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An Identification Method of the Externality of Cultural Facilities from the Perspective of Spatial Distribution of Cultural Industry: A Case Study of Ningbo, China

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Abstract: The identification and depiction of the externality of urban facilities have always been a hot and challenging research issue in human geography and urban planning. However, most of the existing research focuses on exploring the capitalization effect of urban facilities on land prices or housing prices, while ignoring the guiding and promoting effect on related industries. Therefore, this paper proposes an identification method of the externality of cultural facilities from the perspective of cultural industrial agglomeration and industrial abundance, explores the spatial coupling between cultural facilities and cultural enterprises in the central district of Ningbo during different periods, and discusses the role mechanisms of cultural facilities in cultural industry development. Our findings reveal that the spatial pattern of cultural facilities and cultural enterprises evolved in the same way, from single-core or double-core multi-point to "triple-core multi-point," and there is a certain similarity between the change in the agglomeration pattern of cultural facilities and the evolution of the abundance of cultural enterprises. The externality of cultural facilities is mainly manifested in the promotion of quantitative growth, such as the scale of cultural industry agglomeration and qualitative development, such as industrial structure. These outcomes are mainly realized through the creation of cultural atmosphere, the integration of cultural and commercial functions, and the improvement of cultural consumption and cultural productivity. The research results can offer new policy references for the location and layout of cultural facilities and the incentive development of the cultural industry in Ningbo.

Keywords: cultural facilities; externality; industrial agglomeration; industrial abundance; central district of Ningbo

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1. Introduction

Cultural facilities refer to buildings, sites, and equipment used for the provision of public cultural services, which are closely related to the urban economy, society, and environment, and play a great role in promoting the sustainable development of the city [1,2]. Since the 1970s, cultural landmarks and cultural districts based on cultural facilities have become an important means for Western countries to enhance the image of decaying cities, attract investment from private institutions, develop cultural industries, and enhance urban vitality [3–5]. For example, the Guggenheim Museum in Bilbao quickly became the most famous architectural mecca and art palace in Europe, whose direct admission revenue accounts for 4% of the city revenue, and the income of related industries driven by the museum accounts for more than 20%. It has become a successful model of "urban rejuvenation driven by cultural facilities" and has been described as the "Guggenheim Effect" by Harvard University [6,7].

Since the reform and its opening, with more than 30 years of rapid development, China's economy has begun to enter the new normal and post-industrial era, with a gradual slowdown of economic growth, continuous optimization and upgrading of industrial structure, and a rapid rise of service industry and human capital-intensive industry [8]. The national consumption structure has changed from a simple material-demand orientation to a comprehensive service-demand orientation, focusing on diversified and personalized consumption, with cultural consumption soaring [9]. This also puts forward new requirements for China's urban development and urban construction. The traditional incremental-expansion mode focusing on scale growth gradually faded out of government documents and work reports, while the stock updates and industrial transformation focusing on development quality have become a common consensus [10]. Culture-oriented and culture-based cities have become a strategic choice for the renewal, transformation, and development of many cities [11,12], and cultural facilities often become the key point and core support of the cultural-oriented development strategy [13,14]. Therefore, it is of great practical significance to accurately identify the connotation and action mechanism of the externality of cultural facilities in order to guide cultural facilities to drive the development of urban cultural industry and industrial structure optimization.

The externality of urban facilities has been the focus and difficulty of extensive attention in human geography and urban planning, which can be divided into two aspects: objective utility and subjective utility. In terms of objective utility, the hedonic price model combined with the spatial analysis of the geographic information system is generally used to assess the capitalization effect of urban facilities on land or house prices, that the accessibility of facilities such as parks and green spaces, education, and medical care have a significant impact on the price of commercial housing [15–18]. As for subjective utility studies, researchers examine the performance of urban facility configuration from a humanistic perspective, focusing on exploring the enhancement effect of urban facility configuration on residents' satisfaction, physical and mental health, and well-being. The results show that urban facilities have a significant positive impact and promotion on residents' mental health and residential satisfaction [19–21].

Research on the externality of cultural facilities has also yielded some results. Research in the Occident focused on the construction strategies and multifunctional development of cultural facilities. In the 1970s, Western countries generally carried out urban renewal based on cultural orientation. One of the main ways of urban renewal was to strengthen local cultural brands and shape urban cultural clusters through the construction and multifunctional development of large-scale cultural facilities [22–25]. For example, California Square, Dallas Art District, and the Guggenheim Museum in Bilbao were all designed to create a multi-functional cultural cluster with greater vitality through the mixing of cultural facilities, leisure and entertainment facilities, public service facilities, business offices, and other facilities. It was generally believed that cultural facilities with regional characteristics can enhance the urban cultural image and create urban tourism landmarks, and academics called on the city governments to strengthen the connotation improvement, appearance construction of cultural facilities, and multicultural facility network construction [26]. However, some scholars emphasized the negative externalities of cultural facility construction on urban development. Cultural facility construction mostly focused on major flagship projects neglecting infrastructure [27]. The widespread imitation of cultural flagship facilities led to the convergence of urban culture and the decline of regional culture [28]. The construction of cultural facilities paid too much attention to the economic benefits and material environment transformation [29]. In Europe, in the process of urban development under the guidance of cultural policy, the layout of cultural-activity facilities often ignored the balance of the region, which could easily lead to further alienation from the local community [30]. Since the 1990s, cultural and creative industries have been gradually emerging and gaining popularity in many countries and regions due to their advantages of high added value and strong competitiveness. The academic community has also begun to pay attention to the location factors and construction paths of cultural and creative industries,

and successively proposed hypotheses such as "3T," the creative field, and the creative city [31–33]. It is believed that creative talent, technology, tolerance, and infrastructure are significant location factors [34,35]. Among them, cultural facilities, together with schools, green spaces, and leisure facilities, promote the formation of a creative environment to attract creative talents and creative capital, so as to stimulate urban economic vitality and improve urban image [36,37]. Chinese research was relatively fragmented, mainly using methods such as comparative analysis to explore the influences of cultural infrastructure and flagship cultural project construction on urban space, cultural consumption, social development, and image building [38–40]. Some scholars also discussed the reconstruction of urban cultural consumption space by physical bookstores and consumers' perception and identification of cultural consumption space through participatory observation, in-depth interviews, and qualitative analysis. It was found that the new urban cultural consumption spaces with physical bookstores were characterized by openness, interactivity, diversity, and publicness, and that consumers recognized these new cultural consumption spaces through their perception of the bookstore environment, product culture, and crowd quality [41].

To sum up, many previous studies have explored the externalities of cultural facilities in terms of urban image, spatial structure, economic vitality, and consumption space, but the externality of cultural facilities from the perspective of cultural industry has been rarely noticed, and only a few studies based on panel data at regional/urban scale found that the abundance of cultural facilities was one of the influencing factors of cultural industry development [42]. In essence, there is a lack of distribution adaptation characterization and facilitating mechanism identification between cultural facilities and cultural industry at a precise scale within the city. Thus, this paper takes Ningbo, a national historical and cultural city as a case, and uses kernel density analysis, entropy index, and geodetectors to explore the externality of cultural facilities from the perspective of cultural industrial agglomeration and abundance. The study focuses on the following: (1) identifying whether the spatial evolution of cultural facilities and cultural enterprises is similar; and (2) identifying the promotion mechanism of cultural facilities in the development of cultural industry. Our purpose is to develop a new perspective on urban facility externality research and provide a reference for optimizing the supply of urban cultural facilities and promoting the development of the urban cultural industry.

2. Research Framework and Methods

2.1. Identification of External of Cultural Facilities

Externality, also known as external benefit, refers to an economic subject's production or consumption behavior that imposes uncompensated costs on other economic subjects or gives benefits that do not need to be compensated. From this definition, it can be concluded that the connotation analysis of externality should start with the function of the economic subject. Through the literature review, it can be found that the functions of cultural facilities mainly include the macro-level functions such as building and guiding the urban landscape and creating the urban cultural atmosphere, and the micro-level functions, such as providing cultural services and meeting residents' daily cultural needs, which are closely related to the development of urban cultural industries [43,44].

