuring, and the wave of digital transformation have intensified market volatility and uncertainty [2]. In response, the Chinese government has issued the "Outline for Building a Quality Power," which explicitly proposes the creation of "quality brand promotion demonstration zones." Prior to this policy, numerous

regions in China were already pursuing the construction of regional quality brands based on "Standards + Certification," drawing on successful experiences from developed countries. Examples include "Zhejiang Made," "Jiangsu Excellence," "Shanghai Brand," and "Guangdong Quality." The role of regional quality brands in promoting industrial upgrading, stimulating domestic market vitality, and advancing high-quality economic development has become increasingly prominent. Consequently, regional brand economies have emerged as key indicators of a region's or even a country's development level [3-5]. The "Standards + Certification" is posited to effectively mitigate the challenges inherent in traditional regional branding, including limited brand impact, inconsistent product quality, and inadequate development incentives [6]. This approach is crucial for sustaining competitive edge and fulfilling the requirements of high-quality development. Therefore, this study aims to explore the impact of "Standards + Certification" synergy networks on regional quality brands from a spatial spillover perspective.

The regional quality brand construction model characterized by "Standards + Certification" essentially involves leading quality improvement through advanced standards. The implementation process involves multiple organizations, including standardization bodies and industry-leading enterprises, in developing group standards that align with international benchmarks. Through certification, a brand access mechanism is established, which includes encompassing the supervision of corporate standards implementation, third-party certifications, and brand authorization, thereby achieving the efficient construction and cultivation of regional quality brands. Consequently, regional quality brands are cultivated collectively by multiple entities, with the formulation of standards and the conduct of certifications being game-theoretic choices based on aligned interests [7]. In this process, an organization may engage in the formulation of multiple standards, while different organizations seeking certification for the same product will adhere to the same standard. There are intricate and closely knit relationships among the entities involved in the cultivation of regional quality brands, characterized by structural diversity and nodal directionality. Therefore, by viewing advanced standards as edges and organizations as nodes, it is possible to construct networks of regional quality brand standards and certification involving diverse stakeholders.

The standards network and certification network are indispensable core elements in building regional quality brands. The synergy between these two networks is crucial for the development of regional quality brands. Several scholars have conducted comprehensive research on the standards network and certification network from various perspectives, highlighting the profound coupling and coordination relationship between them [8-9]. The standards network provides the basis and evaluation targets within the certification network, ensuring that certification activities adhere to well-defined quality standards and operational guidelines. Conversely, the certification network offers practical feedback through certification results, facilitating the continuous optimization and improvement of the standards network [10]. This bidirectional interaction promotes the implementation of standards and ensures quality, forming a dynamic and self-improving quality enhancement mechanism. Therefore, to achieve efficient construction of regional quality brands, it is essential to conduct in-depth research on the impact

mechanism of the synergistic network on "Standards + Certification" regional quality brand.

In exploring the impact of synergistic network on the "Standards + Certification" regional quality brand construction, scholars have examined from various perspectives, including those of government [11], enterprises [12], and consumers [13]. Research suggest that synergistic network can promote regional quality brands development through several pathways, such as regulatory convergence [14], information transmission advantages [15], and enhancing product added value [16]. Moreover, as research has deepened, some scholars have noted that synergistic network maintain quality and standards on the supply side, extending the success and influence of regional quality brands beyond their original markets or geographical boundarie [17]. This "spillover effect" stimulates the potential value of regional quality brands. Hence, a thorough investigation into the spatial spillover effects of synergistic network on "Standards + Certification" regional quality brand construction is essential.

In summary, synergistic network and "Standards + Certification" regional quality brand have gradually become focal points in academic research. However, few studies have explored these topics from the perspective of spatial spillover effects. To clarify the impact of synergistic network on "Standards + Certification" regional quality brand, this study utilizes panel data from 11 prefecture-level cities in Zhejiang Province from 2012 to 2022. Spatial econometric methods are employed to analyze the comprehensive impact of synergistic network on "Standards + Certification" regional quality brand construction. The marginal contribution of this study lies in: (1) Utilizing social network analysis to measure the coupling and coordination degree of the standards network and certification network to quantify the synergistic network, thereby addressing the limitation in measurement aspects of existing research. (2) Constructing a regional quality brand construction index (MIMIC-RQBCI) model from an input-output perspective, using a Multi-Indicator Multi-Factor Model (MIMIC) and employing Bayesian interpolation to objectively and accurately assess the level of regional quality brand construction; (3) Investigating both the direct effects and spatial spillover effects of synergistic network on "Standards + Certification" regional quality brand construction using a Spatial Durbin Model (SDM), thereby providing theoretical and empirical evidence for policy formulation.

The remainder of this paper is as follows: The Literature Review and Research Hypotheses section reviews the theoretical foundations supporting the main hypotheses. The Research Design section outlines the variables selection, model specifications, sample methods, and data sources. The Results and Analysis section explores the spatiotemporal evolution, spatial autocorrelation, spatial spillover effects, and decomposition results of synergistic network and "Standards + Certification" regional quality brand. Finally, the Conclusion and Implications section summarizes the research findings and offers corresponding policy recommendations.

