

## Article

# Rural Entrepreneurship Development in Southwest China: A Spatiotemporal Analysis

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**Abstract:** Rural entrepreneurship has been seen by the central government of China as a key means to rural vitalization. However, research focus on the long-term developmental status of rural entrepreneurship at local scale has been limited. According to industry types of differentiation, this research describes rural enterprises registered in the administrative area of Mianyang, southwest China, from 2011 to 2020. The spatial-temporal distribution rule of rural entrepreneurship is explored via a quantitative approach focused on spatial analysis and correlation analysis, as well as the application of geocoding on web data. How contexts such as the natural base, socio-economic condition, and institutional arrangements impact this distribution are empirically explored and discussed. The paper adds spatial-temporal insights into the role of the context of rural entrepreneurship. In particular, the paper highlights that rural entrepreneurship is a process potentially best explored at the regional scale and that physical condition and institutional support play central roles in rural entrepreneurship in southwest China.

**Keywords:** rural entrepreneurship; spatial-temporal distribution; context; determinants; China



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## 1. Introduction

Since the advent of the market economy system in China in the 1980s, entrepreneurship has experienced waves of booming in the country [1]. The earliest rural entrepreneurship were township-village enterprises (TVES) established in the late 1980s. Since then, rural entrepreneurship has contributed to China's 10 percent annual economic growth and is transforming the rural countryside. The creation of non-farm employment in rural areas has resulted in return migration of tens of millions of migrant workers from urban areas to their home regions with many of them starting their own businesses using acquired resources and entrepreneurial acumen learned while on migration [2–5]. Return migration is now one of the major driving forces of rural economic development in China [6,7]. Witnessing this, the Central government of China has since the early 2010s developed a series of policies supporting rural entrepreneurship. The policy of “Mass Entrepreneurship and Innovation” launched by the Chinese State Council in 2015 [8] and a nationwide targeted poverty-alleviation campaign aimed at revitalizing rural China initiated in 2014 [9], have stimulated entrepreneurial activities in rural China. Local peasants are, for example, encouraged by the central Chinese government to start businesses as well as developing their agricultural practices towards larger efficiency as well as sustainability [10]. It is estimated that 10 million entrepreneurs will start businesses in rural areas in 2020, an increase of more than 1.6 million from 2019 [11].

The rapid urbanization and industrialization starting in the 1980s have brought huge economic benefits to China, but the massive inflow of capital, labor and resources to urban areas has happened at the expense of rural areas. In response, the central government

has proposed a rural vitalization strategy, in which rural entrepreneurship is encouraged politically [12,13] as a means of agricultural modernization, rural economic development and income generation for farmers [14]. Various government measures such as tax and fee exemptions, entrepreneurial subsidies, guaranteed loans, entrepreneurial training, business start-up competitions and awards are examples of this encouragement (Opinions on further promoting the work of returning to the countryside into entrepreneurship. 2020. Ministry of Human Resources and Social Security Ministry of Finance Ministry of Agriculture and Rural. [http://www.xccys.moa.gov.cn/gzdt/202001/t20200109\\_6334579.htm](http://www.xccys.moa.gov.cn/gzdt/202001/t20200109_6334579.htm), accessed on 8 March 2023). Indeed, in all government policies targeting spatial, economic and social development of the Chinese countryside rural entrepreneurship is a key mechanism [15,16]. The central government plays as such a central role stimulating local governments by formulating policies and reward schemes while local governments carry out the actual planning, management, and investment. This all takes place in a coordinated manner [17] and a central point for local governments is to be able to understand, map and communicate local conditions and needs to facilitate the implementation of efficient policies.

Understanding rural entrepreneurship in its particular context is in this light important [18] and a growing research field is exploring rural entrepreneurship in China [19,20] and elsewhere [21,22]. Understanding the spatial and temporal distribution and the determinants of rural entrepreneurship helps properly respond to and utilize the central government's policies on rural development in conjunction with local context, and is also an emerging theme in this research [23].

