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The Evolution of the Spatial Patterns of Startup Firms in the Tibet Autonomous Region, China in the 21st Century

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Abstract: It is increasingly recognized by policymakers and the academic community that startup firms play an important role in enhancing national and regional economic competitiveness. Existing studies have focused mainly on developed countries and highly marketed city-regions in developing countries, lacking sufficient attention to underdeveloped regions. The Tibet Autonomous Region (TAR) is the poorest province in post 1949 'New China'. In recent years, the TAR's government has released a series of policies to encourage the establishment and development of startup firms, but understanding how to promote social development and economic growth through the creation and development of startup firms is still a significant issue for the TAR's government. Therefore, taking Tibet as a case area, this article discusses the evolution of the spatial patterns of startup firms in underdeveloped regions in China. The findings include: ① The past two decades have witnessed tremendous growth in the number of startup firms; however, the number and rate of growth are not geographically even. ② In terms of geographical distribution, startup firms in the TAR have concentrated on or around key nodes along major transport corridors (place dependence); however, with the development of transportation infrastructure and development zones, they have also been established in new localities (place creation). ③ Although all subregions of the TAR have spatial agglomerations of startup firms, they are different in agglomeration characteristics. Finally, after acknowledging shortcomings in its research, this article calls for multi-sited research to investigate the diversity of the spatial patterns and dynamics of new firm formation in the underdeveloped regions of China.

Keywords: underdeveloped regions; startup firms; spatial pattern evolution; Tibet; kernel density estimation; Ripley's *L(d)* function

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1. Introduction

It is increasingly acknowledged that the establishment and development of startup firms play essential roles in social stability and economic growth by incubating new industries and business modes, facilitating technology diffusion, stimulating innovative and entrepreneurial spirit, enhancing national and regional competitiveness, increasing employment opportunities leading to a dynamic and resilient economy, and improving material well-being [1,2]. The term 'startup' here refers to a young profit-seeking venture founded by one or more entrepreneurs to develop a product or service that they want to bring to market [3,4]. However, there is a wide variety of studies on this topic that pose the question, "how long is a registered company considered to be young?" Global Entrepreneurship Monitor (GEM) [5] considers that this type of business should be established in less than 3 years. Joachim [6] defines a young firm to at most 10 years old. Some studies focus only on annual business registrations and therefore more on "new firm formation" and "firm entry", instead of the concept of startup firms [7–9]. This article is much more interested in the formation of newly registered firms each year.

In recent decades, many countries from North America through to Europe and Asia have launched ambitious initiatives and taken various measures to promote new businesses [5,10,11]. China is no exception, and the Chinese Central Government has proposed the 'mass entrepreneurship and innovation initiative' (dazong chuangye, wanzhong chuangxin), and has implemented a series of policy measures to stimulate the creation and development of new startups. Alongside governments across the world, the international academic community has paid attention to the phenomena and roles of new firm formation and related issues from the different perspectives of various social sciences disciplines [12–17]. For example, psychologists have focused on startup entrepreneurs' psychological characteristics and startup behaviours [18], and have explored the relative influence of the individual characteristics of entrepreneurs (training and education, family backgrounds, and professional experience) and regional and social factors (e.g., human capital, entrepreneurial environment) on the performance of startups, often using the comparative study of different samples [18–20]. Management scholars have investigated the impact of variation in start-up entrepreneurs' personal relationship networks, management models, and personal experiences on their early performance through case analysis and questionnaire research [21–24].

Using statistical analysis and econometric models (e.g., the regression model, the spatial panel data models, and the instrumental variable (IV) estimator), some economists have examined the impact of the demand-side factors (e.g., economic growth, population size, changes in consumer preferences) and supply-side factors (e.g., labour markets, industrial composition, and the level of technological development) on the spatial patterns of new businesses [25–28]. Influenced by institutional and spatial economics, other economists are highly concerned with why some countries and regions have more entrepreneurial activity than others. In other words, they often have been obsessed with the influences of localized knowledge spillover, national and local institutions, cultural diversity, and other cultural and institutional factors on cross-national and cross-regional differences in new firm formation rates [26,27,29–32]. These studies have enriched the understanding of newly founded firms from various perspectives and have increasingly recognized that the business performance of startups is strongly influenced not only by individual factors but also by broader spatial factors. Against this academic background, the spatial characteristics and spatial patterns of new firm formation have become hotly debated issues.

Economic geographers have been extensively engaged in the discussion of the spatiality of new firm formation by examining their geographical determinants, spatial behaviour, and spatial distribution [33,34]. They have collectively highlighted the roles of local characteristics (i.e., industrial and technological accumulation, regional culture and institutions, transport infrastructure, entrepreneurial ecosystems), and have argued that interregional differences in new firm formation and their determinants are persistent over time (which is termed as 'spatial stickiness' or 'place dependence') [35–38]. Some have used spatial econometrics to estimate the relationship between various spatial factors and the locational choice, spatial agglomeration, and spatial effects of entrepreneurial activities [39]. Inspired by evolutionary economic geography [40], some geographers have employed the key concepts of evolutionary economic geography such as path dependence [36], regional branching [40], spatial stickiness [37], knowledge spillovers [27,41,42], and related variety [43–47], to investigate the spatial evolution and resilience of new firms [48–51]. Other economic geographers have studied the spatial characteristics of entrepreneurial networks by using social network analysis [21].

In short, the existing geographical research on startup firms tend to emphasize the dynamic, cumulative, and social nature of new firm formation and the network of relationships between the structure of production and the institutional settings in which startup firms are embedded [47,52]. However, this research concentrates largely on countries with established market economies and highly marketed city-regions in developing countries [8,33,37,53], with insufficient attention paid to peripheral and underdeveloped regions [54]. The peripheral and underdeveloped regions are characterized by a lower

entrepreneurship rate and a strong dependence on natural resources, and external markets and technologies, since they often lack the basic entrepreneurship-facilitating conditions, including market demand, supporting industries that have technological complementarities and supporting infrastructures (e.g., incubators, education systems and research organizations), and relevant regional actors (e.g., entrepreneurial elites and skilled labour forces), entrepreneurship-oriented policies and business-friendly entrepreneurial ecosystems. For example, the rural is generally the 'entrepreneurial laggard' compared to the urban. In addition to the restrictive factors mentioned above [55], there is evidence that the inappropriate socio-cultural traits of their informal institutional framework make rural areas non-conducive for effective entrepreneurial activity because many policies are replications of measures found in urban areas [56,57]. In order to create new development paths through the formation of new businesses, peripheral and underdeveloped regions have taken measures, including the establishment of development zones and incubator centers, the creation of an effective entrepreneurial ecosystem, and the supply of financial incentive policies. Thus, it is safe to state that establishing and developing new firms is particularly important to creating and forming new development paths, which might produce new development hopes for peripheral and underdeveloped regions. As a result, the article attempts to fill the research gap by analyzing the spatiotemporal persistence and change in startup firms in the Tibet Autonomous Region (TAR).