2   Literature Review and Research Hypotheses

2.1   The Direct Effect of the Synergistic Network on "Standards + Certification" Regional Quality Brand Construction

Under the "Standards + Certification" framework, regional quality brands leverage advanced standards to regulate corporate behavior and guarantee the quality of their products and services, while quality certification communicates product reliability and strengthens consumer trust in the brand [18]. The synergistic network operates through three fundamental processes grounded in institutional logic and resource orchestration theories. Initially, institutional pressures regulate corporate behavior [19]. Subsequently, dynamic integration of information, technological, and policy resources addresses market demands. Ultimately, alignment of institutions and resources coordinates stakeholder interests, enabling sustainable regional quality brand upgrading [20-21]. This progressive "institutional constraints—resource activation—relationship coordination" mechanism directly influences regional quality brand development. Specifically: (1) Normative Effect. Synergistic network effectively address the limitations of traditional regional brands that rely heavily on resource endowments and ecological conditions. These networks standardize corporate behavior and enhance the stability of product or service quality under regional brands, thereby facilitating the effective establishment of "Standards + Certification" regional quality brand. For instance, many globally recognized brands treat standardized production as the technical cornerstone of brand development, establishing strict quality standards for every stage of production. This creates a comprehensive standard system and certification across the entire industrial chain, ensuring that product quality meets market demands and consumer expectations [22]. Furthermore, voluntary corporate certification, characterized by strong professionalism and credibility, allow certified companies easier access to limited resources like technical guidance and financial support. These companies also undergo continuous quality monitoring by certification bodies throughout production to uphold brand reputation [23]. (2) Market Effect. Synergistic network promote the informatization of "Standards + Certification" regional quality brand construction by removing information barriers in the branding process. They facilitate the flow and dissemination of information—such as production technologies, market demand, and financial policies—within the network, ensuring effective coordination across various stages of regional quality brand construction. This reduces additional costs caused by information asymmetry [24]. The innovative development strategies employed by regional brands through synergistic network not only satisfy the high market demand for branded products but also reinforce the brand's market position and recognition, thereby advancing the establishment of "Standards + Certification" regional quality brand [25]. (3) Integrative Effect. The creation of "Standards + Certification" regional quality brand is an integrative process involving the adaptation, recognition, certification, and acceptance of products and regions [26]. The "Standards + Certification" model constructs a synergistic network that integrates the complex inerrelationships among resources, environment, products, brands, and stakeholders, fostering a coordinated and symbiotic relationship among these stakeholders [27].

From the above three aspects, it is evident that synergistic network exhibit normative, market, and integrative effects, all of which ultimately benefit the construction of "Standards + Certification" regional quality brand. Based on this analysis, this paper proposes the following hypothesis:

H1: synergistic network can significantly enhance the construction of "Standards + Certification" regional quality brand through direct effects.

2.2   The Spatial Spillover Effect of the Synergistic Network on "Standards + Certification" Regional Quality Brand Construction

Given that a synergistic network is a expansive and intricate system, it not only directly impacts the construction of local "Standards + Certification" regional quality brand but also exert spatial spillover effects on the quality brand development in surrounding areas through the diffusion of information, capital, technology, talent, and culture. The spatial spillover effect constitutes a multi-level co-evolutionary outcome under complex adaptive systems theory [28]. Positive feedback mechanisms propel polarization and trickle-down effect, while adaptive diffusion mechanisms regulate spillover effect, and selection pressure mechanisms activate competition effects [29]. These interconnected processes collectively generate a recurrent "agglomeration—flow—competition—reagglomeration" evolutionary cycle. These effects primarily include: (1) Polarization and Trickle-Down Effect. As synergistic network evolve, certain regions, owing to their locational, policy, economic, and resource advantage, may establish mature networks ahead of others. These regions can then absorb resources from their surrounding areas, enhancing their own influence and capacity, thus creating a polarization effect. Simultaneously, as the synergistic network in these regions reaches saturation, local resources may begin to overflow into neighboring areas, triggering a trickle-down effect that fosters the collective development of "Standards + Certification" regional quality brand across the broader region [30]. (2) Spillover Effect. According to the Factor Mobility Theory, the movement of factors such as information, capital, and culture within a synergistic network is a significant driver of both "Standards + Certification" regional quality brand construction and regional economic growth [31]. The flow of these elements within the network facilitates the spatial and thematic reallocation of economic and social resources, effectively promoting the development of regional quality brands both locally and in surrounding regions, creating a flow effect in regional quality brand construction [32]. (3) Competition Effect. In regions where synergistic network are similarly developed, competition for resources can arise. This competition drives innovation in factors such as technology and quality, optimizing resource allocation and further advancing the construction of regional quality brands [33].

Informed by the above analysis and the practical development of regional quality brands, this paper proposes the following hypothesis:

H2: synergistic network exhibit strong regional externalities, capable of influencing the construction of "Standards + Certification" regional quality brand in surrounding areas.