In this paper, we add to this literature by focusing on the spatial and temporal patterns and determinants of rural entrepreneurship using an empirical study from Mianyang, Sichuan, southwestern China. Southwest China is a key region for poverty alleviation in China [24]. The region has a complex topography and demographic structure. It has experienced a long-standing rural exodus [25] and Sichuan Province has the largest rural poor population in China [26]. We outline and explain rural entrepreneurship in this region and trace how it has played out over time and in space. We define rural entrepreneurship as start-up business activities embedded in a territory characterized by rural attributes such as open spaces, predominantly agricultural activities, a small population settlement density relative to the national context, and administrative rural land use zoning [27–29]. These attributes are also how we define rural areas, although they administratively are called “Cun” (village).

The paper is structured as follows. In Section 2, we review existing literature on rural entrepreneurship, in Section 3 we describe the research setting and the methods. In Section 4 we present the spatial-temporal pattern of rural entrepreneurship in the study area and explore how spatial context shapes the evolution of rural entrepreneurship based on determinants correlation outcome. In Section 5 we discuss our results and their contribution to research on rural entrepreneurship, and in Section 6, we concluded.

## 2. Literature Review

### 2.1. Rural Entrepreneurship

Rural entrepreneurship takes place in what is generally seen as “non-core regions” [30,31]. Various attributes such as distance from infrastructures and in particular markets and constrained resources in terms of access to finance and skilled labor are often mentioned as characterizing ‘non-core’ or rural areas, and rural areas are generally seen as poorly equipped to facilitate new business enterprises. While often difficult to measure rural entrepreneurship due to the existence of informal and unregistered start-ups in such areas [32] early definitions depict rural entrepreneurship as the creation of a new business entity that introduces a new product, service, or market often utilizing new technology in a rural environment [27]. Economical, spatial, cultural, or social attributes shaping entrepreneurial activities such as economic downturn, resource endowments, bridging, meanings of community, etc., have later been added to the understanding of rural entrepreneurship [33–35].

The basic entrepreneurial processes in rural areas are not different from those found in urban areas. Yet research on rural entrepreneurship reveals that many rural entrepreneurs are often more than job creators and innovators motivated by profit [36]. Rural areas introduce diverse opportunities, imposes different constraints, and modify the entrepreneurial process and the entrepreneurial outcome [37] and local embeddedness seems to play a much larger role in rural entrepreneurship compared to that found in urban areas (e.g., [38]). Rural economic activities, for example, often interacted with and depend upon local attributes, structures, and identities such as natural landscapes, traditions, and agricultural opportunities. Whether taking place in Europe or the US or Africa or Asia also seems to matter for how rural entrepreneurship looks [29].

These kinds of observations reflect a more general discussion of the place and space of rural entrepreneurship. The space perspective emphasizes profit-seeking while the place perspective highlights rural communities as a powerful socio-cultural source for entrepreneurial activities [39]. Despite this debate, it is generally agreed in the literature, that context matters and that this enables, influences, co-constructs, maintains and constrains rural entrepreneurship [40–42]. The context, or “enabling” environment, can be macro (international arena, nation), meso (region) or micro (local, individual) [43]. Context is a product of the interaction between various determinants. The economic environment, infrastructure, political constraints or opportunities [44], local government-led Research and Development (R&D) expenses, and labor mobility impact significantly rural entrepreneurship [45]. Social and cultural norms [46,47], as well as landscape features, have also been shown to influence rural entrepreneurship, for example by providing tourism opportunities [48–50]. In current literature such determinants are explored individually but also in combinations [20,51]. Table 1 presents some case studies focusing on context as pools of attributes [52], highlighting the dynamics, forces, and factors, impacting rural entrepreneurship.