For many decades considered to be one of the more economically backward provinces since the foundation of 'New China' [49], the TAR has experienced significant economic transformation and spatial reconfiguration since the Western Development Strategy was implemented in 2000. Under the strong support of the Central Government and other provinces of China, the past two decades have seen significant improvements in infrastructure and socio-economic development. The most spectacular among these were mega transport projects, including the 2006 completion of the Qinghai–Tibet Railway (qingzang tielu), which was extended to Shigatse in 2014 and also linked to Nyingchi in 2021. Other eye-catching development projects include various types of development zones. Moreover, since the launch of the 'prosperous borders and wealthy households' project (xingbian fuming gongcheng), the infrastructural conditions in border areas themselves and cross-boundary connectivity have been improved. Besides these physical infrastructures, the TAR also has issued many business-friendly policies to support and encourage entrepreneurial activities. These efforts collectively contributed to a rapid growth in the number of new firms and the reconfiguration of Tibet's economic landscape.

Against this background, this article attempts to bridge the research gap and analyze the spatial pattern of entrepreneurial activities in geographically peripheral and economically underdeveloped regions of China, taking the TAR as a case area. The term 'startup firm' refers to a new enterprise registered in the TAR's Administration of Industry and Commerce (SAIC). The research period is selected as 2000–2018 for the following reasons: Since the Central government implemented the Western Development Strategy in 2000, the infrastructure and socio-economic conditions in Tibet have greatly improved. Before that, there were very few businesses registered in Tibet, and existing businesses were mainly concentrated in Lhasa. Furthermore, our data come from the SAIC which could only provide information up to 2018. Taking into consideration our dataset ranging from 2000 to 2018, the impact of the 'five-year plan' in China and the 'Tibet Work Forum', and the implementation of the Western Development Strategy, this article will examine the evolution of spatial patterns of entrepreneurial activities in four stages (i.e., 2000–2005, 2006–2010, 2011–2015 and 2016–2018). This article uses the relatively popular sequential explanatory design of mixed methods, which is positioned as a principled complementary research method to the traditional quantitative and qualitative research approaches [58]. The sequential explanatory design is characterized by the fact that quantitative data is collected at first, followed by qualitative data collection, with the latter helping to explain the results of the former [59]. The presentation of qualitative and quantitative elements may be carried out separately or in combination [60], with the latter being chosen for this study.

In this paper, the spatial analysis based on the business registration data (i.e., quantitative data) allows us to know where startup firms are clustering, and what the sizes and intensities of their agglomerations are. Then, field visits verify the results of the aforementioned spatial analysis, and in-depth interviews (i.e., qualitative data) help us to understand the reasons for their clustering.

Based on the above review and analysis, this article aims to explain the following issues: Firstly, what is the spatiotemporal distribution of startup firms in Tibet? What geographical characteristics do they demonstrate? Secondly, what are the agglomeration sizes and agglomeration intensities in the subregions of the TAR during different time periods? Thirdly, in the regional context of underdevelopment, what forces dominate the spatial evolution of entrepreneurial activity? The remainder of the article is structured as follows. The next section presents an overview of the natural conditions, socio-economic development, urban hierarchy, and public policies for new firm formation within the TAR, which provides background knowledge for understanding the spatial evolution of startup firms in Tibet. Section 2 describes the data and methodology employed. Section 3 presents the results. Section 4 offers conclusions, discusses limitations, and suggests avenues for further research.

2. Study Area

The TAR is the second-largest province-level administrative unit in China (next to Xinjiang), with a land area of 1228.4 thousand square km (12.8% of the country's total land area). It is located in the southwest frontier of China, adjacent to Qinghai Province and the Xinjiang Uygur Autonomous Region (both are ethnically Muslim-dominated) to the north, the Han-Chinese-dominated provinces of Yunnan, Sichuan, and Gansu to the north, and shares over 4000 km of international boundary with Nepal, India, Myanmar, and Bhutan along the Himalayas to the northwest and southeast (see Figure 1). Thanks to its geographical location, historically, it has been an important gateway to connect Southwest and Northwest China with South Asia and beyond, although the specific trade routes have been constantly relocated due to changing geopolitical and economic environments and natural disasters. Ringed on the southern and western sides by the snowcapped Himalayas, Tibet is located at the world's highest elevation and in the northeastern corner of the Qinghai–Tibet Plateau, known as 'the Third Pole of the Earth' and the 'Roof of the World', with an average altitude of more than 4000 m.

The TAR has been characterized by economic backwardness and poor transport infrastructure for centuries. Under the Central Government's strong support and economic assistance from other provinces of China, Tibet has made significant progress in social and economic development since both market-oriented reforms and the Pairing-up Aid-Tibet program were introduced in succession in the 1980 s and 1990 s. In 2001, the 4th National Work Forum on Tibet put forward the official concept of 'the leapfrog development' of Tibet for the first time and further increased investments from the Central Government and other provinces of China to support Tibetan rapid development. Since then, cross-regional and internal-regional transport infrastructure has improved remarkably, for example, in the operation of the Qinghai–Tibet Railway, the Lhasa–Shigatse Railway, and the Lhasa–Nyingtri Railway, and in the establishment of airports in Lhasa, Chamdo, Nyingtri, Ngari, and Shigatse. The enhanced physical infrastructure and cross-regional connectivity integrated the once-marginalized region into the Chinese and global economy at an unprecedented speed and contributed a lot to socio-economic progress in Tibet. The TAR's regional gross domestic product (GDP) in 2020 exceeded RMB 190 billion, 15 times more than the figure in 2000; its per-capita GDP in 2020 was RMB 52,345, seven times more than its 2000 figure.