Due to the characteristics of high innovation, content dominance, and knowledge intensity, the location factors of the cultural industries are different from those of traditional industries. Previous studies have shown that the distribution of cultural industries is affected by multiple factors such as resource endowment, economic level, and industrial policies, and the dominant factors vary with the research scale (region, city, block) [45,46]. Within the city, factors such as creative talents, economic level, supporting facilities, cultural atmosphere, and industrial policies will affect the spatial distribution of cultural industry [47]. Among them, outstanding creative talents are the main force of cultural product creation, good economic development levels and supporting facilities determine regional cultural consumption levels and consumption willingness, while a strong cultural

atmosphere and appropriate industrial policies will effectively gather talent, capital, and other cultural-industry production factors.

Cultural facilities facilitate the development and agglomeration of cultural industry by promoting the creation and consumption of cultural products and the construction of a cultural atmosphere. First of all, cultural facilities are places where creative talents engage in inspiration, literary creation, and informal communication. Creative personnel produce opera and dance performance products, by purchasing cultural products such as clothing and musical instruments, providing the driving force for the development of cultural manufacturing. Secondly, cultural facilities are places where residents and tourists conduct a daily cultural experience and consumption, which directly determines people's willingness to consume culture, and then affects the volume of the regional cultural consumption market. Thirdly, cultural facilities not only meet people's cultural needs, but also create a strong cultural atmosphere, which in turn affects consumers' hobbies and value orientations, and drives the development of cultural training and creative industry. Finally, the profit-making cultural facilities such as cinemas are often compounded and linked with neighboring leisure facilities to form one-stop consumption complexes, revitalizing neighborhood commercial vitality, and jointly promoting the development of cultural consumption and material consumption.

Therefore, the development of cultural industry can be regarded as an excellent entry point for the study of the externality of cultural facilities.

2.2. The Technical Route

The development of cultural industry includes the quantitative expansion of the industrial spatial agglomeration scale and the qualitative improvement of industrial abundance. Therefore, based on the data of cultural facilities and cultural enterprises in the central district of Ningbo, this paper discusses the spatial coupling between cultural facilities and cultural enterprises in the central district of Ningbo in terms of agglomeration pattern and abundance in 2010 and 2020, using nuclear density analysis and an entropy index method. In addition, we use geographical detectors to identify the functional mechanism of cultural facilities on the development of cultural industry from four aspects: cultural production, cultural atmosphere, cultural consumption, and commercial supporting facilities, so as to comprehensively explore the externalities of cultural facilities (Figure 1).

2.3. Research Methods

(1) Kernel-density analysis

Kernel-density analysis refers to taking a certain area around a geographical object as the calculation range, and analyzing its spatial distribution pattern by calculating the density of the geographical object within the range. This paper used kernel density analysis to portray the agglomeration pattern of cultural facilities and cultural enterprises in the central district of Ningbo in 2010 and 2020. The calculation formula is:

$$P_i = \frac{1}{n\pi R^2} * \sum_{j=1}^{n} K_j * \left(1 - \frac{{d_{ij}}^2}{R^2}\right)^2 \quad (1)$$

where P_i is the kernel density at point i; K_j is the weight of cultural facilities/cultural enterprises j; D_{ij} is the Euclidean distance between cultural facilities/cultural enterprises j and point i; and R is the bandwidth of the selected range ($D_{ij} < R$). In practical research, the optimal bandwidth can not only obtain the cluster center of the research objects at the micro scale but also takes into account the pattern distribution at the macro scale. According to previous studies [48], the bandwidth of cultural facilities/cultural enterprises was determined to be 3000 m after repeated tests; n is the number of cultural facilities/cultural enterprises within the range of bandwidth R.



Figure 1. Technical route of the externality assessment of cultural facilities.

(2) Entropy index

The entropy index was used to analyze the abundance of cultural enterprises, which refers to the condition that enterprises with different business scopes in a certain region accommodate each other. The common calculation methods of the abundance of enterprises include the entropy index, diversity index, and spatial dimension information entropy. Among them, the entropy index measures the uncertainty and mixing of spatial information by the average information amount, which is the most commonly used method in the abundance measurement of enterprises. This paper used the entropy index to measure the abundance of cultural enterprises at the street/town scale in the central district of Ningbo in 2010 and 2020. The calculation formula is as follows:

$$D_j = \sum_{i=1}^{n} A_{ij} * \ln(1/A_{ij}) \quad (2)$$

where D_j is the entropy index of cultural enterprises of j street/town in the central district of Ningbo; n is the number of industry types of cultural enterprises; and A_{ij} is the proportion of i type cultural enterprises in the total number of cultural enterprises in j street/town. The abundance of cultural enterprises calculated by the entropy index comprehensively considers the types of cultural enterprises in a certain area and the proportion of each category. Most of the existing studies are based on grids or small-scale administrative

areas to calculate specific results. However, it is difficult to determine the size of the grid when calculating based on the grid. Too large a grid will mechanically cut off the important geographical boundaries such as rivers and mountains, while too small a grid will make most areas have no or only one or two types of cultural enterprises, making it difficult to accurately characterize the objective abundance of the cultural enterprises. When calculating based on administrative districts, there is also the interference of different sizes of administrative districts. As larger districts naturally have a higher probability of including more types of cultural enterprises, resulting in a higher calculated abundance of businesses, while smaller districts have the opposite.

Therefore, Equation (2) is modified to Equation (3) to eliminate the interference of the administrative area on the abundance of cultural enterprise forms.

$$D_j^{'} = \frac{\sum_{i=1}^{n} A_{ij} * \ln(1/A_{ij})}{S_j} \tag{3}$$

where $D_j^{'}$ is the entropy index of cultural enterprises in j street/town after area factor modification; S_j is the administrative area of j street/town.

(3) Geodetector

A geodetector is a statistical method to detect the spatial differentiation of geographical objects and explain its driving factors, whose core idea is to detect the influence of independent variables on dependent variables by analyzing the similarity of the spatial distribution of independent variables and dependent variables [49]. This study used the q-statistic of geodetectors to identify the contributing factors of the cultural facilities to the development of cultural industry. The calculation formula is as follows:

$$q = 1 - \frac{\sum_{i=1}^{a} N_i \sigma_i^2}{N\sigma^2} \tag{4}$$

where a is the grade number of the independent variable or dependent variable, N_i and σ_i^2 are respectively the sample number and variance of level i, and N and σ^2 are the sample number and variance of the research area. The range of q is [0, 1], and the larger the value is, the stronger the explanatory power of the independent variable is, and vice versa.

Based on the analysis in Section 2.1, taking 80 streets/towns in the central district of Ningbo as the research unit, the agglomeration, and abundance of cultural enterprises were selected as dependent variables and cultural productivity, cultural atmosphere, cultural consumption, and commercial supporting facilities were independent variables (Table 1). It is worth mentioning that the Ningbo Statistical Yearbook does not contain the data on cultural consumption of streets/towns, so we can only seek other data to represent the level of cultural consumption of streets/towns. According to previous studies, there is a great correlation between the cultural consumption and per-capita GDP [50]. It is feasible to use per-capita GDP to represent the cultural consumption level [51]. All variables were divided into 5 categories by the quantile method.

Table 1. Variable definitions of the geodetector.

Variable Types	Variable Name	Indicators
Dependent variable	Agglomeration of cultural enterprises	Average kernel density of cultural enterprises in streets/towns
	The abundance of cultural enterprises	Entropy index of cultural enterprises in streets/towns
Independent variable	Cultural productivity	The number of cultural facilities in streets/towns
	Cultural atmosphere	Average kernel density and entropy index of cultural facilities in streets/towns
	Cultural consumption	Per-capita GDP of streets/towns
	Commercial supporting facilities	Average kernel density of shopping, catering, and leisure POI in streets/towns

3. Study Area and Data Sources

3.1. Study Area

Ningbo, located on the southeastern coast of China and in the eastern part of Zhejiang Province, boasts a rich cultural history and unique cultural resources. As a result, Ningbo has become the cultural center of the southern wing of the Yangtze River Delta and a national historical and cultural city. The central district of Ningbo covers an area of 3693 km^2 and encompasses six districts of Yinzhou, Haishu, Jiangbei, Zhenhai, Beilun, and Fenghua, with a total of 80 streets/towns (Figure 2). Since the foundation of Ningbo City, the central district has been the political, economic, and cultural center of the region, and therefore it is equipped with the most abundant cultural facilities. By 2020, there were 320 cultural facilities in the central district, of which cultural exhibition facilities, cultural activity facilities, and performing arts facilities were the main components (Table 2). However, the distribution of cultural facilities within the central district of Ningbo is not balanced, and is mainly concentrated in the Sanjiangkou Old Town, the Eastern New Town, and the administrative center of each district. The distribution of the population is similar to that of cultural facilities, mainly being concentrated around the Sanjiangkou Old Town, and presents a circular decline to the periphery. However, there is also high-density population distribution in the street where the district government is located.

