

Spatial Agglomeration and Influencing Factors of Urban Shadow Education under Field Perspective: A Case Study of Xi'an 's Main Urban Area

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Abstract: Rapidly growing shadow education not only brings the socio-economic problems of increasing students' schoolwork and families' burden, but also exacerbates the problem of educational inequality due to spatial differentiation. This study takes shadow education institutions in the main city of Xi'an as the research object, constructs the shadow education field with the help of Bourdieu's field theory, and applies GIS spatial analysis technology to quantitatively understand the multi-dimensional and multi-scale differentiation characteristics of the shadow education field and its influencing factors. The results show that: 1. the intensity of shadow education field in the main city of Xi'an presents the characteristics of core area - core edge area - periphery of the circled field differentiation on the urban scale, i.e., around the ancient city of Xi'an and the second ring road to form a high intensity of the core area between the second ring road and the second ring road for the edge of the core area, and then outward to the shadow education in decreasing trend. 2. The clustering characteristics of different types of shadow education sub-fields differ significantly. The type structure varies and is dominated by the multi-centre agglomeration structure, with significant differences in the spatial agglomeration patterns of different types of shadow education. 3. Because of the different types of shadow education institutions, their market positioning and location requirements are different, and thus the choice of their spatial layout has significant differences. From the results of the influencing factors, habitus, economic capital and cultural capital are the main factors influencing the spatial agglomeration layout of shadow education institutions, while factors such as social capital have a weaker influence on them. 4. The role of various influencing factors varies according to the types of shadow educational institutions.

Keywords: Shadow Education Enterprises; Primary and Secondary Schools; Spatial Agglomeration; Influencing Factors; Xi'an Main Urban Area.

1. Introduction

According to the Survey Report on Chinese Parents' Education Anxiety Index released in 2018, it can be seen that the comprehensive anxiety index of Chinese parents in education is 67 points, and the whole is in a relatively anxious state. In society, education certificates are highly symbolic and function to legitimise social status. In order to "prevent their children from losing at the starting line", Chinese parents are constantly competing for increased spending on education and seeking educational services from market-based extracurricular educational institutions. This phenomenon of extracurricular tutoring is known internationally as shadow education, which refers to complementary educational activities that take place outside of formal schooling and for which fees are charged in order to improve students' performance [6]. In recent years, with the rapid socio-economic development and urban and rural living standards in China, the scale of shadow education institutions has reached 401,000 at the end of 2018 in China, and the market size exceeds 400 billion yuan [10]. As a certain promoter of the privatisation of public education services, shadow education is closely linked to issues such as student development, educational equity and social mobility [8], which came into being when school education could not fully satisfy the educational needs of students, and the aggregation or dispersion of the various educational participatory forces in the educational field contributed to the increasing complexity of the operational issues of shadow education, and

its development is becoming more and more diversified and open [9], and thus has become a hot issue in society. Since the end of the last century, shadow education has received a great deal of official attention, and there have been numerous bans, regulations and policies on shadow education. In fact, the suppression, problematisation and stigmatisation of shadow education not only makes it difficult to explain the essence of the shadow education problem, but also fails to get out of the real dilemma of the educational problems and even the society caused by shadow education [9]. Therefore, the governance of the over-marketisation and lack of regulation of shadow education cannot be ignored. With the help of Bourdieu's field theory, the GIS spatial quantification results are interpreted and analysed, which helps to more accurately grasp the spatial characteristics of shadow education at different different levels of differentiation in Xi'an, as well as how the elements of the field play the role of internal and external pushes in the process of shadow education agglomeration. A more comprehensive and clearer logical perception of the construction of the meaning of shadow education.

Shadow education, which first appeared in the 1980s, has since developed rapidly in Asia, Africa, and Latin America, becoming a common social phenomenon, and scholars at home and abroad have gradually carried out in-depth and extensive discussions on it: including the use of theory in the study of shadow education is still in its infancy, and at present it mainly focuses on the three major categories of neo-liberalism and shadow education, capital and shadow

education, and identity and shadow education, and overall It presents three characteristics: relatively weak and immature theoretical perspectives, a relative disconnect between theoretical exploration and empirical research, and a lack of qualitative analyses and rooted theories in domestic shadow education research. Through the word frequency statistics and clustering function of the visualisation software Citespace, Gao Xiang analysed 200 SSCI journals included in the Web of Science (WoS) database from 1992-2018, showing that "students and shadow education", "shadow education demand", "shadow education", "shadow education" and "shadow education" are the three characteristics of shadow education research in China. educational needs", "social inequality", and "shadow education policy" are the four hot topics of international shadow education research in this period [11].

With the help of Bourdieu's field theory, the interpretation and analysis of GIS spatial quantitative results can help to more accurately grasp the characteristics of different levels of differentiated space and the complex correlation between them, and have a more comprehensive and clearer logical cognition of the construction of the meaning of the object of study, and the field theory is an effective tool for the study of cultural geography [2].

The formation of a socio-spatial field is affected by many complex factors, so the core elements must be selectively extracted before conducting GIS spatial analysis. Among the carriers of shadow education field, shadow education institutions are the most numerous and have the closest relationship with shadow education actors, which are the carriers of intensive life and frequent activities of shadow education actors in Xi'an, and can best highlight the behavioural characteristics of shadow education actors. In this paper, we extract the data of shadow education institutions, which are relatively large in number, have a strong relationship with the habits of shadow education actors, and are most capable of reflecting the shadow education field as a whole, as the core element that influences the geographical and spatial distribution of the shadow education field. In this paper, under the perspective of field, we use GIS spatial analysis method to explore whether there is a subfield of "core area of shadow education field" in the main urban area of Xi'an City, which is obviously densely distributed with this element. If there is, after defining the scope and analysing the influencing factors, the spatial agglomeration pattern will be explained, and then the shaping role of the three types of capital influencing factors in the shadow education field will be analysed progressively.