**Table 1.** Context measurements in rural entrepreneurship research.

Author	Approaches	Study Area	Findings and Determinants
Stathopoulou, S., et al. [37]	Literature deductive analysis (Qualitative)	Europe	Physical environment (natural resources, landscape), Socio-institutional environment (social capital, local and regional governance) Economic environment (business networks, infrastructure)
Kalantaridis, C., and Bika, Z. [53]	Survey (Quantitative)	UK (England)	Markets: labour, capital, non-labour-inputs, knowledge, output markets; Distance: transport (road networks), communications, market information, relationships
Baumgartner, D., et al. [54]	Statistic (Quantitative)	Switzerland	Individual components, Economic components, Institutional components, Socio-cultural components
Lang, R., et al. [39]	Case study (Qualitative)	Central European countries	Cognitive elements: place-bounded categories and frames for interpretation (e.g., entrepreneurial identity); Normative elements: range of embedded norms in a place (e.g., solidarity, reciprocity); Regulative elements: formal rules in a place (e.g., property rights, subsidizing laws)
Müller, S., and Korsgaard, S. [34]	Multiple case study design (Qualitative)	Denmark	Physical resources (Buildings, Natural amenities, Natural resources, etc.), Human resources and Human capital (labour, volunteers, businesses, products and service know-how and expertise); Immaterial (Culture, History and Heritage; Stories, Image, Place brand), Social and community resources (Social networks; Business networks; Partnerships; Cooperative), Financial (Grants, loans or other funding).

Table 1. Cont.

Author	Approaches	Study Area	Findings and Determinants
Muñoz, P., and Kimmitt, J. [51]	Multiple cases, Abductive analysis	Chile	Rural entrepreneurial dynamics (Localised institutional support; Collaborative places for advancing rural enterprises; Place-sensitive trading), Biophysical place (Landscape imprinting; Rural natural capital; Rural built assets), Entrepreneurial rural locale (Social locale of rural entrepreneurship; Cultural locale of rural entrepreneurship), Entrepreneurial sense of rurality (Cultural positioning; Territorial embeddedness; Place-sensitive products)
Wang, Y., et al. [20]	Multiple cases (Qualitative)	China	Macro level sociocultural domain, political domain, economic domain, and environmental domain; Meso-level: Infrastructure, Market, Institutional, Capital; Micro level Local embeddedness, Non-local connection.

## 2.2. Entrepreneurship in Rural China

Research on rural entrepreneurship in China started in the late 1990s [55]. Early studies focused on how decollectivizing the rural market in the 1980s brought a dramatic rise in rural industry and private agricultural trading [56,57]. Especially how local governments and rural enterprises worked together in the so-called collective rural enterprises or “township-village enterprise” (TVEs) received attention and provided understandings of how rural entrepreneurship played out in China [58]. TVEs originated from small-scale industrial enterprises set up by communes in the 1950s and were named “township-village enterprise” by the central government in 1984 along with the abolishing of the commune system. They offered jobs for rural dwellers, enabled rural enterprises to participate in market competition, and were regarded as a representative phenomenon of “socialist market economy” [59,60]. As China became more embedded in a market economy, TVEs carried out the reform of the property rights system enabling private enterprises to gradually replace the TVEs in rural China [61]. The TVEs and the subsequent privatization led to a so-called ‘modernization’ of the rural economy [62]. Further government strategies focused on land policy reforms. An example of this is a 2009 law, which allowed farmers to rent out their land-use rights to other farmers or agriculturally related enterprises. This resulted in an ability to collateralize and mortgage land-use rights, encouraged mortgaging willingness, and entrepreneurial activity of rural households [63]. Employment outside the TVEs in private enterprises grew fast and off-farm job creation since the 1980s was prolific across many areas of China [64,65].

Research aimed at capturing the characteristics of rural entrepreneurship has explored various aspects for example life cycle factors, especially how marriage and children affected entrepreneurial choices [25]. More important for rural entrepreneurship is perhaps the return migrants leaving urban areas to start businesses in their origin region [66]. Using capital earned while on migration, improved Mandarin Chinese skills, their capacity to utilize local networks and wider social capital facilitated this [67]. Moreover, many returned migrants are higher educated, enabling them to understand and adjust to market demands and technology, and access policy support [68]. The entrepreneurial success of many such migrants inspired other residents to become entrepreneurs [69] and rural entrepreneurship has proved to be crucial in the transition and revitalization of rural areas all over China [70]. Rural entrepreneurship in China, as elsewhere, moreover depends upon the ability to connect local ideas, material flows and finance to regional, national and global ideas and markets, an ability dependent upon digital technologies and in particular internet access [15,71].