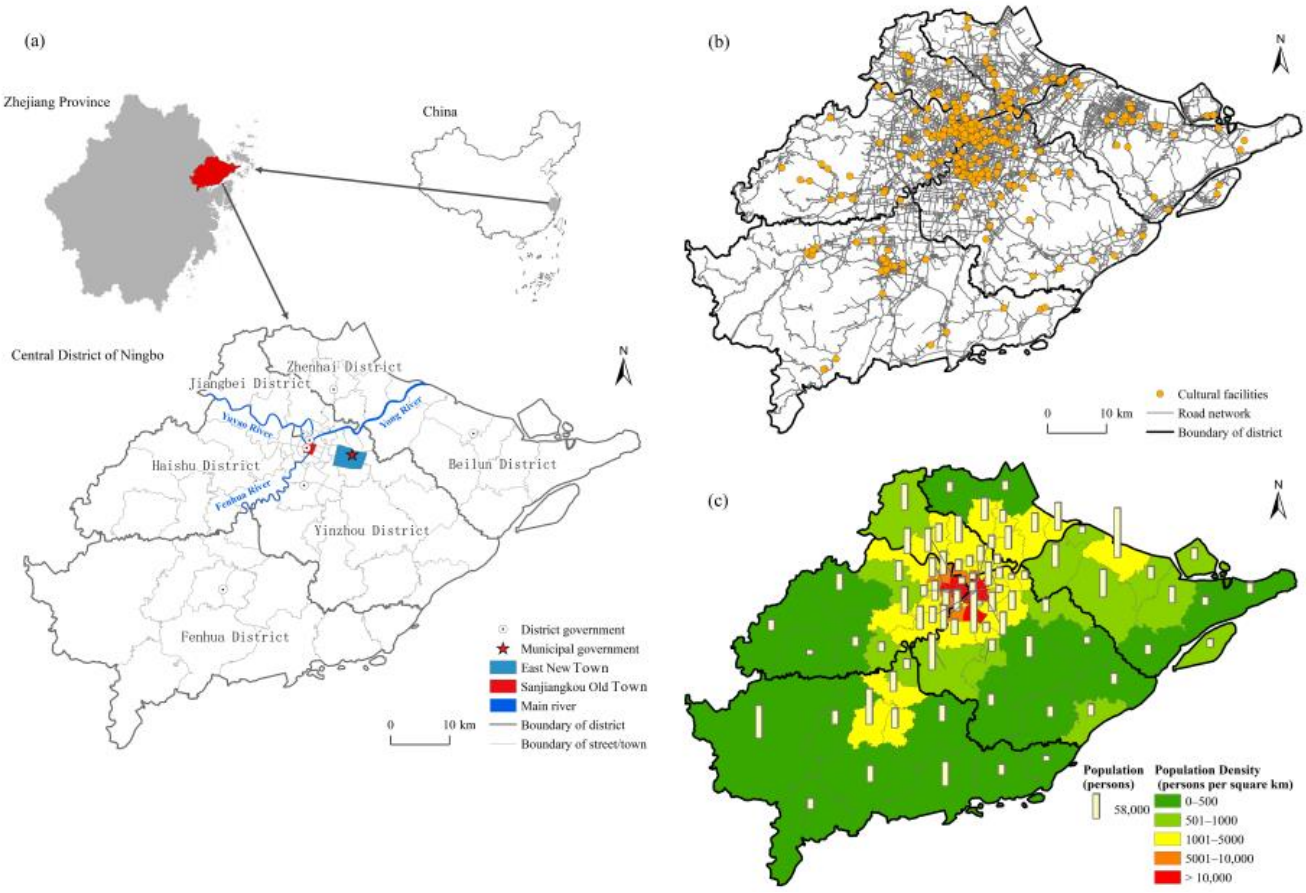


Figure 2. The location (**a**), cultural facilities (**b**), and population (**c**) of the study area. **Note:** This map is based on the standard map of the Map Technical Review Centre of the Ministry of Natural Resources of China (Number: Zhejiang S (2022)34), with no modifications to the base map. Map-making by the author.

Table 2. The composition of cultural facilities in the central district of Ningbo in 2020.

Category	Subcategory	Number	Proportion
Cultural exhibition facility		119	37.19%
	Museum	70	21.88%
	Art gallery	30	9.38%
	Memorial hall	15	4.69%
	Science and technology museum	4	1.24%
Cultural activity facility		95	29.69%
	Cultural center	8	2.50%
	Culture station	74	23.13%
	Youth palace	7	2.19%
	Workers cultural palace	6	1.87%
Performing arts facility		83	25.94%
	Cinema	51	15.94%
	Theater	28	8.75%
	Concert hall	4	1.25%
Book reading facility	Library	23	7.18%

Since the 21st century, the spatial structure of the central district of Ningbo has undergone great changes. Since 2005, the municipal government has begun to plan and construct the Eastern New Town in Yinzhou, and in 2014, the city government was relocated from the Sanjiangkou Old Town to the Eastern New Town, in order to promote the eastward development of Ningbo City and create a spatial pattern of "one city and two centers." This has led to the construction and operation of a large number of high-quality cultural facilities around the Eastern New Town, such as Ningbo Cultural Plaza Grand Theater, Ningbo International Convention and Exhibition Center, and Ningbo Science Exploration Center, which has greatly reshaped the spatial distribution pattern of cultural facilities. Therefore, with this paper taking 2010 and 2020 as time nodes, exploring the evolution of the agglomeration pattern and the abundance of cultural industry under the changing spatial pattern of cultural facilities is conducive to a more accurate judgment of the spatial coupling between cultural facilities and cultural industry, to scientifically analyze the externality of the cultural facilities in the central district of Ningbo.

3.2. Data Sources

There are five types of data used in this paper: cultural facilities, cultural enterprises, administrative division, population and GDP of streets/towns, and shopping, catering, and leisure POI (Table 3). (1) Cultural facilities were from Ningbo Culture, Radio, Film, and Tourism Administration. According to *the Regulations on Public Cultural and Sports Facilities*, *the Law of the People's Republic of China on Guaranteeing Public Cultural Services*, and other relevant laws, regulations, and national standards, the cultural facilities in the central district of Ningbo included the concert hall, theater, cinema, art gallery, library, museum, cultural center (station), memorial hall, science and technology museum, youth palace, and workers' cultural palace, etc. According to the above categories, the list of cultural facilities in the central district of Ningbo was obtained from Ningbo Culture, Radio, Film, and Tourism Bureau, and their geographic coordinates were obtained from the Amap API interface by web-crawler technology, to establish the spatial database of cultural facilities in central district of Ningbo in ArcGIS10.2. (2) Cultural enterprises were from Tianyancha Credit Agency. Cultural enterprises in the central district of Ningbo are selected based on the region (central district of Ningbo) and industry (cultural industry). Among them, the statistical caliber of cultural industry is determined by *Cultural and Related Industries Classification (2018)* and *Industry Classification of National Economy (GB/T4754-2017),* which was made by Standardization Administration of China (Table 4). After removing invalid enterprises, 14,916 cultural enterprises in the central district of Ningbo were obtained, and the registration data of Ningbo industrial and commercial enterprises up to 2020 were used

for the sampling survey to determine the reliability and accuracy of the data. Afterward, the name and address of cultural enterprises are used to extract their geographic coordinates in the Amap API interface, to establish the spatial database of cultural enterprises in the central district of Ningbo in ArcGIS10.2. (3) Administrative divisions were from Ningbo Natural Resources and Planning Bureau. Up to 2020, the central district of Ningbo had jurisdiction over Yinzhou, Haishu, Jiangbei, Zhenhai, Beilun, and Fenghua 6 districts, with a total of 80 streets/towns. (4) The population and GDP of streets/towns were from the statistical yearbooks of six districts of Ningbo and the government work reports of some streets/towns. (5) POI of shopping, catering and leisure were crawled from Amap by web crawler technology, and duplicate values and invalid values are deleted in ArcGIS10.2.