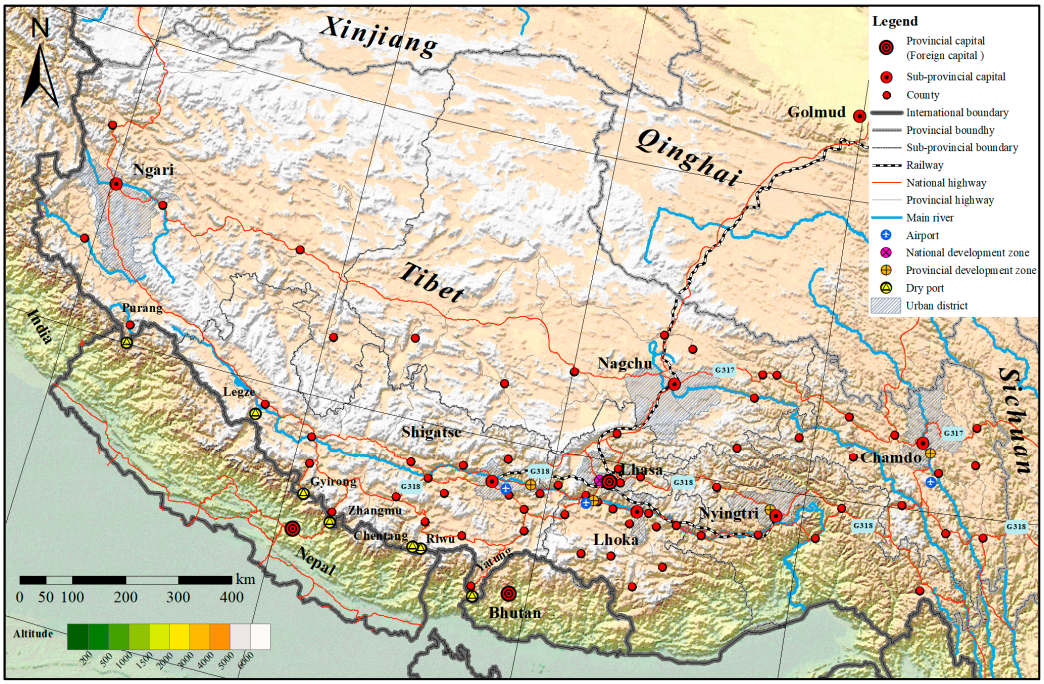

Figure 1. Geographical distribution of major transportation infrastructure, dry ports and development zones in Tibet. Source: Compiled by the authors.

The TAR is divided into seven prefecture-level cities, eight urban districts and sixty-six rural counties. Historically, the TAR has been characterized by a distinct geographical distribution of economic activity, with greater concentrations of activity in the larger urban nodes, particularly in the cities of Lhasa and Shigatse. The former is the political, economic and cultural center of Tibet, while the latter is the second-largest economic center in Tibet. The south and north of the TAR (Ngari, Nagchu) are disadvantaged in terms of infrastructure and natural conditions, which clearly hinder higher levels of entrepreneurship in peripheral regions. According to the 7th Population Census in 2020, the number of Tibetan permanent residents has reached 3.65 million. The resident population in Lhasa was 870,000 and regional GDP reached 67.8 billion RMB, accounting for 23.84% and 35.68%, respectively, of the TAR's total. Shigatse has the second-largest population and economic aggregation in Tibet, with 17% of the TAR's total GDP (32.3 billion RMB) and 21.92% of the TAR's total population (approximately 800 thousand). Chamdo, the east gateway city of Tibet, has 13.32 % of Tibet's GDP (25.3 billion RMB) and 20.82% of the TAR's total population (around 760 thousand). The sizes of the economy and population in Lhoka, Nyingtri, Nagchu and Ngari are relatively smaller, and their shares of GDP in the TAR's total were 11.32%, 10.5%, 9.02% and 3.72%, respectively; their proportions of populations in the TAR's total were 9.59%, 6.58%, 13.70% and 3.28%, respectively.

The historical role of Tibet in bridging the Chinese mainland and South Asia has been emphasized since the belt and road initiative (BRI) was proposed by the Chinese government in 2013. At the 6th National Work Forum on Tibet in 2015, Tibet was officially designated as the 'South Asian Corridor' (nanya datongdao), one crucial passageway for China to open up to South Asia and beyond. Since then, the broader economic integration and infrastructural connectivity (including with domestic neighbour provinces and also with foreign countries) have been reinforced, the construction of development and opening-up platforms has been accelerated, and the entrepreneurial ecosystem has been improved. As a result, the number of new enterprises has increased dramatically, and various types of development zones and industrial parks have been constructed and geographically expanded. For example, the Lhasa Economic and Technological Development Zone (a state-level development zone) established in 2001 has been extended to all districts and counties in the jurisdiction of the Lhasa city, and a batch of new development zones have been

founded in the following years, including the Lhasa Comprehensive Protection Zone (a state-level development zone), the Tibet Airport New Zone, the Shigatse Economic and Technological Development Zone, the Chamdo Economic and Technological Development Zone, and the Nyingtri Economic Development Zones (see Figure 1). The new development zones often provide preferential policies for new firms.

Besides the advances in physical infrastructure (transportation infrastructure and industrial platforms), the TAR government has actively improved soft infrastructure and optimized the entrepreneurial ecosystem under the policy framework of 'the small and medium-sized enterprise (SME) growth project' (zhongxiaoqye chengzhanggongcheng) since the 13th Five-Year-Plan (2016–2020). Under the support of this project, a series of preferential policies for entrepreneurship were issued, many specialized entrepreneurship platforms (e.g., business incubators) have been established across Tibet to host small and micro businesses, and the entrepreneurial ecosystem has been reportedly improved, which has dramatically facilitated startup firm creation.

In history, Tibet was once a vital passageway of the ancient 'Tea and Horse Caravan Road' (also known as the 'Silk Road of Southwest China'), a trade route from the 6th century to the 20th century that started in Southern China, passed through Tibet, Burma, and Nepal, and ended in India [61–64]. In order to strengthen the security and stability of the border areas, the TAR government implemented the 'Prosperous Borders and Wealthy Households' project (xingbian fuming gong-cheng) in the 2010s. Through subsidizing the construction of houses, roads, and communications, the transport and industrial infrastructure in the border areas, particularly in the ports of Gyirong, Zhangmu, Legze, Riwu, and Chentang, were significantly improved, which promoted tourism and trade-related industries. The development of the trade-related economy in turn provided more opportunities to establish new firms in these border areas.

3. Methods and Data Sources

3.1. Kernel Density Estimation

This article takes the locations that startup firms registered in the TAR's Administration for Industry and Commerce as sample points. Placing these points on the map, the dynamic changes in their density can reflect the process of agglomeration and the diffusion of entrepreneurial activity across time and space. Kernel density estimation (KDE) is a classical method in the description of the spatial distribution of sample points. KDE is a mathematical technique to estimate the probability density of random variables [65], and it is often used to depict the phenomenon of spatial agglomeration of social activities such as transportation, criminal activities and industrial distribution. The KDE function has many advantages when compared with other techniques, since it allows for the estimation of the density at any location in the study region, and each location point can be calculated as the distance from each reference cell within the bandwidth. The choice of bandwidth is crucial for density estimation. It is the search radius for the density function. In most cases, researchers need to experiment with different values of the bandwidth to look at the variation of the density function at different scales. The general form of the KDE is given as:

$$f(x) = \frac{1}{nh} \sum_{i=1}^{n} K\left(\frac{x - xi}{h}\right) \quad (1)$$

where n refers to the number of startup firms; K is the spatial weight function, generally the range attenuation function; h refers to the bandwidth; and $x - xi$ represents the distance from the estimation point x to the sample xi. Here, h is the default bandwidth for ArcGIS 10.8 version, which is obtained by dividing the minimum width or length of the analyzed data layer by 30.