In summary, building on existing research, this paper proposes the following analytical framework (Fig. 1.).
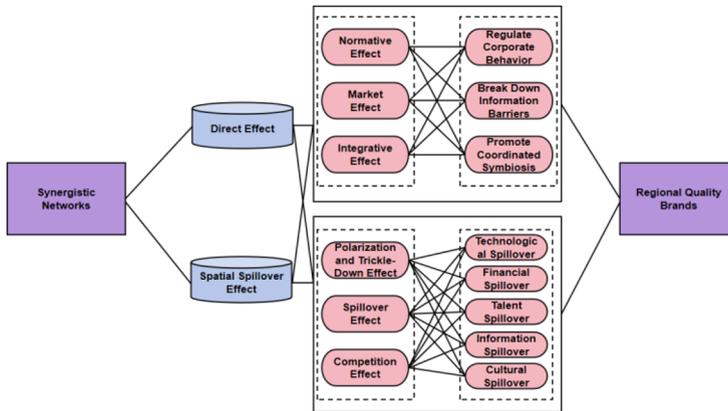
Fig. 1. Framework for analyzing the impact of synergistic network on "Standards + Certification" regional quality brand construction

3 Data and Methodology

3.1 Sample Selection and Data Sources

Zhejiang Province demonstrates two key characteristics that make it an exemplary case study: it leads in institutional innovation while providing transferable insights for regional development. The province's innovative "standards + certification" dual-track model has built a complete quality brand ecosystem. This system operates through a clear three-step process: setting standards, implementing certification, and enhancing brand value - creating a reproducible governance approach. Zhejiang's manufacturing sector shows consistent high-quality growth. The effective spread of development from core cities to surrounding areas confirms the balanced reach of this "standards + certification" system. Compared to Guangdong's export-focused strategy and Jiangsu's industrial park model, Zhejiang's approach better supports China's current shift toward domestic demand-led growth. As of August 2024, Zhejiang has issued a total of 3,606 "Zhejiang Made" standards, certified 7,055 "Zhejiang Made" brand products, and nurtured 4,984 "Zhejiang Made" enterprises. Therefore, this paper selects the "Zhejiang Made" regional quality brand as the research subject, utilizing from 2012 to 2022.

Data on the synergistic network are sourced from the Zhejiang Made Brand Construction official website (https://zhejiangmade.zjamr.zj.gov.cn). Initial data for other indicators are obtained from the Zhejiang Statistical Yearbook, statistical yearbooks of various prefecture-level cities, and official statistics such as the National Economic and Social Development Statistical Bulletins of each city. For any missing values, linear interpolation was employed to complete the dataset, resulting in panel data for 11 prefecture-level cities in Zhejiang Province from 2012 to 2022.

3.2   Variables

Independent variable. Synergistic Network (SN). Previous research frequently employs network characteristics as indicators to measure network development levels [34-36], which tends to overlook the functional coordination among multiple networks. This study addresses this issue by employing social network analysis to construct both the standards network and the certification network, followed by a coupling coordination analysis between them. The coupling coordination degree is then calculated as the indicator for measuring the synergistic network. This metric not only accounts for the network's structural characteristics but also reflects the dynamic interactions among its components. Such a comprehensive evaluation of the synergistic network's overall performance [37].

Dependent variable. "Standards + Certification" Regional Quality Brand (RQB). Given that the construction level of "Standards + Certification" regional quality brand is difficult to observe directly and is not included in conventional statistics, this paper builds on existing literature [38-40]to construct a "Standards + Certification" Regional Quality Brand Construction Index (MIMIC-RQBCI) model. Following the multi-indicator, multi-factor model (MIMIC) proposed by Yang Xu [41], the Monte Carlo-Bayesian interpolation method is employed to calculate the Regional Quality Brand Construction Index.

The MIMIC-RQBCI model includes causal variables such as government input, corporate investment, and resource endowment. Government input includes both the policies issued by the government, which reflect its commitment to the development of "Standards + Certification" regional quality brand, and the guidance and services it provides to support this construction [42]. Therefore, this study quantifies policy support by analyzing the word frequency in annual government work reports from 11 prefecture-level cities, using Python for word segmentation and frequency analysis. Government financial input directly reflects the government's economic commitment and investment in regional brand development [43], is quantified by the proportion of general public service expenditures. On the corporate side, long-term commitment to brand building is key to enhancing the competitiveness of regional quality brands [44], especially in innovation and R&D investment [45]. This study measures corporate investment by the ratio of R&D expenditure to operating costs in large-scale manufacturing enterprises. Regarding resource endowment, the human resource base is measured by the logarithm of the annual average number of employees in large-scale manufacturing enterprises [46]. The brand foundation, reflecting the innovative vitality of the regional brand, is measured by the ratio of trademark applications to the total number of valid registered trademarks [47]. The high industrial agglomeration within the region is measured by the location quotient index to reflect the clustering and synergy effects of related industries [48-49].