Table 3. Sources of research data.

Data Content	Data Sources	Attribute
Cultural facilities	Ningbo Culture, Radio, Film and Tourism Administration (http://wglyj.ningbo.gov.cn/) (accessed on 5 Apirl 2021)	Name, category, location, Building area
Cultural enterprises	Tianyancha Credit Agency (https://www.tianyancha.com/) (accessed on 6 Apirl 2021)	Name, location, industry Category, business scope
Administrative divisions	Ningbo Natural Resources and Planning Bureau (http://zgj.ningbo.gov.cn/) (accessed on 6 Apirl 2021)	Name, area
Population and GDP of streets/towns	The statistical yearbooks of six districts of Ningbo and the government work reports of some streets/towns	/
Shopping, catering, and leisure POI	Amap (https://www.amap.com/) (accessed on 13 October 2021)	Name, category, location

Table 4. The statistical caliber of cultural industry.

Category	Subcategory
Printing and recording media reproduction industry	Printing
	Binding and printing related services
Manufacture of cultural, educational, industrial, sports, and entertainment products	Manufacture of arts and crafts and ceremonial products
	Manufacture of musical instruments
Wholesale industry	Wholesale of cultural articles and equipment
Retail industry	Retail of cultural articles and equipment
Leasing industry	Leasing of recreational equipment and supplies
Commercial service industry	Conferences, exhibitions, and related services
Press and publishing industry	Press
Broadcast, television, film, and sound production	Broadcast
	Television
	Video program making
	Publish of films and radio and television programs
	Motion picture projection
	Audio production
Entertainment industry	Cultural and entertainment activities and brokerage services
Culture and art industry	Literary and artistic creation and performance
	Artistic performance venues
	Protection of cultural relics and intangible cultural heritage
	Martyrs' cemetery and memorial hall
	Recreational and sports activities
	Other cultural and art industries

4. Results

4.1. The Evolution of Cultural Facilities Agglomeration Pattern in the Central District of Ningbo

In 2010, cultural facilities presented an agglomeration pattern of "dual-core and multi-point," namely, two cluster centers were formed in the Sanjiangkou Old Town and Yinzhou Cultural Square, and cluster points were formed around cultural squares in Zhenhai, Beilun, Fenghua, and Jiangdong. Sanjiangkou means the intersection of the Yong River, Yuyao River, and Fenghua River. It is the economic and cultural center and landmark scenic spot of Ningbo, with a prosperous economy and a gathering of talents. Therefore, it has become the core area for the layout of cultural facilities in the central districts of Ningbo. Due to the economic prosperity and high level of urban construction, coupled with the layout of the South Higher Education Park in this area, Yinzhou District was equipped with many high-quality cultural facilities such as the Ningbo Museum, Yinzhou Culture, and Arts Center, Ningbo University Park Library, etc. Therefore, its cultural square has become another core area for the distribution of cultural facilities.

In 2020, cultural facilities further developed and gradually formed an agglomeration pattern of "three-core and multi-point," with the original cluster cores and cluster points growing in size and new cluster points emerging one after another (Figure 3) based on the original double-centered agglomeration, a new agglomeration core has appeared in the Eastern New Town. This was mainly due to the implementation of Ningbo's eastward development strategy and the eastward relocation of the municipal government, which has led to the concentration of a large number of high-quality cultural service facilities such as Ningbo Cultural Square Grand Theatre, Ningbo International Convention, and Exhibition Center, Ningbo Science Discovery Center and Ningbo Library in this layout. In addition, the scale of cluster points such as Beilun Cultural Square, Fenghua 1986 Cultural Square, and North Higher Education Park has grown significantly. New agglomeration points have appeared in the Zhenhai New Town and Hongtang Street, Jiangbei District due to the relocation of the district government and the construction of the Ningbo Olympic Sports Center. Concentration points have also appeared in construction and operation. It can be concluded that the historical and cultural heritage and the administrative power have profoundly affected the agglomeration pattern of the cultural facilities in the central district of Ningbo.

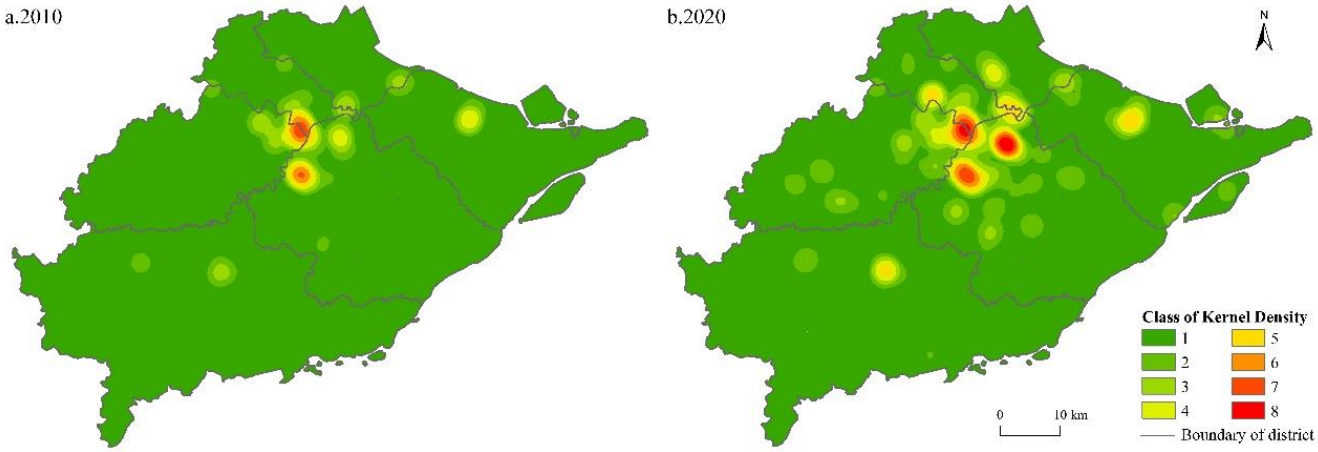


Figure 3. Kernel density of cultural facilities in the central district of Ningbo in (**a**) 2010 and (**b**) 2020. **Note:** This map is based on the standard map of the Map Technical Review Centre of the Ministry of Natural Resources of China (Number: Zhejiang S (2022)34), with no modifications to the base map. Map-making by the author.

4.2. The Evolution of Agglomeration Pattern and Abundance of Cultural Enterprises in the Central District of Ningbo

4.2.1. The Evolution of the Agglomeration Pattern of Cultural Enterprises in the Central District of Ningbo

From 2010 to 2020, cultural enterprises showed an obvious "center-periphery" distribution pattern, and the number and scale of agglomeration centers continued to increase (Figure 4). In 2010, cultural enterprises showed an agglomeration pattern of "single core and multi-point" with only one cluster core formed in Sanjiangkou. In addition, small-scale cluster points have also appeared around the cultural squares in Haishu, Beilun, Fenghua, and Yinzhou. During this period, cultural enterprises were in the ascendant, with relatively small quantity, scale, and agglomeration. In 2020, the pattern of cultural enterprises evolved into the agglomeration pattern of "three-core and multi-point," and the cultural enterprise cluster in the East New Town has grown rapidly and has achieved a reversal in scale to the cluster core of Sanjiangkou. The cluster points around Yinzhou Cultural Square have grown into a cluster core, and the scale of cluster points around Beilun Cultural Square and Fenghua 1986 Cultural Square has also grown significantly. During this period, with the completion and investment invitation of dozens of cultural industrial parks, cultural enterprises began to flourish, showing a more diversified spatial distribution, which meant getting rid of the restrictions of the old town, forming new cluster centers and presenting a trend of spreading to the peripheral areas.