3.2. Ripley's L(d) Function

Geographic patterns of event location data (the locations of all new firms in Tibet for this study) are scale-dependent and their characteristics may change across spatial

scales [66]. That is, they show a clustered pattern at small scales, but they might be dispersed at larger scales. Various statistical methods have been developed to conduct cluster analysis and address the above problem on scale-dependency. Among them, Ripley's *L(d)* function is one of the most popular for three principal advantages: the level of measurement, the scale of analysis, and the properties of complete spatial randomness (CSR) [67]. The *L*-function is derived from the *K*-function [67,68]. Ripley's *K(d)* function, originally developed by Ripley in 1976, is a way to analyze the distribution pattern of sample points at any spatial scale. The *L*-function is used to keep the variance stable of the *K*-function and also simplify interpretation [69]. Consequently, this article uses Ripley's *L(d)* function to identify whether the startup firms in Tibet have regular, random, or clustered patterns, and to quantify and assess their agglomeration sizes and agglomeration intensities at different spatial scales during the different periods. The formula of Ripley's *L(d)* function is given as:

$$K(d) = \mathrm{A} \sum_{i=1}^{n} \sum_{j=1}^{n} \frac{w_{ij}(d)}{n^2} \tag{2}$$

$$i,\ j = 1, 2, \ldots,\ n;\ I \neq j,\ d_{ij} \leq d,\ w_{ij}(d) = \begin{cases} 1(d_{ij} \leq d) \\ 0(d_{ij} > d) \end{cases}$$

$$L(d) = \sqrt{\frac{K(d)}{\pi}} - d \tag{3}$$

where A is the area of a study region; n is the number of the startup firms; d is the Euclidean distance; d_{ij} is the distance between firm i and firm j; and $w_{ij}(d)$ is the weight between point i and point j; it equals 1 when the distance between point i and point j is less than or equal to d, otherwise it equals 0. The value range of the *L*-function is $[-\infty,+\infty]$. $L(d) = 0$ indicates a random pattern. If *L(d)* is greater than zero at a certain scale, it indicates a clustered pattern at that scale. If *L(d)* is less than zero at a scale, it indicated a uniform pattern. In this article, *L(d)* are calculated through CrimeStat 4.02 (a spatial statistics program for the analysis of location data). *L(d)*max and *L(d)*min are generated by using a Monte Carlo method (a mathematical technique developed by John von Neumann and Stanislaw Ulam to estimate the possible outcomes of an uncertain event) with 99 simulation tests, i.e., the confidence interval of *L(d)*. The *L*-function analysis is applied to the results of these simulations to derive a wide range of *L*-function values, from which confidence intervals around the observed *L*-function values can be obtained. When the distribution pattern is clustered, the information on intensity and scale can be obtained. The first peak of *L(d)* can be used to measure the intensity of clustering and the corresponding d can be used to measure the clustering size.

3.3. Qualitative Research

The spatial analysis methods we used in the article help quantify the spatial patterns of startup firms in the TAR. However, they are insufficient to fully reveal the mechanisms driving their changes over time. Hence, this article also draws on the materials and interview data derived from multiple rounds of fieldwork in the TAR conducted in July and August 2020 and from May to November 2021. The fieldworks consist of three parts, involving round-table discussions (three to four hours in length), semi-structured interviews, and informal discussions and site visits.

Part 1, in July and August 2020, involved two extended round-table discussions with senior officials of the TAR and seven prefectural-level governments in charge of macroeconomic planning, industrial development, trade, tourism, transport, and foreign affairs. Discussion themes included social and economic development in the TAR since the Western Region Development Strategy was implemented in 2000, the changing role of the opening-up policy, the aid from the Central Government and other provinces of China, key development projects (transport infrastructure and development zones, business

incubators) in new firm formation, as well as the regional policies concerning startup firms and their spatial consequences.

Part 2, from May to July 2021, included multiple visits to key project sites primarily in Lhasa, Shigatse, Nyingtri and Lhoka, and semi-structured and informal interviews in the above-mentioned areas. In between these site visits, face-to-face interviews and round-table meetings were conducted with local government officials and the senior managers of key development projects. Moreover, in Lhasa, six semi-structured interviews were conducted with local senior scholars from Tibet University and the Tibetan Academy of Social Sciences, two state-sponsored think tanks to further explore the influences of regional entrepreneurship policy and development projects on the locations of startup firms.

Part 3 comprised interviews with 31 enterprises (12 in Lhasa, 6 in Nyingtri, 7 in Lhoka, and 6 in Shigatse). The senior managers or owners of these enterprises were interviewed to understand their entrepreneurial experiences and the rationales behind the locational choice of their ventures. These interviews generally lasted for two hours. Mandarin was used for interviews and discussions because all interviewees, even ethically Tibetan, can understand and speak it very well.

3.4. Data Source

Our data are obtained from the National Enterprise Credit Information Publicity System compiled by China's State Administration of Industry and Commerce (SAIC) from 2000 to 2018. The dataset is the most comprehensive data source on general information about business registration within China and contains extensive information on enterprise names, registration times, registration addresses, business scopes, and registered capital. The latitudes and longitudes of all enterprises in the TAR can be determined based on the names and addresses. The geographical locations of all enterprises in the TAR were geocoded by latitude and longitude obtained through the Gaode Map API (application programming interface) based on their registration addresses. In total, our study contains more than 372,894 firms registered within the TAR from 2000 to 2018. Since the SAIC data do not provide the exact information on industry affiliation, this article focuses on the geographical dimension of new firm formation in the TAR, without considering their industrial dimensions.

4. Results

4.1. Overall View of the Startup Firms in the TAR

From Figure 2 and Table 1, the number of new firms in the TAR has grown rapidly since 2000, with the exception of a few years. Of particular note is that the beginning of the 2010s (the 12th and 13th Five-Year-Plan) was a period of high growth rate. Regarding regional distribution, the seven prefecture-level municipalities exhibited marked spatial variations in new firm formation, with the cities of Lhasa and Shigatse being more entrepreneurial than the rest of the TAR. Taking major political–economic events and the quantitative changes of the startup firms into consideration, the development process of entrepreneurial activities in the TAR is divided into four periods.

The first period (2000–2005): This period witnessed a steady increase in the absolute number of newly registered enterprises, where they were concentrated mainly in Lhasa. The total number of startup firms in the TAR was 2402 in 2000 and grew to 3291 in 2005, while the number of startup firms in Lhasa increased from 2105 in 2000 to 1897 in 2005. Although the share of the startup firms in Lhasa in the TAR's total declined from 87.64% in 2000 to 57.64% in 2005, the absolute number of startup firms doubled. After the 4th National Work Forum on Tibet (in 2001) proposed the official concept of 'the leapfrog development' of Tibet for the first time, the Central Government provided increased assistance to improve infrastructure (e.g., transportation, energy, and other public facilities) in Tibet. The improved infrastructure not only ignited the entrepreneurial enthusiasm of local people, but also attracted entrepreneurs from other regions of China to open businesses in Tibet.