2. Theoretical Foundation

French sociologist Pierre Bourdieu introduced the concept of "field" in physics into sociology and put forward the field theory, stressing that thinking in the perspective of field is thinking from the perspective of relationship. Field theory focuses on two aspects in spatial analysis: (1) the network of relationships inside and outside the space. According to field theory, society can be divided into independent and closely related spaces, which can be divided into different levels of sub-spaces, and the connection between the hierarchical spaces will form a complex network of relationships. Spatial analysis under the field perspective not only focuses on the internal space, but also on the network relationship between hierarchical spaces of different sizes and locations. (2) Actors, habitus and capital. Actors with subjective initiative in the

field are the main constructors, habitus is the internal logic, "capital" constitutes the basis of the subject's action, and various intricate intra- and inter-field conflicts around capital are omnipresent, which is the exogenous driving force that gives rise to the expansion of the field. The field can influence and shape actors, habits and capital, and actors, habits and capital simultaneously construct the meaning of the field. Introduction to introduce the field perspective, Xi'an shadow education institutions cluster formed space can be considered as a regional informal education space field, (overview of the actors involved, former students are the main, geography POI subject for the institution) have tuition needs of consumers is the core actors in the shadow education field, with its cultivation of excellence and make up for the difference, promotion, the proximity of distance and other habitual habits and the individual in the practice of the activities of individuals to apply the Various resource conditions, as tools for the actors' behaviour and as capital for the individuals' competitive goals, jointly construct the field as the character and meaning of "further education". Therefore, the shadow education field formed in the built-up area of Xi'an City is constructed by this aggregation. We analyse the correlation between the influencing factors, including mainstream education, traffic environment, business environment, and residents' ability to pay, and the carrier of the shadow education field, and progressively analyse how the habitus and various types of capitals exert internal and external dynamics to promote the aggregation of shadow education institutions in the main urban area of Xi'an and shape the shadow education field, which is important for the formation and standardisation of informal education spaces in Xi'an outside of the formal education field. It is of great significance to promote the formation and regulation of informal education space outside of formal education in Xi'an. How various types of socio-economic factors are expressed uniformly in terms of fields, and the characteristics of convergence are manifested.

According to Bourdieu, the field is a collection of relations shadow education is also an aggregate of socio-spatial economic relations Introduction Field is a collection of relations, put the first paragraph of the introduction, a field can be considered to be a network system of objective relations that exist between various locations to characterise a certain order of social life. Each field prescribes its own values and regulating principles that govern the socially constructed space and its internal and external actors. However, Bourdieu does not see the structural relations within the field as mechanically constraining the behaviour of the actors, but rather as "habitus" and "capital" that explains the formation of the individual's behaviour in the field scenario [1]. This is also true in the field of shadow education. For the individual, "habitus" links the individual's current situation with past experiences, describes the individual's persistent and changeable disposition, enables the actor to cope with unforeseen and changing situations [1], is the principle of behaviour that the individual may have, and is the endogenous motivating factor for the expansion of the field. "Capital" constitutes the basis of the subject's action, and the various intricate intra- and inter-field conflicts around capital are omnipresent, which is the exogenous driving factor that gives rise to the expansion of the field. In the context of shadow education, this habitus is reflected in the choice of the geographical location of the shadow educational institution, in addition to the various types of capital factors affecting the

location of the shadow educational institution. Various types of capital can flow and transform into each other, and the total value of capital determines the location of actors in the field domain. Actors determine their position in the field by acquiring capital [21].

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explained, and the shaping role of the three types of capital influencing factors in the shadow education field will be analysed progressively.

3. Overview of Study Area

Xi'an is one of the largest educational centre cities in western China and one of the cities with the largest number of universities in China, which can well reflect the general pattern of socio-spatial allocation of educational resources in large cities in western China. In this paper, we choose the main urban area of Xi'an, including the six districts of Xincheng District, Beilin District, Baqiao District, Yanta District, Lianhu District, as well as Weiyang District, as the study area (Figure 1). It is an important national research, education, and industrial base. The main urban area of Xi'an includes six districts with a total area of 829.17 km² and 52 street units. By the end of 2021, its jurisdiction had a resident population of 5,857,400, a GDP of 733,918 million yuan, 472 primary and elementary schools (315 primary schools and 157 middle schools), and 240 middle schools; the number of primary and secondary schools in the six districts of the city and the number of shadow educational institutions ranked among the top in Xi'an, and they have a high level of economic and educational development, which makes them a typical case site for the conduct of the study.

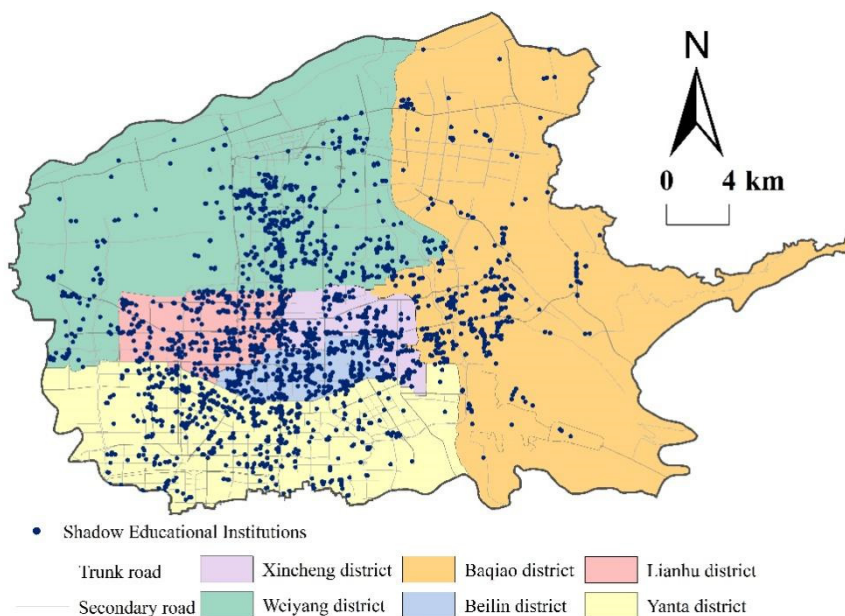


Figure 1. Research area and research object

4. Data Sources and Research Methods

4.1. Data Sources

The road traffic data of Xi'an urban area used in this study was obtained from OSM open source map, which was corrected by combining high-definition image maps after stratification, screening and topology processing, and the bookstores, libraries, schools and shadow educational institutions POI data was obtained from 2021 through the crawler based on the open platform of Gaode Map, and a total of 487 secondary primary schools and 226 secondary schools were obtained, as well as the screened and cleaned Shadow educational institutions for primary and secondary school students tutoring for further education 3,556, of which a total

of three types of institutions were selected: comprehensive primary and secondary school tutoring, primary school tutoring, and early childhood and primary school articulation. According to the popular review website, education counselling institutions can be divided into two categories: arts and sports and academic subjects, of which academic subjects include language, mathematics, English and other in-class courses, and arts and sports include painting, calligraphy, programming, robotics, dance and other extracurricular courses, which were acquired in September 2021. Among the influencing factors, the house price is obtained from the data of Anjuke website (<https://www.anjuke.com>) in 2021, the school point data is obtained by crawling and correcting the bias with the metro and bus stops in 2021, the school-age population data is obtained from the street-scale data of the

sixth national census, and in order to match with the age of the service objects of the educational counselling institutions, the age group data of the age group of 5 to 19 years old population data was selected for analysis.