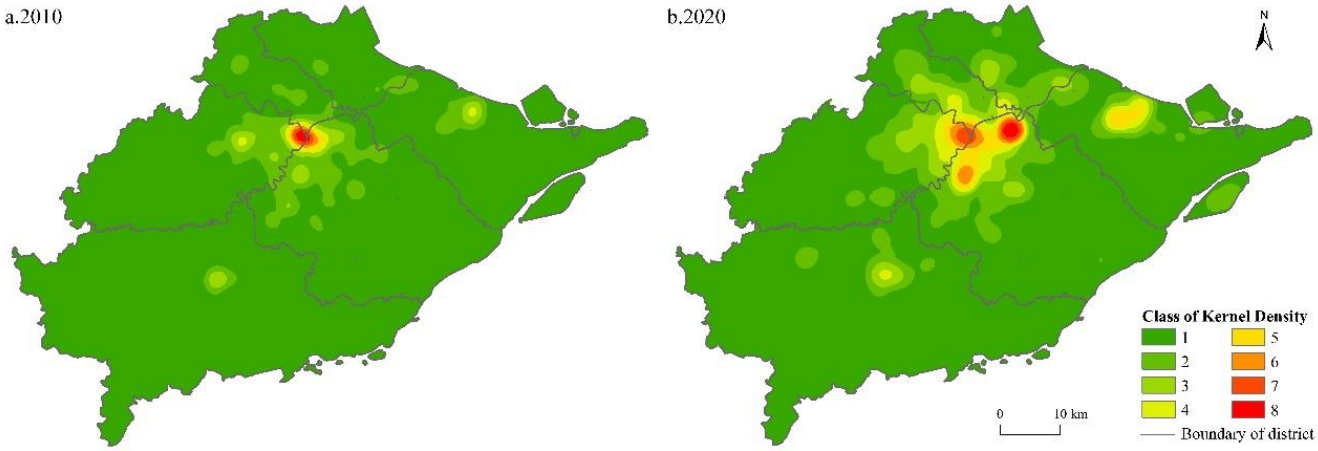


Figure 4. Kernel density of cultural enterprises in the central district of Ningbo in (**a**) 2010 and (**b**) 2020. **Note:** This map is based on the standard map of the Map Technical Review Centre of the Ministry of Natural Resources of China (Number: Zhejiang S (2022)34), with no modifications to the base map. Map-making by the author.

4.2.2. The Evolution of the Abundance of Cultural Enterprises in the Central District of Ningbo

From 2010 to 2020, the abundance of cultural enterprises in the central district of Ningbo showed a significant "center-periphery" circular distribution trend, decreasing from the Sanjiangkou Old Town and Eastern New Town to the periphery (Figure 5). The abundance of cultural enterprises in the Sanjiangkou Old Town and the Eastern New Town to the periphery has been continuously strengthened and has driven the common development of cultural industry around North and South Higher Education Park and Yinzhou Cultural Square. Areas with relatively simple business forms were generally located in the marginal hilly areas, such as the Dayan Town, Fenghua District, and the Zhangshui Town, Haishu District, which were rugged, sparsely populated, economically backward, and lack of cultural needs, so the development level of cultural industry was relatively low. On the contrary, the surrounding area of Sanjiangkou was rich in business forms due to the developed economy, dense population, and strong cultural demand.

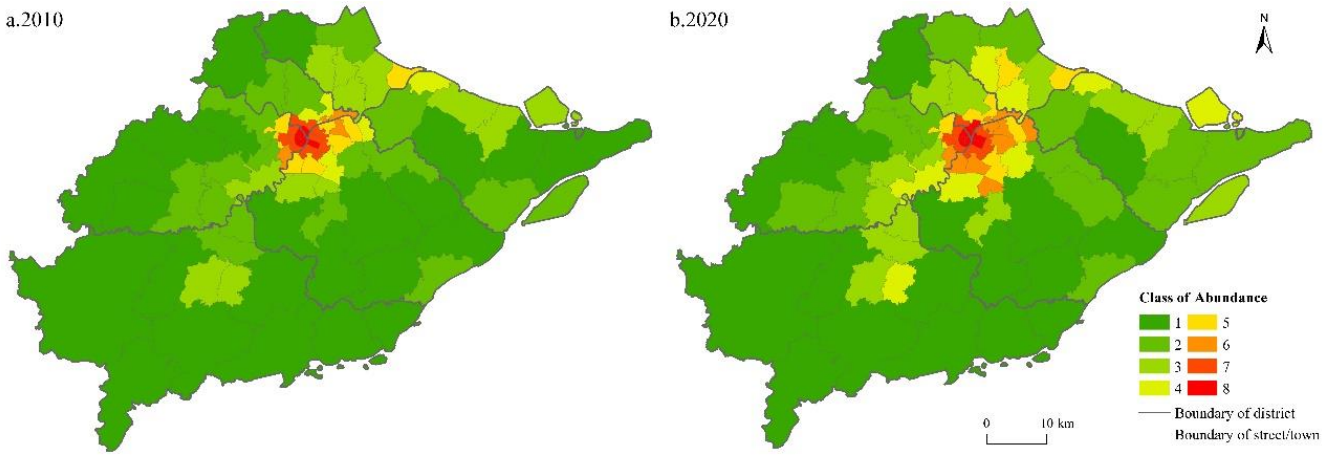


Figure 5. The abundance of cultural enterprises in the central district of Ningbo in (**a**) 2010 and (**b**) 2020. **Note:** This map is based on the standard map of the Map Technical Review Centre of the Ministry of Natural Resources of China (Number: Zhejiang S (2022)34), with no modifications to the base map. Map-making by the author.

4.3. The Spatial Coupling Analysis of Cultural Facilities and Cultural Enterprises in the Central District of Ningbo

4.3.1. The Spatial Superposition of the Agglomeration Pattern of Cultural Facilities and Cultural Enterprises

From 2010 to 2020, the evolution of the agglomeration pattern of the cultural facilities and cultural enterprises was basically the same (Figure 6). Firstly, the agglomeration pattern has evolved from the single core or dual cores and multiple points to "three-core and multi-point." In addition, the new cluster cores/cluster points in the Eastern New Town, Yinzhou Cultural Square, Zhenhai New Town, and other larger scales were basically the same location, and the new cluster core in the Eastern New Town has exceeded the agglomeration scale of cultural facilities and cultural enterprises in the Sanjiangkou Old Town. Finally, the scale expansion of the original agglomeration points such as the Fenghua 1986 Cultural Square, Beilun Cultural Center, Zhenhai Old Town, and North Higher Education Park was also relatively consistent. This suggested that the locations of the cultural facilities and cultural enterprises were deeply guided by the administrative forces and tended to be near the city center. The urban government gave priority to the layout of high-quality cultural facilities around the city or district center to form cultural squares or cultural facilities cluster areas with initial scale, and then attract cultural enterprises to settle in, so as to promote the agglomeration and development of regional cultural industry, which was particularly evident in the construction of public cultural centers in the Eastern New Town and the Zhenhai New Town. Taking the provincial-level cultural industry demonstration base of Ningbo Cultural Square as an example, it was located in the core area of the Eastern New Town and formed under the background of regional transformation and development driven by urban government policy. As one of the key construction projects in the 11th Five Year Plan of Ningbo, it took the lead in configuring many high-quality cultural facilities such as Ningbo Scientific Exploration Center, Ningbo Cultural Square Grand Theater, and Ningbo Smart City Exhibition Hall, and held a series of special brand cultural activities such as Ningbo Summer Solstice Music Day, the Asian Art Festival, and Orange City Market. At the same time, it innovated the operation style and carried out low-fare activities to benefit the citizens. Ningbo Cultural Square organized more than 2000 public cultural activities and provided the citizens with public cultural products worth more than 260 million yuan every year. While improving the supporting facilities such as catering, shopping, and leisure, the square took the distinctive cultural characteristics and complex business functions as the entry point for publicity, and finally successfully attracted nearly 50 cultural enterprises engaged in performing arts, film, and television production, creative design, and cultural training to settle in. Cultural enterprises

account for nearly 60% of the total number of settled enterprises, with an annual output value of 330 million yuan, accounting for 77% of the total annual output value of the square. The square attracted more than 2.6 million visitors every year, forming a good industrial agglomeration benefit and becoming a well-known one-stop cultural consumption complex in Ningbo.