The MIMIC-RQBCI model evaluates the outcomes of regional quality brand construction across four dimensions: regional economic benefits, industrial structure upgrading, employment opportunities, and environmental protection. In terms of regional economic benefits, regional quality brands meet consumer demand, driving both government and corporate participation in brand building, thereby shifting the economy

from investment-driven to demand-driven. This is measured by the GDP growth rate [50]. Regional quality brands optimize the industrial structure, promoting high-quality development [51], and this is measured by the industrial structure upgrading index. The expansion of employment opportunities due to regional quality brand construction is measured by the employment rate [52]. Furthermore, regional quality brand construction promotes green production and achieves coordinated economic and environmental development, measured by the comprehensive utilization rate of general industrial solid waste [53]. The MIMIC-RQBCI model is illustrated in Fig. 2.
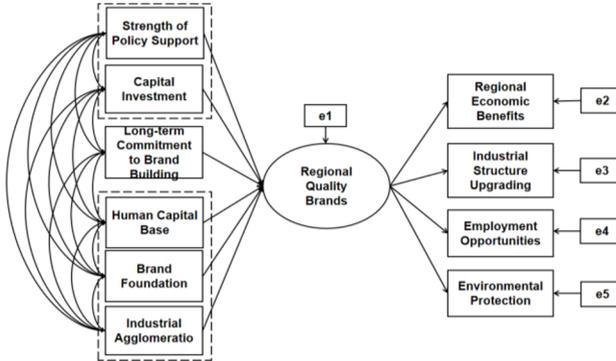

Fig. 2. MIMIC-RQBBI model.

Control variables. Based on the MIMIC-RQBCI model and existing literature [54-56], the following control variables are considered: Economic Environment Stability (EES), represented by the Consumer Confidence Index; Financial Investment (FI), represented by the ratio of government general public service expenditure to general public budget expenditure; Market Regulation (MR), represented by the logarithm of the number of market regulation cases; Foreign Investment Attractiveness (FIA), represented by the growth rate of foreign capital; Brand Foundation (BF), represented by the ratio of trademark applications to valid registered trademarks; and Industrial Agglomeration (IA), represented by the Location Quotient Index.

3.3   Model specifications

Both theoretical and practical evidence demonstrate that synergistic network have significant spatial spillover effects on "Standards + Certification" regional quality brand construction. This study aims to use the Spatial Durbin Model (SDM) to examine the impact of synergistic network on "Standards + Certification" regional quality brand construction. The SDM is given by:

$$Y_{it} = \beta X_{it} + \rho \sum_{j=1}^{n} W_{ij} Y_{jt} + \gamma \sum_{j=1}^{n} W_{ij} X_{jt} + \mu_i + \sigma_t + \varepsilon_{it} \tag{1}$$

In the equation, Y_{it} and Y_{jt} represent the observed values of the dependent variable for regions i and j, respectively; X_{it} and X_{jt} represent the observed values of the independent variables (including key explanatory variables and control variables) for regions i and j, respectively; W_{ij} is the spatial weight matrix; β is the vector of estimated

parameters for the independent variables; ρ is the spatial lag coefficient of the dependent variable; γ denotes the spatial regression coefficient of the independent variables; μ_i and σ_t represent spatial effects and temporal effects, respectively; ε_{it} is the stacked error term. When γ =0, ρ ≠ 0 is applied, the SDM degenerates into the Spatial Lag Model (SLM); when γ + ρβ =0 is applied, the SDM degenerates into the Spatial Error Model (SEM).

Based on the above model, the SDM for examining the effect of the synergistic network on "Standards + Certification" regional quality brand construction is formulated as:

$$RQB_{it} = \beta_1 SN_{it} + \beta_2 X_{it} + \rho \sum_{j=1}^n W_{ij} RQB_{jt} + \gamma_1 \sum_{j=1}^n W_{ij} SN_{jt} + \gamma_1 \sum_{j=1}^n W_{ij} X_{jt} + \quad (2)$$
$$\mu_i + \sigma_t + \varepsilon_{it}$$

In this study, the adjacency weight matrix based on the number of neighbors is chosen as the spatial weight matrix. The calculation methods for the dependent variable, core explanatory variables, and control variables are detailed in Table 1.

Table 1. Explanation of model variables and descriptive statistics.

Variable Type	Variable	Symbol	Calculation Method	Mean	Standard Deviation
Dependent	synergistic network	SN	Constructed using social network analysis and coupling coordination model	0.263	0.128
Explanatory	"Standards + Certification"Regional Quality Brand Construction	RQB	Calculated using the MIMIC-RQBCI model with Monte Carlo-Bayesian interpolation	0.332	0.142
Control	Market Regulation	MR	Logarithm of the number of market regulation cases	1.716	0.150
	Financial Investment	FI	Proportion of government general public service expenditure to general public budget expenditure	0.111	0.017
	Foreign Capital Attraction	FIA	Foreign capital growth rate	0.149	0.041
	Economic Environment Stability	EES	Logarithm of the consumer confidence index	2.025	0.221
	Brand Foundation	BF	Proportion of trademark applications to effective trademark registrations	0.167	0.036
	Industry Agglomeration	IA	Location Quotient Index	0.996	0.210

4   Results and Discussion

4.1   Spatiotemporal Analysis

To analyse the spatiotemporal evolution of the synergistic network and "Standards + Certification" regional quality brand construction, ArcGIS 10.8 software was used to apply a quartile classification system. This approach divides the data into three levels to illustrate the spatial pattern evolution of both elements, as shown in Fig. 3. and Fig. 4.