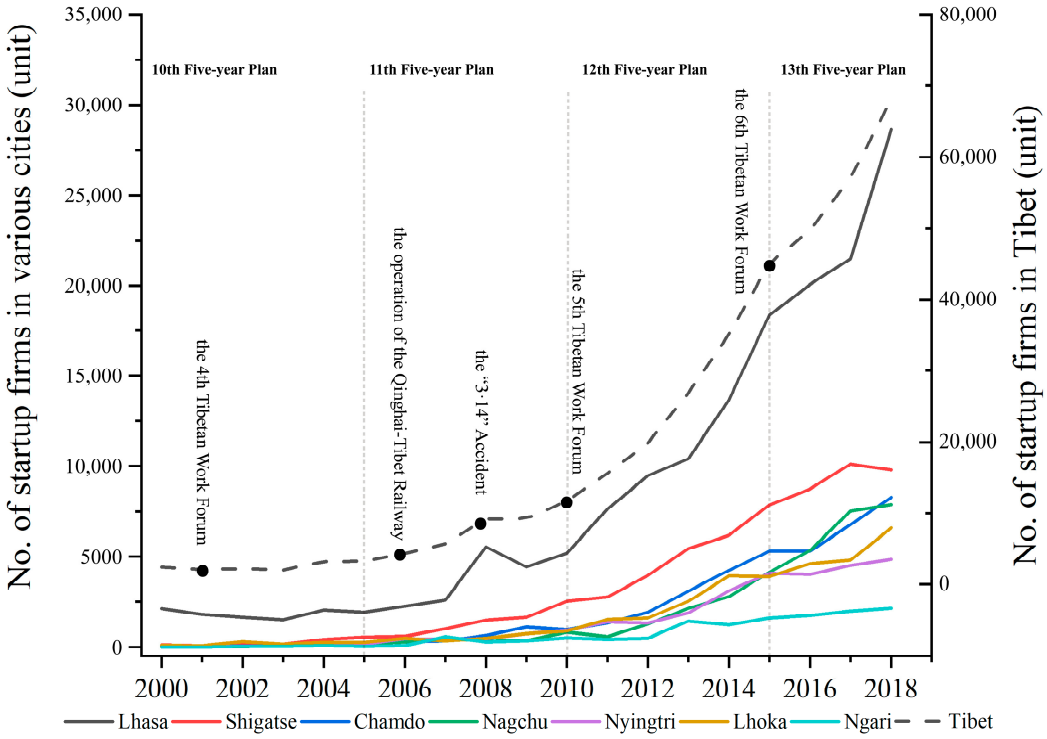

Figure 2. The changes in the number of the new firms in the TAR from 2000 to 2018.

Table 1. The number of the new firms in the prefectural and municipals and their shares in the TAR from 2000 to 2018.

City	In 2000		In 2005		In 2010		In 2015		In 2018	
	No. (unit)	%	No. (unit)	%	No. (unit)	%	No. (unit)	%	No. (unit)	%
Lhasa	2105	87.64	1897	57.64	5189	44.26	18,358	40.67	28,621	42.05
Shigatse	114	4.75	534	16.23	2535	21.62	7850	17.39	9789	14.38
Chamdo	17	0.71	209	6.35	943	8.04	5303	11.75	8265	12.14
Nagchu	46	1.92	184	5.59	801	6.83	4112	9.11	7872	11.57
Nyingtri	17	0.71	154	4.68	906	7.73	4056	8.99	4833	7.10
Lhoka	98	4.08	266	8.08	858	7.32	3870	8.57	6563	9.64
Ngari	5	0.21	47	1.43	493	4.20	1586	3.51	2120	3.11
Total	2402	100	3291	100	11,725	100	45,135	100	68,063	100

The second period (2006–2010): The 1992–2000 period witnessed ups and downs in the number of startup firms in the TAR, with Lhasa being the most affected area. In 2010, the number of newly registered enterprises in the TAR was 11,725, while the figures for Lhasa and Shigatse were 5189 and 2535, respectively, accounting for 44.26% and 21.62%. Since the operation of the Qinghai–Tibet Railway in 2006, the strengthened links between the TAR and mainland China in terms of population mobility and economic exchanges have provided opportunities for local and non-local people to operate new businesses in Tibet. However, the high-profile political unrest in Lhasa in March 2008 negatively impacted the entrepreneurial activities in Tibet, particularly in Lhasa.

The third period (2011–2015): The 2011–2015 period was characterized by a steady increase in the number of new firms in the TAR and its seven cities. In 2015, there were 45,135 enterprises registered in the TAR, with an increase of 2.8 times compared to 2010. Moreover, this period witnessed rapid growth in the number of startups in all cities, albeit at varying rates. The number of the newly registered enterprises in Lhasa climbed from 5189 (in 2011) up to 18,358 (in 2015), a 2.5-fold increase; however, its share in the TAR fell from 44.26% to 40.67%. The number of the new firms registered in Shigatse grew from 2535 to 7850, while its share fell by 4.23%; The number of the new startups in Chamdo increased by 4.6 times, from 943 to 5303. Since the 5th National Work Forum on Tibet (in 2015), increased

economic aid has been invested into the TAR to develop social undertakings, industries and infrastructures. During the 12th Five-Year Plan period (2011–2015), investment in projects at and below the county-level accounted for 61.31% of the aid funding for the TAR. Meanwhile, under the SME Growth project, the local governments accelerated the cultivation of industrial parks and approved the establishment of several provincial-level development zones. According to interviews with the government officials from the Commerce Department of the TAR, the development of these transport infrastructures and development zones and the implementation of the SME Growth project have contributed a lot to the increase in the number of startup firms.

The fourth period (2016–2018): The period witnessed a continuous increase in the number of startup firms in the TAR and its prefecture-level cities. The number of new firms registered in the TAR reached 68,063 in 2018, an increase of 22,928 over 2015. At the same time, the number of startup firms in these prefecture-level cities grew unevenly. The shares of Lhasa and Nagchu increased by 1.38% and 2.46%, respectively, while the shares of Shigatse, Nyingtri and Ngari decreased by 3.01%, 1.89% and 0.4%, respectively. After the 6th National Work Forum on Tibet (2015) put forward the development strategy of 'South Asia corridor 'as part of the Belt and Road Initiative (BRI), the Tibetan government proposed the 'Three-hour Economic Circle centered around Lhasa', and further strengthened the economic status of the city of Lhasa in the whole of Tibet. Therefore, the share of its startup firms in the TAR continued to increase.

4.2. Changes in the Spatial Patterns of the Startup Firms at the TAR Level

As shown in Figure 3, the spatial pattern of the startup firms at the TAR level exhibits three main characteristics. Firstly, all municipalities tended to spread from the central areas to the peripheral areas to varying degrees, amongst which Lhasa and Shigatse are the most remarkable. This spatial diffusion trend reflects, to some extent, the fact that the spatial structure of the municipalities spread outwards as their urban economies continue to grow. Secondly, the economic circle centered around the three cities of Lhoka, Lhasa and Shigatse has long been the center of the startup firms in the TAR. This shows that Lhasa and Shigatse as two important economic centers in the TAR have strong agglomeration effects, indicating the path-dependent nature of entrepreneurial activities in Lhasa and Shigatse, two historical economic centers in the TAR. Thirdly, with the improvement in the physical linkage of Tibet with neighbouring countries and also with domestic parts of China, the border areas and eastern Tibet are growing into new agglomeration areas of the new firm creation. Further detail is provided below.