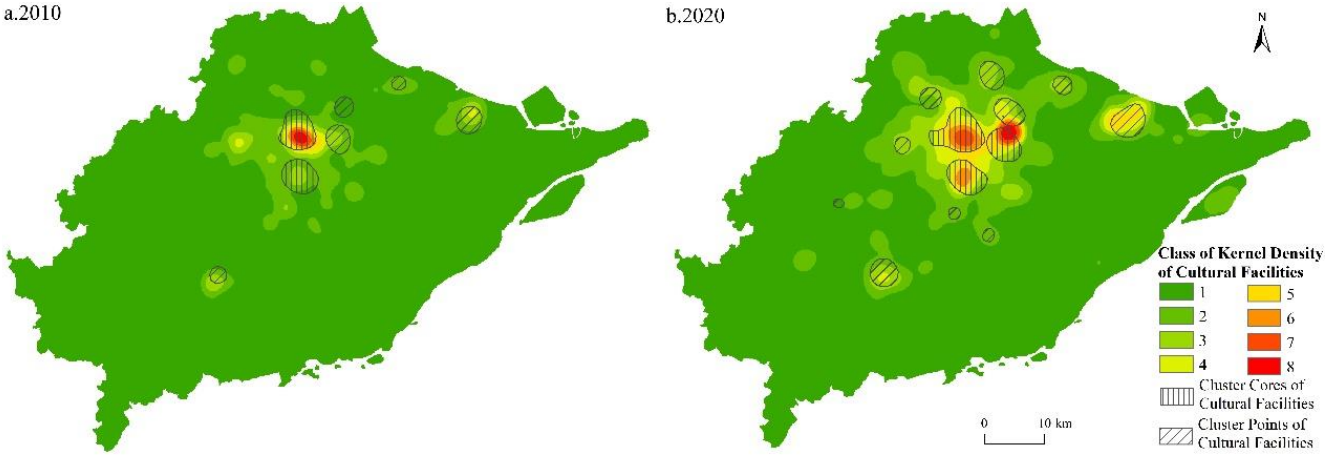


Figure 6. The spatial superposition of the agglomeration area of cultural facilities and the kernel density of cultural enterprises in the central district of Ningbo in (**a**) 2010 and (**b**) 2020. **Note:** This map is based on the standard map of the Map Technical Review Centre of the Ministry of Natural Resources of China (Number: Zhejiang S (2022)34), with no modifications to the base map. Map-making by the author.

4.3.2. The Spatial Superposition of Agglomeration Pattern of Cultural Facilities and the Abundance of Cultural Enterprises

From 2010 to 2020, the evolution of the agglomeration pattern of cultural facilities was also similar to the evolution of the abundance of cultural enterprises (Figure 7). First of all, Sanjiangkou Old Town has always been the cluster center of cultural facilities and the area with the highest abundance of cultural enterprises. Additionally, the abundance of cultural enterprises around the new cluster center/cluster points such as the Eastern New Town, or the initial cluster center/cluster points such as Yinzhou Cultural Square, which are of a relatively large scale, has also been improved. The new construction or the renovation of cultural facilities will open up new fields of cultural consumption, improve the consumption power of the cultural market, and then drive the transformation and development of cultural industry and enrich the industrial abundance. For example, Ningbo Music Port, the national music industry base, was rooted in the profound music history of Ningbo, with the support of the Ningbo Grand Theater and North Shore Star Neighborhood Music Theme Living Block and integrated business formats of music creation, performing arts, music trading, and digital music. It successfully held large-scale music festivals such as the Haishi International Music Festival, Music Ningbo Gang Conference, and China New Country Music Festival. Ningbo Music Port holds more than 100 music activities of various kinds every year, and eventually attracted more than 60 cultural enterprises engaged in music performance, education and training, musical instrument sales, and recording production. It has built a comprehensive music industry system and become a landmark area of "Music Ningbo."

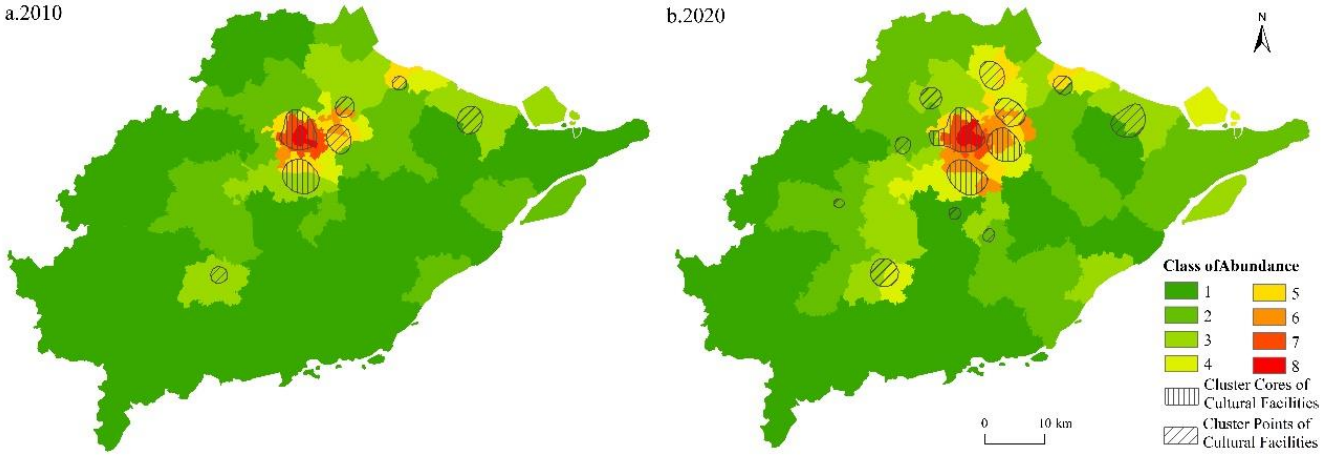


Figure 7. The spatial superposition of agglomeration area of cultural facilities and the abundance of cultural enterprises in the central district of Ningbo in (**a**) 2010 and (**b**) 2020. **Note:** This map is based on the standard map of the Map Technical Review Centre of the Ministry of Natural Resources of China (Number: Zhejiang S (2022)34), with no modifications to the base map. Map-making by the author.

4.3.3. The Promotion of Cultural Facilities in the Development of Cultural Industry

(1) The detection results of cultural industry-influencing factors

We used the geographic detector tool to obtain the detection results of cultural industry-influencing factors in the central district of Ningbo (Table 5). The results show that the indicators of cultural atmosphere, commercial supporting facilities, cultural consumption, and cultural productivity all pass the significance test at 0.01 level, which jointly promote the agglomeration and development of cultural industry.

Table 5. Factor detection for the cultural facilities promoting the development of cultural industry.

Independent Variable		Detection Results	
		***q* of Agglomeration Degree of Cultural Enterprises**	***q* of Format Abundance of Cultural Enterprises**
Cultural atmosphere	Average kernel density of cultural facilities in streets/towns	0.831 ***	0.730 ***
	Entropy index of cultural facilities in streets/towns	0.677 ***	0.649 ***
Commercial supporting facilities	Average kernel density of shopping, catering, and leisure POI data in streets/towns	0.771 ***	0.630 ***
Cultural consumption	Per-capita GDP of streets/towns	0.662 ***	0.582 ***
Cultural productivity	The number of cultural facilities in streets/towns	0.447 ***	0.278 ***

Note: *** Represents that results are significant at the 0.01 confidence level.

(i) Cultural atmosphere

The cultural atmosphere is the primary factor that explains the promotion of cultural facilities in the development of cultural industry. The density and the abundance of cultural facilities represent the cultural atmosphere. Their *q* values are as high as 0.831 and 0.677, respectively, in the factor detection with cultural enterprise agglomeration is the independent variable, and are 0.730 and 0.649, respectively, in the factor detection

when the abundance of cultural enterprises is the independent variable. By creating the cultural environment and atmosphere, cultural facilities have a subtle impact on the interests and aesthetic preferences of urban residents, and ultimately guide citizens to participate in cultural skills training and cultural creation, such as dance, vocal music, and opera, then drive the industrial development of cultural training and creation. This is particularly typical in the nationwide art popularization project of "One person, One Art" in Ningbo. Taking cultural centers at all levels in Ningbo as the main carrier, with the help of social alliances, art popularization points, and other popular institutions and units, and through the intensive holding of vocal music, dance, drama, exhibition, and other cultural events and activities, this project creates a national artistic atmosphere and drives the dual development of social art training and cultural consumption.