Spatial pattern analysis was conducted for the years 2012, 2017, and 2022. Fig. 3 shows how well standards and certification systems worked together across regions in 2012, 2017, and 2022. Darker colors mean stronger coordination between these systems. Fig. 4 displays regional quality brand development during the same years. Darker areas indicate better brand performance, showing stronger competitiveness, market acceptance, and standardization. The analysis of the mean and standard deviation statistics for the synergistic network and the "Standards + Certification" regional quality brand construction index uncovered notable changes since 2012, with an overall trend toward decreasing relative differences. The spatial patterns displayed a degree of consistency and clustering effects, indicating a spatial interrelationship between the synergistic network and "Standards + Certification" regional quality brand construction. These findings suggest the presence of potential spatial and temporal dependencies, warranting further investigation.

Fig. 3. Spatiotemporal Patterns of the Synergistic Network for 2012 (left), 2017 (middle), and 2022 (right)
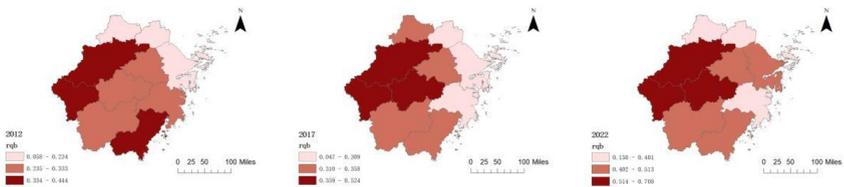

Fig. 4. Spatiotemporal Patterns of the "Standards + Certification" Regional Quality Brand Construction for 2012 (left), 2017 (middle), and 2022 (right)

4.2   Spatial Autocorrelation Analysis

Before applying the SDM to examine the spatial spillover effects between the SN and RQB construction, it is essential to confirm that the core variables exhibit spatial auto-correlation. In line with established research practice, this study employs Moran's I index to test the global spatial autocorrelation of SN and RQB. The global spatial auto-correlation test assesses the spatial correlation of variables across the entire sample. The degree of spatial dependence is reflected by Global Moran's I, which ranges from -1 to 1. A negative value indicates a negative spatial correlation, a positive value indicates a positive spatial correlation, and a value of 0 indicates no spatial correlation. The Global Moran's I for the synergistic network and "Standards + Certification" regional quality brand is shown in Table 2. By observing the temporal evolution of the Global Moran's I for the synergistic network and "Standards + Certification" regional quality brand, it can be noted that the Moran's I index for the former significantly increased between 2012 and 2021, although it declined in 2022. The latter's Moran's I index exhibited a fluctuating upward trend. Throughout the study period, the Moran's I for both the synergistic network and the "Standards + Certification" regional quality brand remained positive and passed the 5% significance level test. This indicates that at the prefecture-level in Zhejiang Province, the distribution of the synergistic network and "Standards + Certification" regional quality brands is not random in geographical space but rather shows significant spatial clustering characteristics.

Table 2. Global spatial autocorrelation test results.

Year	Synergistic Network			"Standards + Certification" Regional Quality Brand		
	Moran's I	Z-value	P-value	Moran's I	Z-value	P-value
2012	0.151	2.158**	0.031	0.126	2.000**	0.046
2013	0.141	2.029**	0.042	0.133	2.075**	0.038
2014	0.136	2.354**	0.019	0.126	1.981**	0.048
2015	0.175	2.476**	0.013	0.131	2.050**	0.040
2016	0.152	2.180**	0.029	0.137	2.014**	0.044
2017	0.183	2.508**	0.012	0.112	2.111**	0.035
2018	0.122	1.981**	0.048	0.137	2.077**	0.038
2019	0.156	2.258**	0.024	0.151	2.237**	0.025
2020	0.174	2.555**	0.011	0.159	2.206**	0.027
2021	0.174	2.487**	0.013	0.148	2.163**	0.031
2022	0.103	2.136**	0.033	0.132	2.068**	0.039

To elucidate the spatial agglomeration characteristics of the synergistic network and the "Standards + Certification" regional quality brand, Moran scatter plots for the years 2012, 2017, and 2022 are presented in Fig. 5. and Fig. 6. These plots reveal that a majority of cities, in both the context of the synergistic network and the "Standards + Certification" regional quality brand, are situated in either the first quadrant (high-high clustering, where cities with high levels of clustering are surrounded by similarly high-clustering cities) or the third quadrant (low-low clustering, where cities with low clustering levels are surrounded by similarly low-clustering cities). Specifically, the proportion of cities in the first and third quadrants for the synergistic network was 72.7%, 90.9%, and 90.9% in 2012, 2017, and 2022, respectively. For the regional quality brand,

these proportions were 72.7%, 90.9%, and 81.8% during the same years. These findings confirm the spatial clustering characteristics of both the synergistic network and the "Standards + Certification" regional quality brand. Cities exhibiting a higher level of development in the synergistic network tend to be surrounded by cities with similarly high levels, and this pattern is consistent for the "Standards + Certification" regional quality brand. These results align with the Global Moran's I analysis, reinforcing the significant positive spatial autocorrelation between the synergistic network and the "Standards + Certification" regional quality brand construction, thus supporting the subsequent spatial econometric regression analysis.
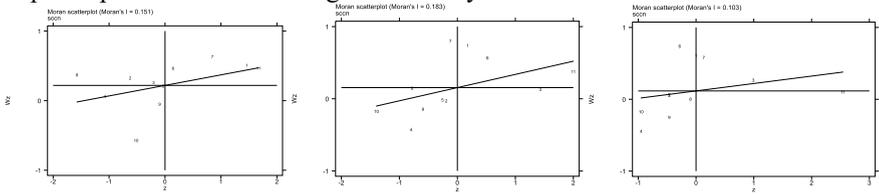