The first stage (2000–2005): the newly registered enterprises were mainly located in the central urban district or core county of each municipality, but with various degrees of geographical concentration. The central urban district or rural county is often the municipality's administrative center. Lhasa is the capital city and an economic center of the TAR, Shigatse is the second largest economic center, Chamdo is the 'East Gate' to Sichuan province, and Nyingtri is a historical important hub of the ancient 'Tea Horse Road' linking Tibet and South Asia. Thus, the central urban districts in these four cities were the main territorial concentrations of its population and economy. Concretely speaking, the new newly registered enterprises were concentrated mainly in the central districts and counties of Lhasa and Shigatse, followed by Chamdo and Nyingtri. This viewpoint was confirmed by our onsite observations in Lhasa, Shigatse, Chamdo and Nyingtri.

The second stage (2006–2010): The geography of the new firms spread outwards from the central districts or counties, particularly Lhasa, Shigatse, Lhoka and Chamdo. According to the interviews with the senior officials from the Transport Department of the TAR, with the development of the Lhasa Economic Development Zone and the opening of the Qinghai–Tibet Railway, the newly registered enterprises trended to expand from the 'old' urban area to the newly established spaces such as the Lhasa Economic Development Zone and the new urban sub-center (Liuwu New District). Similarly, the improved intra-

city transport infrastructure facilitated the suburbanization of the new establishments in other cities such as Lhoka and Chamdo.

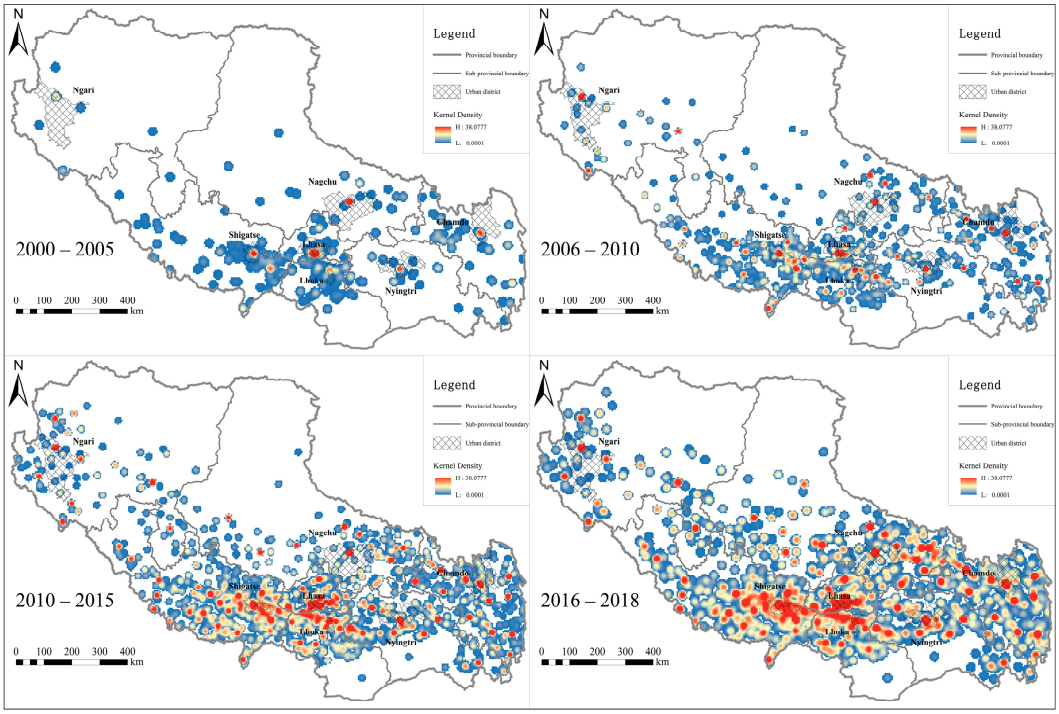

Figure 3. The kernel density of the startup firms in the TAR at different periods.

The third stage (2011–2015): There were three main features in relation to the changes in the spatial patterns of the newly registered enterprises. Firstly, since the transport integration between Lhoka, Lhasa and Shigatse accelerated, the startup firms in these cities spread gradually along important transport routes (e.g., the national highway of G318), and two major clusters of the new firms emerged (Lhasa- Lhoka Area and Shigatse Area). Secondly, with the improvement of cross-regional transport infrastructure and the increasing openness of the border areas, the counties in Chamdo bordering Sichuan and Yunnan and the border counties in Shigatse particularly bordering India became new emerging agglomeration areas. Thirdly, since the infrastructure and business environment in rural counties had been effectively improved, an increasing number of new startup firms began to be registered in rural counties.

The fourth stage (2016–2018): There were three significant new trends. Firstly, the newly registered enterprises were further clustered along the national highway of G318, which is attributed to a large extent to the advance in the Lhasa-centered transport network construction. Secondly, the areas along the national highway of G317 became an emerging region for startup firm creation in the TAR, due to the rise in the administrative hierarchy and aid funding into Chamdo. Thirdly, with the implementation of the 'South Asian Corridor' strategy and the development of the well-off border villages, an increasing number of entrepreneurs have started their own businesses in the border areas of Shigatse.

4.3. Changes in the Scales and Intensities of the Start Firm Agglomerations in Prefecture-Level Cities

In order to evaluate the geographic concentration of the newly registered enterprises in Tibet more precisely at different spatial scales, Ripley's *L(d)* function is used in this article. The *L(d)* values of all municipalities in Tibet are greater than 0 in most years, indicating that the startup firms in every municipality of the TAR exhibited the clustered pattern (Figure 4 and Table 2). Concretely speaking, all *L(d)* values were greater than 0 and higher than the *L(d)*max of the random distribution simulation at the 99% confidence level, except

for Chamdo in 2000 and 2018 which were below 0 at the distances of 100 km and 90 km, respectively. This suggests that the startup firms in the seven cities were significantly clustered in the four years at the corresponding spatial distance, however, their scales and intensities of spatial clustering varied.

Table 2. Ripley's *L(d)* function peak value and distance of startup firms in the seven prefecture-level cities.