(ii) Commercial supporting facilities

Commercial supporting facilities are the secondary influencing factors. The q values of catering, shopping, and leisure POI density, which represent the configuration level of commercial supporting facilities, are respectively 0.771 and 0.630 in the two detections, indicating that the improvement of commercial supporting facilities will also affect the layout and development of cultural industry. This is mainly because the change in residents' consumption structure forces the transformation of the urban commercial complex. Since the new normal of China's economy, the consumption trend of residents has gradually shifted to comprehensive service consumption, focusing on diversification and quality, and the proportion of cultural consumption has been rising. Thus, the city government is encouraged to integrate cultural facilities with catering, shopping, leisure, and other supporting commercial facilities to construct the urban commercial complex or cultural consumption complex, in order to activate the commercial potential of the block, and then attract cultural capital to participate, so as to create a new driving force for the growth of cultural industry.

(iii) Cultural consumption

The q values of the cultural consumption indicator are 0.662 and 0.528, respectively, which confirms that the improvement of cultural consumption can promote the development of cultural industry. On the one hand, the improvement of cultural consumption is caused by the improvement of regional economic development level. Economic development and income growth will improve people's cultural literacy, artistic appreciation, and value orientation, with the demand for personalized, fashionable, and high-quality cultural consumption rising significantly. On the other hand, the construction and operation of cultural facilities are closely related to the improvement of cultural consumption [52]. By innovating cultural goods and services, cultural facilities can open up new cultural markets, thereby improving comprehensive cultural consumption and driving the development of cultural industry. For example, the Ningbo Museum set up an exhibition area for cultural products in 2021, launched a series of cultural products such as architectural stationery, primitive beasts, and Shili Red Makeup, and thus established Ningbo Art Store to sell unique and exquisite works of art and cultural books to visitors, which are well received by consumers.

(iv) Cultural productivity

The impact of the cultural productivity indicator is the weakest, with q values of 0.447 and 0.278, respectively, but it also indicates that cultural productivity represented by the number of cultural facilities can affect the development of cultural industry. Cultural productivity refers to the ability to produce cultural products and provide cultural services. The construction and operation of cultural facilities promote the generation of cultural productivity, and the improvement of cultural productivity will facilitate the development of cultural industry. For example, cultural facilities purchase cultural products from surrounding cultural enterprises and then convert them into cultural services for the public to enjoy, which not only ensures the performance of their cultural functions but also increases the product sales and profit of cultural enterprises.

(2) The promotion mechanism of cultural facilities for the development of cultural industries

(i) Land finance—behavior logic of Ningbo City government

In the past decade or so, economic growth has been the main appeal of local governments in China for the sake of performance evaluation and job promotion. Land finance is one of the main means for Chinese local governments to develop the urban economy and seek political achievements. Land finance means that some local governments rely on the revenue from the sale of land-use rights to maintain local fiscal expenditure, which generally accounts for about 45% of the local government's fiscal revenue [53]. The operation mode of land finance is as follows. (1) The government announces that it will build a new town, satellite town, etc. (2) The urban construction investment company (a state-owned enterprise established by the local government) uses the land as collateral to obtain loans from banks for the construction of infrastructure and major public service facilities in the new town. (3) The urban construction investment company sells urban land to real estate companies at high prices, with the completed infrastructure and public service facilities as the highlight of publicity, repays the previous bank loans, and hands over the profits to local governments or continues to use them for other infrastructure construction. (4) The real estate companies acquire land-use rights, build houses, and sell them to citizens at a high price to make profits. (5) Residents use their houses as a mortgage to obtain long-term housing loans from banks. Finally, infrastructure and residential investment create a large amount of GDP, which drives urban economic development [54–56].

Taking the Eastern New Town as an example, Ningbo City government has invested in a number of high-quality cultural facilities in this new eastern city. It has relocated the municipal government there to build the urban administrative and cultural center and the second urban center of Ningbo, so as to relieve the pressure of population, environment, and land use in the old town and create a new growth point of the urban economy. The construction of the Ningbo Cultural Square in the Eastern New Town began in 2008, and the major cultural facilities were completed in 2013, while the city government moved to the Eastern New Town in 2014. High-quality cultural facilities and promising development prospects have led to a large population concentration and eventually to the flourishing of cultural industries (Figure 8) [57].

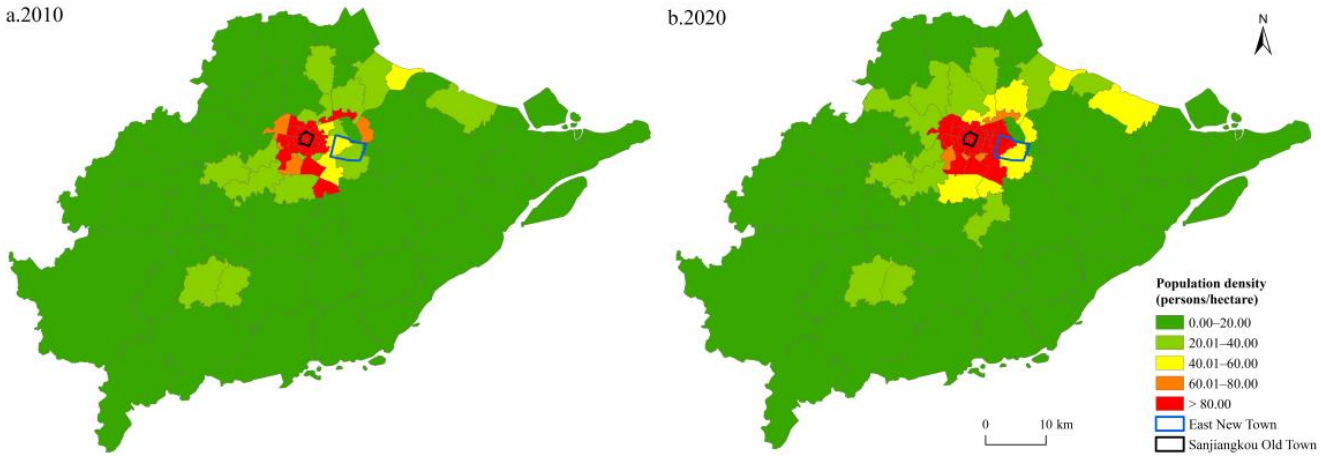


Figure 8. Population density in the central district of Ningbo in (**a**) 2010 and (**b**) 2020. **Note:** This map is based on the standard map of the Map Technical Review Centre of the Ministry of Natural Resources of China (Number: Zhejiang S (2022)34), with no modifications to the base map. Map-making by the author.

(ii) The promotion ways of cultural facilities for the development of cultural industries in Ningbo City

Based on the results of the spatial coupling of cultural facilities and cultural enterprises, factor detection analysis, and the analysis of the behavior logic of Ningbo City government, it can be concluded that cultural facilities will significantly promote the agglomeration and development of cultural industry, mainly in two ways: dominant type and collaborative type (Figure 9). The dominant type refers to the public cultural facilities promoted by the government. These are concentrated in areas with weak cultural industry foundations such as new urban areas, which promote the construction of the surrounding cultural atmosphere and cultural landscape, and then guide the agglomeration and development of cultural enterprises. Cultural enterprises have achieved significant growth and development in both scale and business abundance, which is especially typical in Eastern New Town and Zhenhai New Town. Collaborative type refers to the construction of cultural facilities in areas with a certain cultural industry foundation, and then integrates the original cultural market, creates new cultural industry growth points, enriches the cultural industrial abundance, and extends the industrial chain, so as to promote the sustainable development of cultural industry, which is represented by Ningbo Music Port, Liangzhu Cultural Industry Park, and 1844 Heyi Art Life Center.