Fig. 5. Moran scatter plots of synergistic network for 2012 (left), 2017 (middle), and 2022 (right).
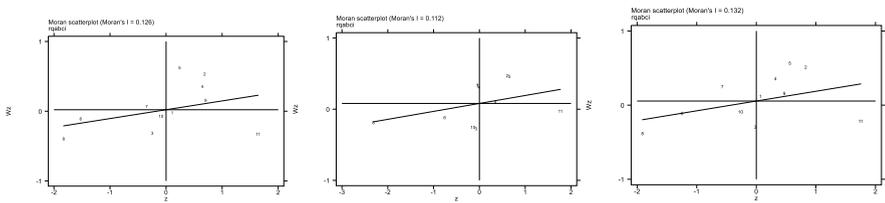

Fig. 6. Moran scatter plots of regional quality brand construction for 2012 (left), 2017 (middle), and 2022 (right).

4.3   Model Selection

The spatial autocorrelation analysis indicates that both the synergistic network and the "Standards + Certification" regional quality brand exhibit pronounced spatial clustering characteristics. Consequently, it is crucial to apply spatial econometric models and maximum likelihood estimation techniques to assess the spatial spillover effects of the synergistic network on the "Standards + Certification" regional quality brand.

Prior to performing spatial regression analysis, model testing is essential, with the results detailed in Table 3. Initially, we assessed the effectiveness of spatial econometric models compared to conventional regression models. The LM_Spatial lag, Robust LM_Spatial lag, LM_Spatial error, and Robust LM_Spatial error tests confirmed the appropriateness of spatial econometric models. Next, the Wald and LR tests were employed to evaluate whether the Spatial Durbin Model (SDM) simplifies to a Spatial Lag Model (SLM) or a Spatial Error Model (SEM). As indicated in Table 3, the results of both tests reject the null hypothesis, suggesting that the SDM is preferable to the SLM and SEM. Finally, a Hausman test was conducted to decide between fixed effects and random effects for the spatial econometric model. The test results were significant at the 1% level, leading to the selection of a fixed effects SDM. Further testing confirmed

the use of a double fixed effects SDM, addressing both spatial and temporal dimensions.

Table 3. Model selection test results.

Model Identification Test Methods	Z-value	Model Identification Test Methods	Z-value
LM_Spatial lag	4.043**	Wald_Spatial lag	13.230*
Robust LM_Spatial lag	4.287**	LR_Spatial lag	19.130**
LM_Spatial error	19.130***	Wald_Spatial error	77.170***
Robust LM_Spatial error	19.374***	LR_Spatial error	19.880**
Id vs both	39.170***	Time vs both	177.180***
Hausman test	18.930***		

4.4   Empirical Results

To investigate the impact of the synergistic network on "Standards + Certification" regional quality brand development, this paper constructs a bidirectional fixed-effects SDM, focusing on 11 prefecture-level cities in Zhejiang Province. The model evaluates the robustness of regression outcomes and compares results from panel regression, SLM regression, and SEM regression. According to Table 4, the spatial autocorrelation coefficients for SLM, SEM, and SDM are significantly positive at the 10% level, indicating a notable positive spatial correlation in regional quality brand development and consistent with the patterns observed in the Moran scatter plots. The synergistic network coefficient in all models is significantly positive at the 1% level, underscoring its significant positive influence on "Standards + Certification" regional quality brand construction. The results demonstrate that the synergistic network aids in the aggregation of effective information, standardization of corporate practices, and concentration of production factors, thereby mitigating development costs and liquidity risks associated with quality brand construction.

The analysis of spatial autocorrelation indicates that both the spatial autocorrelation coefficient ρ and the spatial lag term of the explanatory variables (W×cn) are positive and significant, revealing a spatial effect between the variables. To further elucidate the spatial spillover effects, this study employs the partial differentiation method by LeSage and Pace to assess the impact of each variable on the construction of regional quality brands, with the findings presented in Table 5.

Regarding direct effects, the coefficient for the synergistic network is 0.385, statistically significant at the 1% level. This suggests that a 1% increase in the development of the synergistic network results in a 0.385% rise in regional quality brand construction. This significant positive effect implies that improvements in the synergistic network lead to greater regional quality brand development by reducing costs and liquidity risks, thereby supporting H1.

For indirect effects, the coefficient for the synergistic network is 0.496, also significant at the 1% level. This indicates that a 1% increase in the synergistic network's de-

velopment results in a 0.496% increase in regional quality brand construction in neighboring cities. The synergistic network's ability to leverage standard-setting and quality certification systems expands spillover effects and enhances resource flow and talent allocation, thereby bolstering regional quality brand development in adjacent areas. The close values of direct and indirect effects, with the latter being higher, suggest that the synergistic network not only benefits the local city's brand construction but also significantly promotes the development of neighboring cities through spillover effects, validating H2.