	In 2000	In 2005	In 2010	In 2015	In 2018
City	Peak Value	Dist./km	Peak Value	Dist./km	Peak Value
Lhasa	80.63	12.45	79.64	11.86	66.72
Lhoka	44.39	43.28	44.72	1.88	35.40
Shigatse	104.99	82.47	81.06	4.26	59.38
Nyingtri	122.43	4.54	89.46	4.54	79.23
Chamdo	75.24	4.42	80.60	2.21	61.08
Nagchu	301.84	2.02	215.48	6.08	149.99
Ngari	203.00	1.83	164.72	3.67	115.76

The spatial pattern of startup firms in Lhasa was relatively stable, without any new observable spatial cluster. However, the established clusters have been gradually expanding outwards. The concentration intensity (the values of *L(d)*) of the startup firms in Lhasa in the four years continuously increased and then slowly decreased after it reached a particular point, which forms an inverted 'U' shape. Its peak value decreased from 80.63 in 2005 to 68.12 in 2018, and the radius of the concentration area (i.e., the distance corresponding to the peak value of *L(d)*) increased from 12.45 km to 15.42 km. According to onsite observations, there are two main reasons for these changes. First, the outward expansion of development space has led to the continued outspread development of the locations of the startup firms, principally due to the continuous improvement of intra-city transport infrastructure and the increasing amount of tourists and immigrant residents. Second, since the development zones, including the two national-level ones (the Lhasa Economic and Technological Development Zone, the Lhasa Comprehensive Bonded Zone) and two provincial-level ones (a High-Tech development zone, and an airport new area) have been established, they have provided new spaces for new firm formation.

The Ripley's *L(d)* function of the startup firms in Lhoka and Shigatse reveals that these two cities did not have relatively stable core spatial agglomerations, and the startups in these two cities showed patterns of decentralized distribution. There is an evident variation in the cluster scale corresponding to the peak values of *L(d)* in these two cities, with 43.28 km, 1.88 km, 5.64 km and 47.05 km in Lhoka, and 82.47 km, 4.26 km, 65.41 km and 4.27 km in Shigatse. Because of the geographical proximity to Lhasa and the policy of the regional economic integration between the cities of Lhasa and Lhoka by the TAR government in recent years, the central urban district of the Lhoka city (the Naidong District) has been weaker in attracting new businesses. At the same time, Gonga County (the second largest county in terms of population and economy in Lhoka), a rural county bordering the Lhasa city, did not generate agglomeration effects, possibly because it has been under construction for a short time. Moreover, the border counties in the Lhoka city bordering Bhutan and India have not yet become strong agglomerations of entrepreneurial activities because the international dry ports in the Lhoka city have been closed since the Sino-Indian border war in 1962. Although Shigatse is the second-largest economic center in the TAR, the attractiveness of the core district (the Sangzhuzi District) to the new firms has fallen in the recent decade, partly because of the advancement in transport integration with Lhasa (especially with the opening of the Lhasa–Shigatse Railway in 2014). Likewise, both the central district and border counties of Shigatse city did not exhibit significant agglomeration. According to the interview materials, this phenomenon can be attributed to the short history of the development zones in Shigatse, the unstable international political relations of China with India for decades, and the 2015 earthquake in Nepal. Following the death of about 9000 people and the loss of about a third of its GDP [70], Nepal saw its

vital imports plummet as India imposed a de facto trade embargo [71]. As the main foreign trade partner of Tibet, the disaster hampered the expansion of trade between China and Nepal, and dampened the enthusiasm of entrepreneurs for foreign trade in Shigatse.

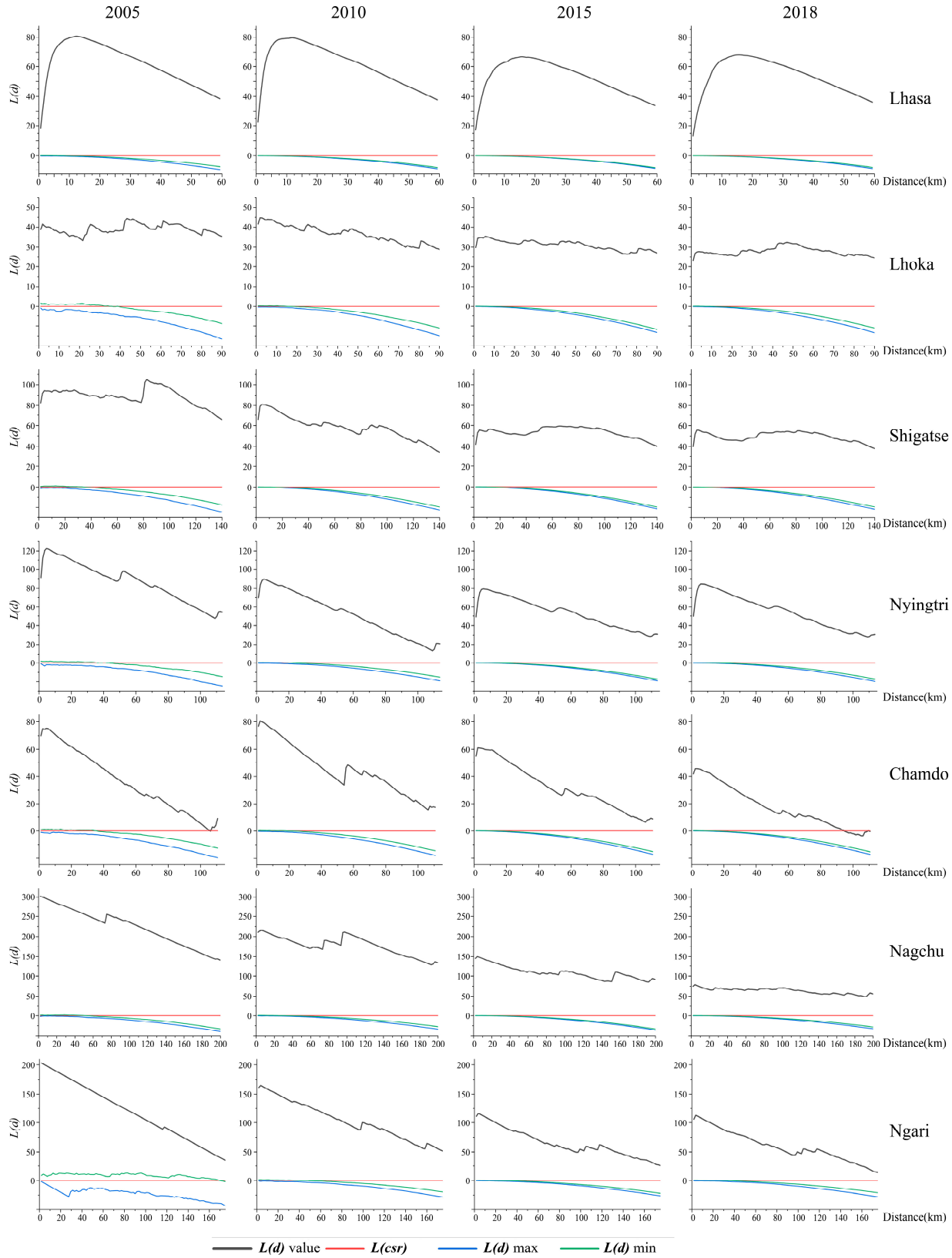

Figure 4. Ripley's *L(d)* function of startup firms in the seven prefecture-level cities at different periods.