4.2. Research Methods

4.2.1. Kernel Density Analysis

KernelDensityEstimation (KDE) is a spatial density analysis method based on the clustering algorithm of the data density function, which can intuitively and accurately reflect the relative degree of clustering of the elemental measurements in a continuous region, with the formula:

$$f(x) = \sum_{i=1}^n \frac{1}{h^2} k\left(\frac{s-c_i}{h}\right) \quad (1)$$

In the context of kernel density estimation, the function $f(x)$ is the value of the kernel density function at distance s , k is the spatial weight, h is the search radius, c_i is the core intermediate element i , n is the number of samples whose distance from position s is less than or equal to h . Points close to the centre are given higher weights, which decrease with distance, resulting in smooth surfaces with large intermediate values and small peripheral values.

4.2.2. Standard Deviation Ellipse

The standard deviation ellipse (SDE) can reflect the contour and dominant direction of the spatial distribution of geographic elements based on the spatial location of geographic elements, and the distribution range of the standard deviation ellipse is the main range of the spatial distribution of geographic elements [12]. The mean centre of the ellipse is the centre of gravity of the spatial distribution of geographic elements, the azimuth angle indicates the main trend direction of its distribution, and the standard deviation on the long axis can reflect the degree of dispersion of geographic elements in the main trend direction [13].

4.2.3. The Nearest Neighbour Index (NNI)

The nearest neighbor index (NNI) is an analytical method for identifying "hot spots" in the spatial distribution of point data. By defining the "limiting distance" of a cluster unit, when the distance between a point and other points (at least one) is less than the "limiting distance", it is counted as a cluster unit. Alternatively, it is possible to define the minimum number of points in the clustering unit, and the system automatically identifies the "limit distance" to generate clustering hotspots. According to the above method, if the point data have strong spatial clustering, second-order or even higher-order hotspots will be formed [14].

Before doing nearest-neighbour clustering, the nearest-neighbour index (NNI) is usually used to determine the type of spatial distribution of the point data; when $NNI > 1$, the sample data is uniformly discrete; when $NNI < 1$, the sample data is agglomerative; when $NNI = 1$, the sample data is randomly distributed characteristics. In practical calculations, the Z value is usually used to test the reliability of the results [15].

4.2.4. Spatial Autocorrelation

Kernel density analysis, spatial autocorrelation analysis, hotspot analysis, etc. are the most commonly used methods to study the degree of industrial spatial agglomeration [26,27] Kernel density analysis can be used to calculate the density of the elements in their surrounding neighbourhoods, in this paper, we introduce the shadow educational institutions POI data into ArcGIS10.2, and according to the information of its coordinate points to draw the kernel density map of the spatial

distribution of the shadow educational institutions, so as to express the spatial agglomeration characteristics of the educational counselling institutions. The spatial clustering characteristics of educational counselling institutions and the differences in the spatial clustering characteristics of different types and sizes of children's educational counselling institutions are used to reveal their spatial clustering patterns.

Spatial autocorrelation is used to analyse the degree of association between research objects [28]. In order to measure the degree of spatial agglomeration of primary and secondary school shadow education institutions in the built-up area of Xi'an, Moran'sI index is used to calculate the spatial correlation of shadow education institutions, and the spatial autocorrelation statement is obtained by ArcGIS10.2. The formula for calculating the Moran'sI index is shown in equation (1):

$$I = \frac{n \sum_{i=1}^n \sum_{j=1}^n W_{ij} (x_i - \bar{x})(x_j - \bar{x})}{\sum_{i=1}^n \sum_{j=1}^n W_{ij} \sum_{i=1}^n (x_i - \bar{x})^2} \quad (2)$$

Where: I is the Moran'sI index; x_i and x_j are the attribute values of location i, j respectively; \bar{x} is the average value of x_1, x_2, \dots, x_n ; W_{ij} is the spatial weight matrix; n is the number of research objects.

Moran'sI index is between $[-1, 1]$, when the index > 0 , it is spatial positive correlation, the closer to 1, indicating the greater spatial correlation; when the index < 0 , it is spatial negative correlation, the closer to -1, indicating the greater spatial variability; when the index $= 0$, it indicates that there is no spatial correlation.

4.2.5. Geographic Detector

Geographic detector are used to analyse the extent to which each factor is important in shaping shadow educational institutions. It is a measure that detects spatially stratified heterogeneity and analyses the driving factors behind it, with the core idea being that if an independent variable has an important effect on a dependent variable, the spatial distributions of the independent and dependent variables should be similar [24]. A total of four detectors are included, and in this paper, the factor detector is selected to detect the spatial dissimilarity of shadow educational institutions, and to detect to what extent a factor X explains the spatial dissimilarity of the attribute shadow educational institutions, using the q -value for the measure, with the following algorithm:

$$q = 1 - \frac{\sum_{h=1}^L N_h \sigma^2 h}{N \sigma^2} = 1 - \frac{SSW}{SST} \quad (3)$$

where: $h = 1, 2, \dots, L$ is the stratification of Y and X ; N_h and N are the number of cells in stratum h and the whole region, respectively; $\sigma^2 h$ and σ^2 are the variance of the Y values in stratum h and the whole region, respectively; SSW and SST denote the sum of the variance within the stratum and the total variance in the whole region, respectively. q value is $(0, 1)$, where the larger the value indicates that the more pronounced spatial dissimilarity of Y is; if independent variable X is generated from stratification where a larger value of q indicates that the independent variable X has stronger explanatory power for the attribute Y , and vice versa.

5. Characterization of the Spatial Pattern of the Shadow Education Field

5.1. Overall Spatial Pattern and Direction of Distribution of Shadow Education Venues

(1) A semi-circular distribution pattern of "dense inside and sparse outside" and a northeast-southwest distribution direction.

Through the standard deviation ellipse analysis, it is found that the shadow education field in Xi'an has a significant north-south axial and potential south-west-north-east axial distribution, and the various types of shadow education institutions in the field are in line with the characteristics of the overall layout, but each of them has a certain degree of specificity. The spatial pattern of the overall shadow educational institutions and the shadow educational institutions of early childhood care, arts and sports training, and subject tutoring all show the characteristics of distribution along the northeast-southwest direction, which is consistent with the direction of urban development in Xi'an. The spatial pattern of shadow educational institutions of skills and vocational qualifications is not as strong as that of the above shadow educational institutions, which are mainly distributed in the city centre and slightly inclined to the north-west-south-east direction. The reason for this may be that, firstly, the number of samples of shadow institutions of vocational qualifications is small, which leads to a slight directional bias; secondly, such institutions belong to comprehensive specialised social education, vocational qualification exams, etc., which are comparatively more unique in terms of service targets and specialised targeted courses, and their distribution is less affected by external influences, and they are more inclined to the city centre where the economic level and the population density are higher.