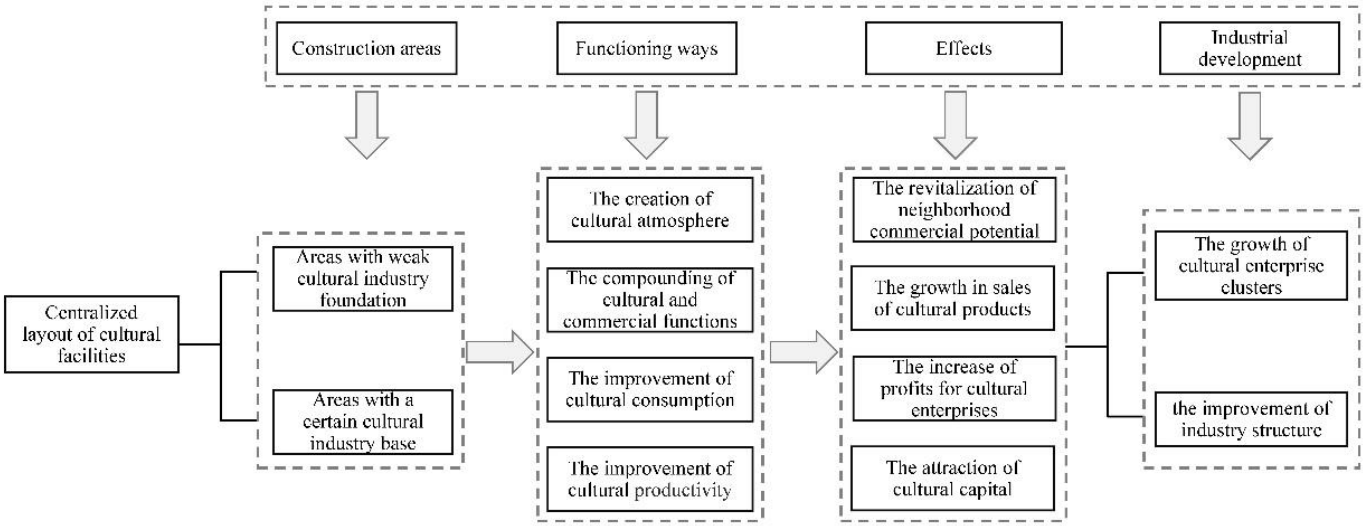


Figure 9. The promotion mechanism of cultural facilities for the development of cultural industry in the central district of Ningbo.

To sum up, the promotion of cultural facilities for the development of cultural industry is mainly achieved through the creation of a cultural atmosphere, the integration of cultural and commercial functions, and the improvement of cultural consumption and productivity, which is mainly to promote the growth of cultural enterprises and the improvement of industry structure in areas with a weak cultural industry base, while enriching the cultural industry in areas with a certain cultural industry base and extend the industry chain.

5. Discussion

5.1. Methodological Advantages

The identification and analysis of the externality of urban facilities have always been a hot topic in the field of geography and urban planning. Previous studies on the externalities of urban facilities mostly discussed the capitalization effect of facilities on land or house prices, or the enhancement effect on residents' physical and mental health and well-being, but failed to pay sufficient attention to the guiding and promoting effects of urban facilities on the related industry [58]. Compared with previous studies, the method proposed in this paper has two advantages: firstly, this paper aims to construct the analysis framework and identification route of the externality of cultural facilities from the perspective of

cultural industry, in order to open up a new perspective for the study of the externality of urban facilities. Secondly, this paper explores the externalities of cultural facilities from the perspective of cultural industry from the two aspects of spatial and temporal pattern coupling and promotion mechanisms, which is more detailed than the regression analysis in previous studies.

It is noteworthy that we compare the research results with the existing research and find that similar phenomena also appear in other cities such as Tianjin, Wuhan, and Taiyuan in China. That is, the city governments build the sub-center of the city through the concentrated construction of cultural facilities, so as to relieve the development pressure of the old town, narrow the regional development gap, stimulate the urban vitality, and improve the image of the city [59]. This shows that the research framework of the externality of cultural facilities we proposed is scientifically valid.

5.2. Differences in the Role of Cultural Facilities in the Development of Ningbo and Western Cities

The culture-oriented urban renaissance of Western cities is to replace the decaying traditional manufacturing industry with cultural industries, so as to enhance the vitality of urban centers [60–62]. Namely, city governments create the cultural landmarks and cultural districts through the renovation of old industrial buildings and the construction of cultural facilities, promote the development of tourism, attract private-sector investment to improve the urban environment and increase employment opportunities, and finally attract people back to the urban center [63,64]. However, cultural facilities led the city to develop in groups in Ningbo. Due to the huge pressure on land use, construction, infrastructure, and the environmental capacity of the Sanjiangkou Old Town, the city government chose to relocate to the Eastern New Town to relieve the development pressure of the old town, promote the Eastward Development Strategy, and create a spatial pattern of one city with two centers. This has also driven the construction and operation of many high-quality cultural facilities, such as the Ningbo City Exhibition Hall, and greatly promoted the agglomeration and development of cultural industries in the Eastern New Town. In addition, under the background of green economy, resource conservation, environmental protection, and sustainable development gaining popularity, the city government will continue to rely on high-quality cultural facilities to vigorously develop cultural industries so as to achieve industrial transformation and sustainable development of the city.

5.3. A New Research Direction for the Location Selection of Cultural Facilities

The existing research on the location selection of urban facilities is mostly carried out for livelihood facilities such as hospitals, schools, parks, etc., using configuration models such as P-median, Location Set Covering Problem (LSCP), and Maximum Covered Location Problem (MCLP), with the help of GIS technology and multi-criteria decision analysis, and strive to achieve the largest service population coverage with the lowest cost [65]. However, cultural services are not daily necessities, and the frequency of receiving cultural services is lower than that of livelihood services such as education and recreation. Thus, the layout of cultural facilities can take more consideration of the economic benefits. Therefore, after clarifying the driving effects of cultural facilities on the development of cultural industry, how to build a location-allocation model aiming at cultural industry cultivation and urban industry transformation based on regional cultural heritage and economic foundations, so as to maximize the externality of cultural facilities, is a major direction for future research on the allocation of cultural facilities.

5.4. Research Limitations

There is also room for improvement in the research, which can be further explored in the following aspects. (1) This research focuses on the spatial correlation between cultural facilities and cultural enterprises. In the future, with the support of new functions of geodetectors, whether the externality of cultural facilities is affected by a combination of multiple factors need to be further studied. (2) There are many types of cultural industry,

covering plenty of fields from professional design, production, wholesale and retail, to personalized services. This article has not been able to subdivide them. In the future, we will explore the interaction mechanism between cultural facilities and different types of cultural industries. (3) This paper simply discussed the differences in the role of cultural facilities in the development of Ningbo and Western cities. In the future, more in-depth comparative studies can be conducted through field investigation and detailed data.

6. Conclusions

Based on the data on cultural facilities and cultural enterprises in the central district of Ningbo in 2010 and 2020, the externality of cultural facilities was comprehensively analyzed from the agglomeration and abundance of cultural industry by using nuclear density analysis, entropy index method, and geodetectors. The results showed that the evolution of the agglomeration pattern of cultural facilities and cultural enterprises was basically the same, from the single core or dual core and multi-point to "three-core and multi-point." The evolution of the agglomeration pattern of cultural facilities was also similar to the evolution of the abundance of cultural enterprises. The externality of cultural facilities is mainly realized through the construction of cultural atmosphere, the integration of cultural and commercial functions, and the improvement of cultural consumption and productivity, which is mainly to promote the growth of cultural enterprises and the improvement of industry structure in areas with a weak cultural industry base, while enriching the abundance of cultural industry and building a comprehensive industrial development system in areas with certain cultural industry foundation.

Since 2010, as the concepts of the green economy, resource conservation, environmental protection, and sustainable development have been gaining popularity, the world economy has embarked on a path of transformation and upgrading. Meanwhile, cultural industry has gradually become a strategic emerging industry that major cities around the world are competing in to cultivate and develop, due to the many advantages such as being knowledge intensive, innovation intensive, and environmentally friendly. Based on the research results of this paper, we put forward the following suggestions to stimulate the development of cultural industry in famous historical and cultural cities like Ningbo. (1) Attach importance to the site selection of cultural facilities. Comprehensively consider factors such as transportation, population distribution, and economic level to reasonably arrange cultural facilities, in order to meet the cultural needs of citizens as much as possible, with low investment and to improve regional cultural consumption. (2) Pay attention to the product quality of cultural facilities. Relying on the regional cultural heritage and historical tradition, launch cultural products with local characteristics to expand the cultural consumption market. (3) Take the construction of cultural landmarks into account. Based on the regional landscape pattern and humanistic characteristics, construct cultural landmarks with unique local charm to create urban cultural landscapes, enhance cultural fame, and attract cultural capital.

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