Table 4. Statistical results of spatial spillover effect testing

Variable	OLS	SLM	SEM	SDM
cn	0.485***	0.261***	0.264***	0.409***
	（0.056）	（0.081）	（0.082）	（0.094）
ees	0.0803**	0.0847***	0.0828***	0.0764**
	（0.039）	（0.030）	（0.031）	（0.032）
fi	-0.636*	-0.521	-0.590	-0.375
	（0.348）	（0.356）	（0.372）	（0.400）
mr	0.145***	0.0136	0.0133	-0.010
	（0.045）	（0.036）	（0.037）	（0.037）
fia	0.475***	0.223*	0.248*	0.449***
	（0.169）	（0.134）	（0.140）	（0.163）
bf	-0.416***	-0.556***	-0.547***	-0.562***
	（0.147）	（0.125）	（0.124）	（0.116）
ia	-0.043	-0.039*	-0.044*	-0.054***
	（0.033）	（0.023）	（0.024）	（0.025）
W×cn				0.751**
				（0.313 ）
W×ees				-0.059
				（0.103）
W×fi				-1.964
				（1.301）
W×mr				-0.048
				（0.128）
W×fia				1.014**
				（0.474）
W×bf				0.540
				（0.392）
W×ia				-0.237**
				（0.093）
Regional Fixed Effects	Controlled	Controlled	Controlled	Controlled
Temporal Fixed Effects	Controlled	Controlled	Controlled	Controlled
ρ		0.121*	0.221*	0.329*
		（0.171）	（0.202）	（0.188）
R2	0.469	0.341	0.360	0.397
Log-like		255.627	255.998	265.565
Observations	121	121	121	121

Analysis of control variables reveals that economic environment stability has a significantly positive direct effect on regional quality brand construction, promoting

growth through stable economic conditions and policy support. However, its indirect effect on neighboring regions is not significant, likely due to inadequate economic linkages and policy coordination between regions. Market regulation and capital investment show insignificant negative correlations with direct, indirect, and total effects. Excessive regulation may increase operational costs and stifle innovation, while inefficient capital allocation can lead to waste and reduced effectiveness in brand development. Foreign investment attractiveness, however, exhibits significantly positive direct, indirect, and total effects. Foreign investment brings advanced technology and enhances domestic brands through cooperation and competition, driving regional quality brand construction and benefiting neighboring areas through extended industrial chains and economic linkages. The direct effect of brand foundation is significantly negative, while the indirect effect is significantly positive. The total effect, however, is insignificant. This discrepancy may be due to a weak brand foundation hindering local brand development while allowing neighboring regions to improve their brands by learning from the local experience. Industrial agglomeration presents a significant negative correlation with regional quality brand construction. This negative impact may arise from excessive competition and resource concentration, leading to market saturation and diminished brand differentiation, while causing resource siphoning and industrial decline in surrounding areas.

Table 5. Spatial effects decomposition results.

Variable	Direct Effect	Indirect Effect	Total Effect
cn	0.385***	0.496**	0.882***
	（0.092）	（0.216）	（0.261）
ees	0.081***	-0.057	0.024
	（0.030）	（0.085）	（0.097）
fi	-0.254	-1.392	-1.646
	（0.371）	（0.996）	（1.114）
mr	-0.010	-0.029	-0.039
	（0.035）	（0.098）	（0.108）
fia	0.419***	0.700*	1.119**
	（0.154）	（0.360）	（0.442）
bf	-0.591***	0.565*	-0.025
	（0.117）	（0.302）	（0.309）
ia	-0.045*	-0.177**	-0.222***
	（0.024）	（0.072）	（0.081）

4.5   Robustness Checks

To assess the robustness of the research findings, this study explores two key aspects: the substitution of the weight matrix and the modification of control variables. Table 6 illustrates that the coefficients estimated using the first-order inverse distance weight matrix and the distance-based adjacency weight matrix are both significantly positive and consistent with those obtained from the adjacency weight matrix based on the number of neighbors. This consistency confirms the robustness of the initial estimates. Ad-

ditionally, considering that capital investment, market regulation, and economic environment stability did not exhibit significant effects on regional quality brand construction, these control variables were excluded based on existing literature. A re-evaluation was then performed, which reaffirmed that the synergistic network maintains significant positive direct and indirect effects on the "Standards + Certification" regional quality brand, thereby substantiating the robustness of the original results.

Table 6. Robustness test results.