Shadow education institutions in the main urban area of Xi'an generally show the characteristics of aggregation and distribution, forming a semi-circular spatial pattern of "dense inside and sparse outside, dense in the south and sparse in the north" and "strong main core and weak secondary core". Through the core density analysis, it is found that there is a significant clustering phenomenon in the spatial distribution of shadow educational institutions in the built-up area of Xi'an, and the spatial distribution of resources is characterised by "dense in the three central districts and sparse in the three peripheral districts" (Figure 2). The clustering characteristics show a "half-ring and one-axis" clustering belt with Beilin, Lianhu and Xincheng districts as the core and the central road network as the axis, which extends along the north-south axis, and a number of secondary clustering cores are scattered around the periphery of the clustering belt. In the agglomeration belt, Taiyi Road Street, Changle Middle Road Street, Youth Road Street and Xiyi Road Street intersect, followed by Zhangjiacun Street, Chang'an Road Street and Zhongshanmen Street. Most of the agglomeration cores on the periphery of the agglomeration belt are located in the centres of other districts, including Zhangjiabu Street in Weiyang District, Xiaozhai Road Street and Electronic City Street in Yanta District, and Shilipu Street in Baqiao District.

From an inter-district perspective, the absolute number of primary and secondary shadow education institutions in the city of Xi'an reached 699 in Weiyang District, 662 in Yanta District, and 629, 555, 517, and 494 in Lianhu, Beilin, Baqiao,

and Xincheng Districts, accounting for 19.66 per cent, 18.62 per cent, 17.68 per cent, and 15.61 per cent, respectively, of the total number of shadow education institutions, 14.54% and 13.89% respectively, with the highest in Weiyang District and the lowest in Xincheng District. From the perspective of spatial density, Beilin District is as high as 23.75/km², Lianhu District and Xincheng District are the next highest with 16.41/km² and 16.40/km², respectively, while the spatial densities of shadow educational institutions in Yanta District, Weiyang District, and Baqiao District are 4.37/km², 2.64/km², and 1.59/km², respectively. Looking at the absolute number, there is not much difference between the districts of primary and secondary shadow education institutions in Xi'an. However, if we look at the spatial density, it is the highest in Beilin District (23.75/km²) and the lowest in Baqiao District (1.59/km²), and the former is nearly 15 times higher than the latter, which is a huge difference. The difference in absolute number between districts is not large, but the difference in spatial density is large because of the large difference in area between districts, so the inter-district difference in the distribution of shadow education is still large. This shows that shadow education institutions are spatially unevenly distributed, with "dense in the three central districts and sparse in the three peripheral districts", and that Beilin District has become the main core area of the spatial pattern of shadow education institutions in the main urban area of Xi'an.

(2) Presenting a cluster and multipolar spatial structure of "one main and many times".

Through the calculation of the NNI, the average neighbour distance of shadow educational institutions in Xi'an is 99.9m, and the R value is 0.39, indicating that the shadow educational institutions in Xi'an show significant spatial agglomeration characteristics. Kernel density analysis is further used to determine the spatial agglomeration characteristics of shadow educational institutions in the main urban area of Xi'an, and the results show that the shadow educational institutions in the main urban area of Xi'an spatially exhibit a multi-centre spatial ring-like agglomeration structure with "one main and many times" distributed along the city centre area within the city expressway and the traditional cultural and educational area in the southern part of the city, i.e., there exists a larger high agglomeration core and multiple high agglomeration cores. In other words, there is a large-scale high agglomeration core and several secondary agglomeration cores, and they are arranged in groups in each district (Figure 2). A large number of hotspots of shadow education institutions show a concentrated and continuous distribution, focusing on expanding to the south along the "south-north" axis, which is the concentration area of the spatial distribution of shadow education.

Among them, the main core of high agglomeration is represented by Taiyi Road Street in Beilin District, which forms the agglomeration core of shadow education institutions at the city level, while the secondary agglomeration core is basically represented by the developed commercial districts where the flow of people in various districts is relatively concentrated. In the new city mainly Zhongshanmen, Changle and Hujiamiao as the agglomeration core, forming the new city group; in the Lianhu District mainly Lianhu and the new city intersection of Youth Road, Hongmiao Po and West Huancheng Road as the agglomeration core, forming the Lianhu District group; in the Weiyang District, mainly Beiguan, Zhangjiaobao, and the

streets of Hancheng as a contiguous small-scale agglomeration core, to form a group of the Xigu District. In Yanta District, small clustering cores are mainly located in Xiaozhai Road, Electronic City and Zhanba Gully, forming the Yanta District cluster; in Baqiao District, small clustering cores are mainly located in Shilipu, the intersection of Shilipu and Xiwang Streets, and Textile City, forming the Baqiao District cluster.

These agglomerations roughly correspond to the distribution space of district-level centres and commercial centres in the main urban area of Xi'an, while low-density

areas are mainly found in the urban periphery of Liucunbu in Weiyang District, Xinhe in Baqiao District, and Dazhao in Yanta District, which belong to the urban-rural transition zone. This suggests that shadow education institutions in Xi'an prefer the more developed areas of economic activities such as city and district centres, which can make full use of the location advantage of these areas in gathering people and information flows from all sides, and provide the largest and most convenient source of students for all kinds of shadow education institutions, thus maximizing the benefits.

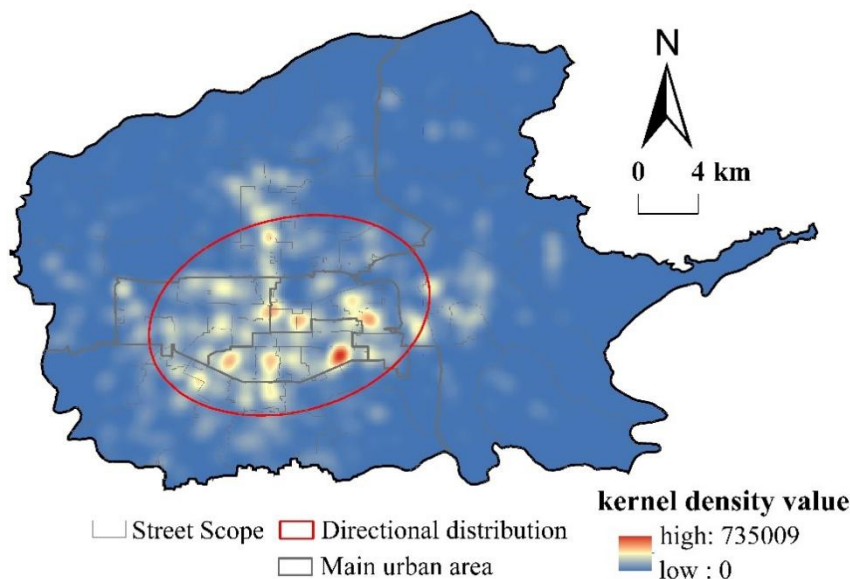


Figure 2. Overall spatial layout of shadow educational institutions based on kernel density analysis

5.2. Clustering Characteristics of Different Types of Shadow Education Subfields

(1) The number of shadow education institutions is the highest in the quality enhancement category, with obvious differences in the structure of the types in each district.