Regarding the other municipalities of Nyingtri, Chamdo, Nagchu and Ngari, their startup firms exhibited spatial agglomerations at the small geographical scale for a long time, and their intensities of clustering have gradually weakened within the observed range. The *L(d)* values of these cities decreased with the increase in the spatial distance at the four time points. Meanwhile, there were much greater *L(d)* values within 5 km in 2005 than at other spatial distances in these cities, but their peak values decreased significantly over time (especially the intensity of agglomeration in Nagchu decreased from 301.84 in 2005 to 78.65 in 2018). At the same time, the agglomeration scales corresponding to their peak values have been around 0–5 km without much variation. The main reasons for these spatial characteristics could be the small economic size, the weak market demand, the unsustainable supply of entrepreneurial talents, the severe natural conditions, and the insufficient physical space for economic development.

5. Discussion

The past two decades have witnessed tremendous growth in the number of the startup firms; however, the number and rate of growth are not geographically even. Located in southwest China, Tibet is far from the economic center of China, with backward infrastructure and inadequate endogenous development power. With the construction of mega transport projects (e.g., the Qinghai–Tibet Railway, the Lhasa–Shigatse Railway, and the Lhasa–Nyingtri Railway), development zones, and other types of infrastructure (e.g., energy, public services), physical infrastructure in the TAR has significantly improved the entrepreneurial environment, which has in turn promoted the creation of new firms. The number of new firms registered in the TAR has risen from 2402 in 2000 to 68,063 in 2018 (27.3 times). Among the seven subregions of the TAR, the number of new firms in Lhasa has increased the most, from 2105 in 2000 to 28,621 in 2018 (12.5 times). The figure in Shigatse has grown from 114 to 9789 (84.8 times). The number of startup firms in Ngari has been the lowest, but its growth rate is the highest (423 times).

In terms of geographical distribution, startup firms in the TAR were concentrated on or around key nodes along major transport corridors (place dependence). With the improvement of transport infrastructure, two entrepreneurial corridors along major transport routes have gradually been formed. One is the entrepreneurial corridor of Nyingtri–Lhoka–Lhasa–Shigatse along the G318; the other is the entrepreneurial corridor of Chamdo and some counties of Nagchu along the G317. These two entrepreneurial corridors are centered on Lhasa, Shigatse and Chamdo, all of which have been historical economic centers, reflecting the strong path-dependency of entrepreneurial activities. However, the construction of major transport infrastructure and development zones has made it possible to create new sites for hosting new firms. With the economic development of the areas along G317 and G318, and in particular the establishment of development zones (e.g., the Nyingtri Economic Development Zone, the Jiangbei New District in Lhoka, and the National Agricultural Science and Technology Park in Nagchu), new aggregations of startup firms have been formed. This article concludes that startup firms are often located along major transport routes, consistent with the pattern found in developed countries and highly marketed city regions in China [72,73].

Although all subregions of the TAR have spatial agglomerations of startup firms, they are different in agglomeration characteristics. With the continuous development of urban construction, the cluster of the new firms in Lhasa is gradually spreading outward, where national-level and provincial-level development zones have become the critical sites for hosting new firms. Lhoka and Shigatse have not yet formed relatively stable agglomerations. There are multiple agglomerations of entrepreneurial activities due to fierce competition between the traditional central district and the economically strong counties within these two cities. Primarily because of the strengthened inter-city integration, the central districts of both Lhoka and Lhasa–Shigatse have weakened their attractiveness to new entrepreneurs. Due to the smaller economic scale and limited development space, the startup firms in Nyingtri, Chamdo, Nagchu, and Ngari are concentrated mainly in or around their ‘old’

districts. In general, due to a low population density, small economic size, and relatively harsh natural environment, the spatial concentration of entrepreneurial activities in all cities except for Lhasa needs to be improved.

6. Conclusions

In recent decades, the governments of various countries have widely acknowledged the importance of startup firms in creating new industries and generating considerable economic and societal impacts. Accordingly, they have launched a variety of policy initiatives aimed at promoting the establishment, growth, and impact of startups. Meanwhile, international academic communities have discussed entrepreneurial activities from the perspectives of economics, management, psychology, and geography. However, these empirical studies have focused mainly on developed countries and highly marketed city-regions in developing countries, lacking sufficient attention to entrepreneurial activities in underdeveloped regions. The TAR is a typical underdeveloped region in China. Since the beginning of the 21st century, with the support of the Central Government and other provinces of China, the TAR has improved its infrastructure and business environment with the hope of promoting entrepreneurship and innovation. Therefore, this article takes the TAR as a case area to explore the evolutionary characteristics of spatial patterns on startup firms in underdeveloped regions of China.

Integrating spatial analysis and qualitative methods, this article portrays the spatial distribution of new firms in Tibet and its seven prefecture-level cities since the implementation of the Western Development Strategy in 2000. The findings are summarized as follows: Despite tremendous growth in the number of startup firms in the past two decades, the number of firms and their rate of growth are not geographically even. There is spatial dependence in new business formation activity in Tibet (dependence on key nodes along major transport corridors), the establishment of development zones makes possible the creation of new agglomerations, and their agglomeration sizes and spatial scales vary across the subregions of the TAR. The evolution of the spatial patterns of startup firms in the TAR is usually dominated by multiple forces, such as the assistance policy provided by the Chinese Central Government, the construction of infrastructure projects, the path dependence of urban development, and the optimization of the business environment.

Combining the register data with in-depth qualitative insights, this article makes several contributions to the emerging geographical research on startup firms in developing countries. Firstly, according to our knowledge, this study is the first attempt to quantify the spatial patterns of entrepreneurship in Tibet, an underexplored research area in the international academic community of economic geography. This analysis of entrepreneurial activities emphasizes the relevance of the local context in explaining how and where new firms emerge, and what characteristics are necessary to consider when addressing entrepreneurship-oriented policies, particularly in context of underdeveloped regions. Secondly, this article introduced kernel density estimation and Ripley's *L(d)* function (a slight variation of Ripley's *K* function), which complement each other in order to produce a complete description of the geographical distribution of entrepreneurial activity at various spatial scales. Thirdly, this article extends this type of analysis by considering the geographical distribution of new firm formation as a time- and space-dependent process. This dynamic approach is crucial to understanding both why spatial inequality in start-up rates persists, and under which circumstances some municipalities are able to improve their growth rates of new firms. Hence, our results provide support for public policies oriented to encourage new firms as a means for local economic development, particularly in the contexts of deep and long-lasting spatial inequality.

However, the article has two shortcomings. Firstly, owing to the lack of county-level socio-economic data, we focused mainly on the spatial patterns of new firms with a preliminary qualitative analysis on the evolutionary dynamics, rather than a rigid quantitative study with spatial econometrics. Secondly, since the economically underdeveloped regions of China vary to a different degree in natural conditions, social and economic development

levels, and infrastructure conditions, their new firms' spatial distributions and locational dynamics might be diverse. Thus, we call for a multi-site study to investigate the diversity of spatial patterns and dynamics of new firm formations in the underdeveloped regions of China in future studies.

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