Variable	Weight Matrix Replacement		Adjustment of Control Variables
	First-order Inverse Distance Weight Matrix	Distance-based Adjacency Weight Matrix	
Direct Effect	0.409***	0.304***	0.482***
	（0.090）	（0.089）	（0.089）
Indirect Effect	0.507**	0.518**	0.567***
	（0.256）	（0.235）	（0.244）
Total Effect	0.916***	0.822***	1.049***
	（0.297）	（0.267）	（0.287）
Control Variables	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes
R^2	0.448	0.304	0.409
Log-Like	272.570	264.993	259.184

5   Discussion and Policy Implications

Understanding the impact of synergistic networks on "Standards + Certification" regional quality brand construction is crucial for both theoretical advancement and practical implementation of high-quality development strategies. This study differentiates itself from previous research by integrating synergistic networks, "Standards + Certification" regional quality brands, and spatial spillover effects into a cohesive analytical framework. It comprehensively explores the theoretical mechanisms by which synergistic networks influence local "Standards + Certification" regional quality brand development and their spatial spillover effects on neighboring areas. Utilizing "Made in Zhejiang" as a case study, the analysis employs panel data from 11 prefecture-level cities in Zhejiang Province spanning 2012 to 2022. The study constructs the synergistic network through social network analysis, estimates the regional quality brand construction index using the MIMIC model and Bayesian interpolation, and empirically evaluates both the direct impacts and spatial spillover effects of synergistic networks on "Standards + Certification" regional quality brand construction using spatial econometric models. The findings of this research are summarized as follows:

First, the spatial patterns of both synergistic networks and "Standards + Certification" regional quality brand construction reveal notable regional agglomeration and varying developmental trajectories. This agglomeration highlights significant dispari-

ties in resources and capabilities related to standard-setting and certification across different regions. Factors such as geographical location, economic development levels, industrial structure, and policy support contribute to this agglomeration effect. It fosters collaborative development among regional enterprises and boosts the competitiveness and market influence of regional brands. However, the observed volatility in the development of synergistic networks and regional quality brand construction underscores the dynamic nature of this process, which requires sustained engagement and investment from enterprises, governments, and society. Currently, most cities are at an intermediate stage in developing synergistic networks and regional quality brands, indicating progress but also substantial potential for further improvement.

Second, synergistic networks play a dual role in enhancing local "Standards + Certification" regional quality brand construction while also exhibiting spatial spillover effects that accelerate brand development in neighboring areas. These networks improve local brand quality and reputation through standardized practices and certifications, setting clear quality goals and operational standards for enterprises, which enhances consumer trust and satisfaction. Furthermore, the spatial spillover effect is evident as regional networks, through demonstration and knowledge transfer, inspire neighboring areas to adopt similar standards and certification systems. This effect operates through channels such as inter-enterprise collaboration, talent mobility, policy learning, and regional partnerships, allowing neighboring areas to rapidly improve their brand building and quality management by leveraging successful experiences from within the region.

Third, the attractiveness of foreign investment significantly positively impacts regional quality brand construction, whereas excessive industrial agglomeration negatively affects it. Empirical analysis reveals that foreign investment not only provides local enterprises with models for learning and internationalization but also supports the upgrading of regional quality brands. Conversely, while industrial agglomeration can initially foster economies of scale and synergy, excessive concentration can lead to raw material shortages, rising labor costs, and market saturation. These issues contribute to brand homogenization among regional enterprises and can hinder the long-term development of the regional brand.

Here are two versions of the policy recommendations, refined for clarity and alignment with the style of the Journal of Urban Affairs:

Firstly, enhance regional coordination and optimize resource allocation. It is crucial to refine the spatial organization of synergistic networks and "Standards + Certification" regional quality brand development while fostering cross-regional coordination. Region specific strategies must account for varying local conditions. Core regions including Hangzhou and Ningbo require focused support for dominant firms to establish international standards, complemented by dedicated funding for cross-border certification services. Peripheral areas like Lishui and Quzhou benefit from branch testing facilities that distribute certification costs across regions. A staged implementation approach proves essential, initial big data platforms enable product certification reciprocity, followed by permanent institutionalization of cross-regional standards alignment, certification compatibility and coordinated oversight. Such actions will facilitate the

efficient flow of quality brand resources, extend the impact of synergistic networks, and support the high-quality development of regional brands across more areas.

Secondly, strengthen synergistic network development mechanisms. Fully capitalize on the role of synergistic networks in advancing "Standards + Certification" regional quality brands. The tripartite governance framework requires strengthened coordination among government leadership, enterprise participation, and industry association involvement. Government agencies need real-time monitoring of regional certification approval rates and standard coverage metrics, with mandatory technical intervention when industry performance drops below established thresholds. Enterprises achieving substantial standard development contributions qualify for tax incentive eligibility to enhance engagement motivation. Industry associations must establish graded certification body management systems complemented by disciplinary blacklisting mechanisms. Regional evaluation criteria demand differentiated focus advanced areas emphasize international standard adoption rates and foreign certification body recruitment, while developing regions prioritize measurable quality brand development outcomes.

Thirdly, balance foreign investment and industrial agglomeration. Ensure the sustainable development of regional quality brands by managing foreign investment and controlling industrial agglomeration. The implementation of a negative list management system with clearly defined market access thresholds enables effective screening of high-quality foreign enterprises. Restricted category foreign investors must obtain green certification within predetermined time limits. Controlled industrial agglomeration development, regulated through certification-linked spatial planning policies, ensures balanced growth. Industrial park land allocation priorities should favor performance excellence-certified enterprises to simultaneously advance quality improvement and ecological sustainability. Promote innovation and brand differentiation among businesses to support the long-term growth of regional quality brands.

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