There are 3,556 shadow education institutions in the main urban areas of Xi'an, of which 56, 297, 1,434 and 1,769 are in the categories of skills and vocational qualifications, early childhood care, arts and sports training and subject tutoring, accounting for 1.57%, 8.35%, 40.33% and 49.75% of the total number of shadow education institutions, respectively (Table 1). It can be seen that shadow education institutions in Xi'an are dominated by arts and sports training and subject tutoring, accounting for 90.07% of the total number of institutions. In terms of the nature and purpose of their training, they focus more on basic and generalised interest cultivation and quality enhancement, as well as after-school tutoring for primary and secondary schools, tutoring for higher education in middle and high schools, and tutoring for summer and winter holidays, and they focus more on the enhancement of course performance to strengthen the ability to take exams, which is more comprehensive and specific compared to the overall types of institutions. Only 10.03 per cent of the institutions are oriented towards childcare and vocational training for college students and adults. From the nature and purpose of their training, more inclined to the nature of the small table hosting after-school homework tutoring, as well as focusing on, comprehensive specialised social education, vocational qualification exams, etc., relatively speaking, institutions have a more unique service object, and specialised targeted

courses.

There are significant differences in the type structure of shadow education institutions in each district of Xi'an, with subject tutoring, arts and sports training, childcare and skills vocational qualifications accounting for 58.56%: 34.77%: 4.32%: 2.34%; 40.89%: 47.77%: 9.51%: 1.82% in Beilin, Xincheng, Lianhu, Weiyang, Yanta and Baqiao districts, respectively; 39.27 per cent: 47.85 per cent: 12.08 per cent: 0.79 per cent; 60.80 per cent: 32.05 per cent: 5.01 per cent: 2.15 per cent; 59.82 per cent: 32.93 per cent: 5.44 per cent: 1.81 per cent; 33.66 per cent: 50.68 per cent: 15.28 per cent: 0.39 per cent. Beilin District has a more balanced share of all types of shadow education, but the vocational training category is more prominent than in other districts, the arts and sports training category is more prominent in Baqiao, Lianhu and Xincheng districts, early childhood care is more prominent in Baqiao and Lianhu districts, and subject tutoring is more prominent in Weiyang and Yanta districts. The dominant types of shadow education in each district have some correlation with urban functions. Yanta District is the largest core district in the central city of Xi'an, the political centre of the province, located in the south city block of Xi'an City, Shaanxi Province, with the Xi'an Hi-Tech Industrial Development Zone and the Qujiang New District within its jurisdiction, which is the most mature space in the main urban area of Xi'an, with the greatest density of population, a complete infrastructure and a better business environment, which is absolutely advantageous for attracting various types of training crowds; while the Weiyang District relies on the city's cultural and educational functions. Weiyang District relies on the city's cultural and educational functions and sits

on a cluster of colleges and universities, with a broad space for cultural and creative development, providing strong conditions for the development of art training and curriculum counselling; Baqiao District is more similar to Lianhu District, with early childhood care and education as its main type of shadow education institution; Beilin District has better development of subject counselling institutions; and Xincheng District has more prominent development of art training.

(2) Dominated by a multi-centre agglomeration structure, with significant differences in the spatial agglomeration patterns of different types

The distribution of various types of shadow education institutions in Xi'an presents a multi-centre agglomeration distribution pattern of different forms (Figure 3). The core density of each type of institution shows that: arts and sports training institutions in each district show a large range of "face + point" "multi-core, multi-agglomeration" distribution characteristics, agglomeration of cores in succession, forming a larger scale agglomeration area; and vocational training institutions only to Taiyi Road-Dongguan South Street in Beilin District and Changle Street and Zhongshanmen Street in Xincheng District are the main clustering areas, and there are no obvious density cores in the other four districts,

presenting an obvious tri-polarised spatial distribution structure; art training institutions have density cores in the central three urban districts and Baqiao District; and curricular counselling institutions have density cores in the distribution of five districts, except Baqiao District, but the performance of the arts and sports and curricular categories is relatively balanced, with a relatively low density core in the centre. However, the performance of the arts and sports and curriculum categories is relatively balanced, falling between the early childhood care and vocational training categories. This indicates that, relative to the overall distribution of the city, the more basic and universal social education needs are in line with society's need to improve the overall quality of individuals, the more balanced and connected the multi-centre layout is, and the more comprehensive and special social education needs are, the more single-centre and isolated the layout is, for example, accounting, taxation, computer programming, medical exams, civil service exams, further education exams, adult self-tests, and career guidance, Study abroad and language training, and vocational skills education and training are relatively special and professional, and their relatively dispersed service targets for the whole city make their spatial layout poorly balanced.

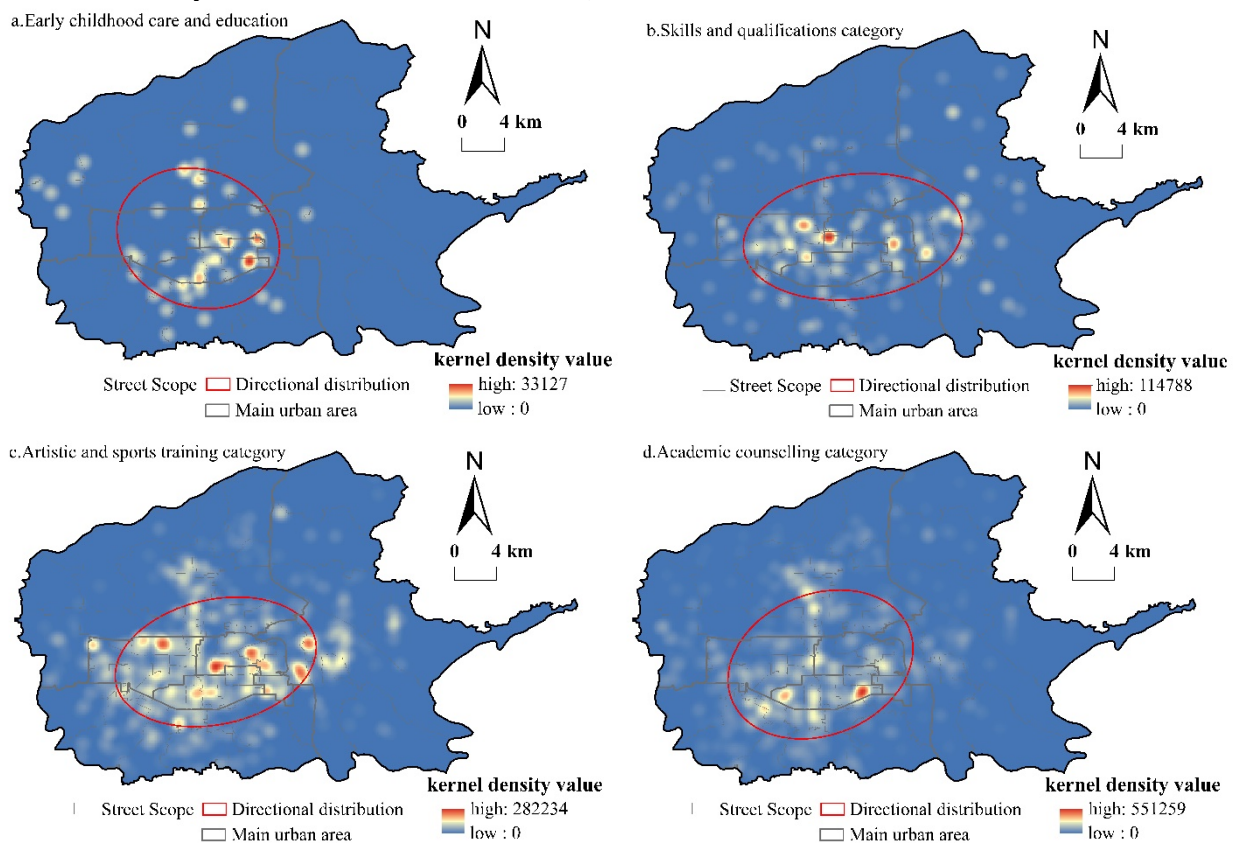


Figure 3. Map of spatial distribution kernel density and direction of different types of shadow educational institutions

According to the contents of the shadow education institutions, the shadow education institutions for primary and secondary school students are divided into four categories: subject tutoring, arts and sports training, child care and vocational skills, and the kernel density and spatial autocorrelation analyses are conducted for each of the four categories of shadow education institutions. According to Figure 3, all four types of shadow educational institutions show obvious agglomeration distribution, but there are obvious spatial differences in the agglomeration

characteristics of different types of shadow educational institutions. The subject tutoring category has scattered clustering cores in Beilin, Yanta, Weiyang, Xincheng, and Lianhu Districts, and has the highest degree of clustering and a large clustering area in Beilin District, while Baqiao District has the lowest degree of clustering, and does not even have any clustering cores; the arts and sports training category also has scattered clustering cores in all urban areas, with more clustering cores than subject tutoring, and there is a clear tendency for the continuous distribution of clusters in the

central three urban areas, especially in In the new urban areas, there is a clear trend of continuous distribution of agglomerations in the three central urban areas, especially in the new urban areas; the agglomeration cores of the childcare category are mainly located in the Lianhu, Xincheng, and Baqiao districts; there are a small number of dispersed agglomeration cores in the Beilin district; there are a small number of agglomeration cores but no agglomeration cores in the Yanta and Weiyang districts; and there are scattered agglomeration cores of the skills and vocational training category in the Beilin, Xincheng, and Weiyang districts, which are roughly along the central axis of the central urban areas. Baqiao and Lianhu districts have fewer centres.

6. Formation of the Shadow Educational Field and its Influencing Factors

6.1. Selection of Impact Factor Indicators

The study of industrial agglomeration and the factors affecting it is a much-discussed topic among geographers, involving various types of enterprises [29], retail [30], manufacturing [31], and many other aspects. In terms of the consumer service industry, there are many scholars exploring its spatial agglomeration characteristics in terms of B&B [32], real estate agency [33], public service facilities [34], and office space [35], etc., and they believe that the population, income, information technology level, rent, and the degree of pollution are the most significant factors influencing the agglomeration of the consumer service industry. Combined with the research object of this paper, school grade, house price, distance to metro station, number of bus stops, road density, age-appropriate population density, and peer industry agglomeration are selected as independent variables and estimated using multiple linear regression analysis. First of all, we construct a cell grid with a size of 600m×600m according to its actual area and operability in the six districts of the main city of Xi'an, take the number of primary and secondary shadow education institutions in the grid as the dependent variable, and connect each independent variable with the grid, and carry out the multivariate linear regression analysis with the unit of the cell grid to find out what factors have a significant impact on the spatial agglomeration of primary and secondary shadow education institutions.

Bourdieu gives a broad definition of capital, meaning a

force embedded in the structure of an object or subject, the fruit of accumulated labour, including economic capital, social capital, cultural capital and other forms. Economic capital can be understood as money and financial wealth; social capital refers to capital acquired through social networks or group relations; and cultural capital refers to the appropriation of cultural resources. The various types of capital can flow and transform into each other, and the total value of the capital determines the position of the actor in the field. Actors determine their position in the field domain by acquiring capital; conversely, their position determines their pursuit of capital differently [21]. Based on this theory, in this paper, the six built-up districts of Xi'an were divided into 500*500 grids through Arcgis 10.2, and each grid was taken as a unit to count the number of shadow educational institutions distributed, and the GeographicalDetector was applied to the explanatory power of the influence factors of the shadow educational institutions as a whole in the main urban area and the four types of shadow educational institutions, respectively. The exploration was carried out. This is done by measuring the shadow educational institution accessibility (X1), shadow educational institution size (X2), peer clustering (X3), number of bus stops (X4), distance to metro station (X5) road density (X6), population density (X7), school grade (X8), number of libraries (X9), number of bookstores (X10), per capita educational attainment (X11), neighbourhood house price (X12), and number of large shopping malls (X13). X12 and the number of large shopping malls (X13) are divided into 5 levels by the natural breakpoint method of ArcGIS tool, and the shadow educational institutions' accessibility is graded separately as 9 levels considering the large gap in their data for a more precise exploration of their influence. In order to eliminate the influence of shadow education institutions and mainstream education institutions on the measurement accuracy due to different scale sizes, according to the eye of the sky and the public review website, the shadow education institutions are divided into three levels according to the number of different outlets, such as (Table 3). For mainstream school education according to its teaching quality and the list of provincial model schools in the past years, secondary schools and primary schools are each divided into five levels. The natural breakpoint grading was then performed separately to obtain the final result of the discretisation process required by the geodetector.

Table 1. Indicator system of influencing factors of shadow educational institutions

Primary Indicator	Secondary Indicator	Variable Explanation:
Habit	X1 Accessibility	Residential accessibility score to high quality shadow providers within the cell grid
	X2 Institutional level	Grade of counselling institutions in the cell network
	X3 Peer agglomeration	Z-value of local autocorrelation of educational counselling institutions within the cell grid
Social Capital	X4 Bus stop distance	Number of bus stops in the cellular grid
	X5 Distance to metro stations	Distance of unit grid centre from metro station
	X6 Density of roads	Density of roads in the cell grid
	X7 Population density	Density of school-age population in the cell grid
Cultural Capital	X8 School level	Level of schools in the cellular grid
	X9 Number of libraries	Number of libraries in the cellular grid
	X10 Educational attainment per capita	Population with a university (i.e., college and above) level of education in the cell grid (persons/100,000)
	X10 Number of bookshops	Number of bookshops in the cell network
Economic Capital	X11 Subdivision house price	Housing prices within the cell grid
	X12 Number of large shopping centres	Number of large shopping centres in the cellular grid

6.2. Analysis of Factor Results

The q-value in the geographic detection results indicates the degree of explanation of the independent variable X on attribute Y. The larger the q-value, the stronger the

explanatory power of the X variable on Y, and vice versa, the weaker, the model detection results are shown in (Table 4). The p-value of the detection results of the 12 influencing factors in this paper are all 0, indicating that they are all significantly correlated, and the detection results show that:

Table 2. Interactive detection results of shadow education influencing factors.

	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	x11	x12
x1	0.699											
x2	0.870	0.815										
x3	0.778	0.846	0.461									
x4	0.778	0.848	0.539	0.289								
x5	0.743	0.831	0.497	0.342	0.078							
x6	0.759	0.843	0.491	0.342	0.120	0.016						
x7	0.755	0.842	0.516	0.356	0.250	0.139	0.112					
x8	0.737	0.831	0.486	0.317	0.106	0.051	0.139	0.025				
x9	0.723	0.831	0.472	0.311	0.106	0.047	0.148	0.048	0.017			
x10	0.740	0.835	0.500	0.318	0.127	0.070	0.129	0.068	0.050	0.037		
x11	0.738	0.830	0.534	0.322	0.159	0.107	0.158	0.099	0.096	0.107	0.076	
x12	0.740	0.819	0.498	0.319	0.108	0.033	0.130	0.039	0.031	0.056	0.100	0.015

(1) Habits, economic capital and cultural capital are the main factors influencing the spatial agglomeration layout of shadow educational institutions, while factors such as social capital have a weaker impact on them. Specifically, shadow education institutions are of different types, with different market positioning and location requirements, and thus their choice of spatial layout has great differences. Habits determine, to a certain extent, the tendency of actors in the shadow education field, i.e. the audience of shadow education, to participate in shadow education. Regions with strong habits have a greater willingness and demand to participate in shadow education, generating a large number of students and thus attracting a large concentration of institutions. Economic capital also has a significant effect on the location choice of shadow education institutions, indicating that the layout of shadow education institutions, as a consumer service industry, is still highly dependent on the business service environment despite its educational attributes. Areas with high cultural capital in the main city of Xi'an are also areas where shadow education is clustered. Areas with high cultural capital have a high level of education per capita and a strong cultural atmosphere, and the higher the parents' expectations for their children's education. 1) In the habits, the effect of shadow education institution size and peer agglomeration on the spatial agglomeration of shadow education institutions is significantly positive, and is the primary factor influencing the spatial distribution of shadow education institutions, with an explanatory power as high as 39.20% and 26.70%, which is greater than other variables, indicating that agglomeration benefit is the most prominent factor contributing to the agglomeration of shadow education institutions. This may be due to the fact that large shadow education institutions are more attractive to the audience, leading to more shadow education institutions clustering here in pursuit of agglomeration benefits, while the clustering of many shadow education institutions can also make parents feel that there is a rich variety and more convenient for picking up and dropping off, thus attracting students, and the increase in the number of students can further attract other related educational counselling institutions to enter, forming a local agglomeration.

(2) The role of various influencing factors varies with the

type of shadow educational institutions. Habits have the primary influence on the skills and vocational qualifications type of shadow education institutions. 1) in which the influence of peer agglomeration and the size of institutions on the spatial distribution of skills and vocational qualifications type of institutions is higher than its factors, which is because the service targets of this type of shadow education institutions are biased towards social groups, and the examination of qualifications and certificates require higher immediate effects of tuition, so they are more in pursuit of the institutions' multi-selectivity as well as brand benefits, and thus consumers are more inclined to choose shadow education institutions that have Diversified choice of shadow education institutions cluster, as well as large educational institutions with a high brand reputation. 2) Habits and economic capital of early childhood care institutions have a significant impact, in which high-grade residential areas and shadow educational institutions on residential accessibility to the spatial distribution of shadow educational institutions of early childhood care higher than other factors, this is due to the age of the service users, service security requirements, the site should be close to residential areas, high accessibility, and thus easy to pick up and drop off, paid service costs are high, the layout of high-grade residential areas can be used to expand the effective student population, but also convenient for families The cost of paid services is high, and the layout of high-grade residential areas can not only expand the effective source of students, but also facilitate the pick-up and drop-off of families. 3) The influence of economic capital and habit on the distribution of shadow education institutions in the arts and sports training category is significantly higher than that of other factors, especially the size of the institutions, the agglomeration of the same industry, and the prosperity of commercial services and high-priced residential areas in the economic capital in the habit, which is because the shadow education institutions of this category have the characteristics of the specificity of the place and space, the preference of the audience, and the high-end nature of the service, which makes their paid services more expensive and the student source more dispersed, and the student source more dispersed. Higher costs and dispersed student sources make them more

inclined to be located in commercial areas with busy business services. 4) The explanatory power of habits and cultural capital on subject tutoring shadow educational institutions is significant, because the service targets of such shadow educational institutions are students in compulsory education, which indicates that such institutions effectively make up for the shortcomings of school education, and the layout near mainstream educational institutions can absorb as many school students as possible, and at the same time can share the educational environment of mainstream educational institutions and their convenient transportation, such as a large number of shadow educational institutions distributed along schools, especially those located in busy commercial areas, and thus more inclined to the layout of busy business districts. The distribution of educational institutions along the school distribution, especially around the "famous school", is the core area of the field of shadow educational institutions, in order to share the symbolic connotation of the famous school, and the higher cultural capital of the region for the children's education to hold higher expectations, manifested in the habit of more inclined to send their children to participate in the shadow education.

7. Conclusion and Discussion

7.1. Conclusion

(1) Using the kernel density analysis, standard deviation ellipse and average nearest neighbour calculation method, it can be seen that the shadow education field constitutes the carrier of the elements of the shadow education field - the shadow education institutions, and the shadow education field in the main urban area of Xi'an city shows the characteristics of the core area - core edge area - periphery of the circled field of the field of heterogeneity, i.e., around Xi'an ancient city and the second ring road to form a high-aggregation. That is to say, a highly aggregated core area is formed around the ancient city of Xi'an and between the Second Ring Road and the Third Ring Road, and between the Second Ring Road and the Third Ring Road is the edge area of the core area, and then the shadow education field is decreasing, which is basically the same as the distribution pattern of the shadow education nucleus density of the "multiple cores" of the "inner density and outer sparseness". Not only that, the structure of shadow education agglomeration centre-periphery is the most significant, and the spatial agglomeration is outstanding, which is most typical of the core areas of Lianhu, Beilin and the new city.

(2) There are significant differences in the clustering characteristics of different types of shadow education sub-fields. Shadow education in Xi'an has the largest number of shadow education institutions in the quality enhancement category, and there are obvious differences in the type structure of each district, and each type of shadow education institution in each district is dominated by a multi-centre agglomeration structure, with significant differences in the spatial agglomeration patterns of different types. For example, arts and sports training institutions in all districts show a wide range of "face + point" distribution characteristics of "multi-core, multi-aggregation"; while vocational training institutions are only located in Beilin District, Taiyi Road - Dongguan South Street, and the new city district, Changle Street, Zhongshanmen Street, and Changle Street. Changle Street and Zhongshanmen Street are the main agglomeration areas, and there is no obvious density core in the other four

districts, presenting an obvious tri-polarised spatial distribution structure; however, the performance of the arts and sports category and the curriculum category is relatively balanced.

(3) Due to the different types of shadow education institutions, their market positioning and location requirements are different, thus their choice of spatial layout has great differences. From the results of the influencing factors, habits, economic capital and cultural capital are the main factors influencing the spatial agglomeration layout of shadow educational institutions, while factors such as social capital have a weaker influence on them.

(4) The role of various influencing factors varies according to the types of shadow educational institutions. For example, habits have a primary impact on the skills and vocational qualifications of shadow education institutions, in which the impact of peer agglomeration and the size of institutions on the spatial distribution of skills and vocational qualifications is higher than its factors; habits and economic capital of early childhood hosting institutions have a significant impact, in which high-grade residential areas and shadow education institutions and residential accessibility to the spatial distribution of early childhood hosting institutions is higher than the impact of other factors; business and service environment type of economic capital. The influence of habits and inertia on the distribution of shadow education institutions in the arts and sports training category is significantly higher than that of other factors, especially the size of the institutions and the agglomeration of the same industry in the habits, as well as the business and service prosperity factor and the high-priced residential area in the economic capital; since the shadow education institutions make up for the shortcomings of the school education for the compulsory education stage students, the explanatory power of the habits and the cultural capital on the subject tutoring category of the shadow education institutions is significant.

7.2. Discussion

(1) The field theory can effectively reveal the spatial dynamics of the supply and demand subjects of shadow education, the spatial behaviour of the site selection of teaching venues and its spatial sociality, which not only portrays the multidimensionality of economic, cultural and social capital of the shadow education field, but also embodies the spatial heterogeneity of the multiple scales, which enriches, to a certain extent, the understanding of the regularities in the spatial heterogeneity of the shadow education, and also indicates that the cross integration research through sociology, education and geography is more conducive to the overall understanding of the phenomenon of human geography. It also indicates that the cross-fertilisation of research through sociology, education and geography is more conducive to the holistic understanding of human geography phenomena. However, there is still room for further improvement and enhancement of the shadow education field constructed on the basis of the interaction logic between social space and geographic space of the field, mainly because the field is a complex social concept, a theoretical tool for recognising the regularity of social space without a clear spatial scope, and characterising the field without a clear spatial scope with a clear spatially scoped geographic space is a difficult problem worth exploring in itself, particularly for the spatialised understanding of social capital is difficult to quantify and spatialise the

individual social relationship networks based on class differentiation and cultural consumption differences in addition to the external accessibility function of the transport network [22], which is worthy of further thought and exploration.

(2) This study uses big data to explore the spatial differentiation of shadow education, which has been growing rapidly in recent years, from a field perspective, but the formation and development of the shadow education field and its spatial differentiation process are comprehensive and complex. Under the current market-driven educational involution and class differentiation and the "double reduction" policy regulation, the spatial differentiation of shadow education helps to form the pressure of "improving quality and efficiency" on the market of off-campus training of good and bad quality on the one hand, and promotes the standardisation of the training institutions and the advanced operation and management on the other. Management. On the other hand, shadow education accelerates the process of cultural reproduction and social reproduction of the dominant social classes, reduces the competitiveness of low-income groups in the field of education, and promotes the marginalisation of low-income classes, which is not conducive to the realisation of educational equity [23]. In the face of the complex social problems exposed by the spatial differentiation of shadow education, we should actively take the advantage of educational resources agglomeration formed by the spatial differentiation of shadow education and the market order of the teaching and training industry as the endogenous driving force for the reconstruction of the formalisation of shadow education, and correctly guide the society to pay attention to the all-round development of the students and improve the concept of talent cultivation, so as to combine the blocking and blocking of obstacles, and to promote the effectiveness of the governance of shadow education.

(3) This study only takes the main city of Xi'an as a case study, and quantitatively recognises the spatial differentiation characteristics of urban shadow education under the plain terrain. It should be said that the spatial distribution characteristics of cities with different urban forms, urban natures, urban scales, and stages of development are inevitably different, and the future should take the inter-city differences into account, explore the common and different characteristics of the spatial differentiation laws of shadow education among different cities, and form a spatial differentiation law with common significance. The future should fully consider the differences between cities and explore the common and different characteristics of the spatial differentiation law of shadow education among different cities, so as to form a spatial differentiation law with common meaning. In addition, because the POI data obtained in this study are cross-sectional data, only static spatial analyses are conducted, and the dynamic understanding of spatial differentiation in the course of time is lacking. Therefore, the problem of spatial differentiation of shadow education still needs to be further explored, so as to provide theoretical reference for scientific guidance and precise management of shadow education.

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