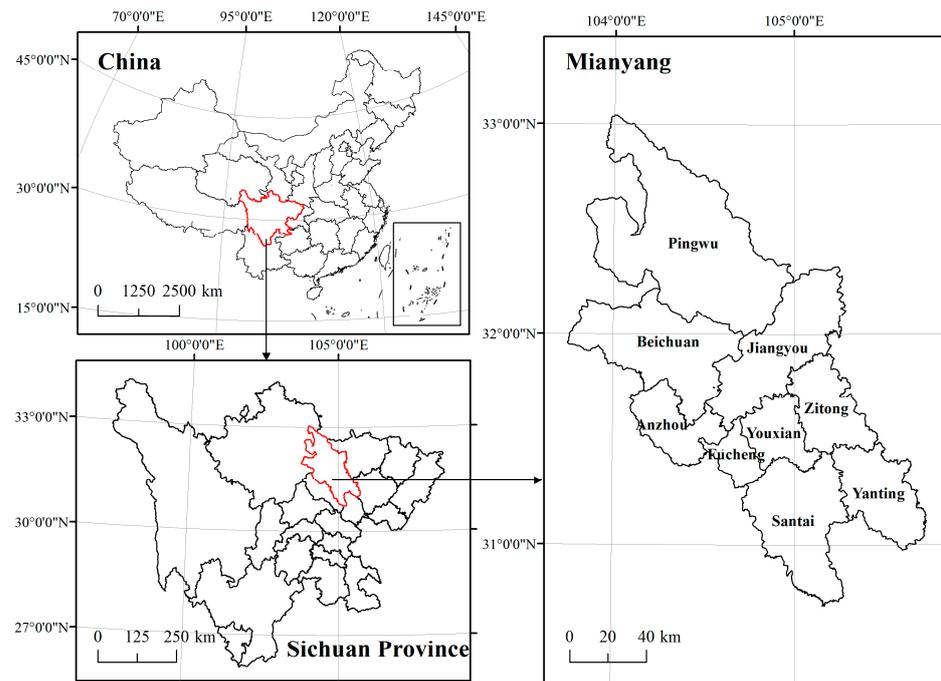
### 2.3. Spatial Analysis in Entrepreneurship Research

Regional economy and economic geography studies have since the 1990s worked on identifying the importance of the relationship between the spatial distribution of entrepreneurship and knowledge spillovers for entrepreneurship [72,73]. Knowledge spillovers (interactions and communication) are more likely to happen in areas with a high agglomeration of entrepreneurs [74]. Especially in the high-tech industry do knowledge spillovers between spatially close entrepreneurs help these exploit opportunities [75]. The determinants behind entrepreneurship, such as knowledge spillovers, can therefore be partly captured by spatial analysis and it has been shown that spatial analysis help uncovers the main drivers behind the phenomenon [76]. Methods such as the spatial lag model, the spatial error model, and the geographic weighting model have helped show the geographic spatial effect of knowledge spillover in regional entrepreneurship. Especially how geographical proximity influences an efficient absorption of knowledge and how knowledge spillover decay over spatial distance affects entrepreneurship, have been captured by such methods [77–79]. Panel data have helped capture how entrepreneurship and the dynamics behind it evolved through time and over regions giving an integrated perspective on for example how entrepreneurship connects across neighbor regions [80]. Knowledge spillovers also manifested in rural entrepreneurship such as the influence of the creative class in the US on rural growth in the 1990s [81]. Even in knowledge-poor peripheral regions of China, spatial analysis evidence supports the knowledge spillover theory of entrepreneurship and can be used to guide policy makers in less developed regions to follow national development strategies [23]. Spatial analysis enables also an identification of the ecosystem factors affecting entrepreneurship in rural areas from secondary data [82]. Yet a lack of data and especially economic statistic data investigating low population density settings means entrepreneurship studies in rural areas have mainly focused on individual cases, narrative studies, and local surveys [83,84] rather than macro analysis [85].

## 3. Research Setting

### 3.1. Study Area

Mianyang is the second-largest prefecture-level city in the Chinese province of Sichuan, as the vice center city of Sichuan and the only officially approved science and technology city in China, it is an important growth pole in the Chengdu-Chongqing Economic Zone. Mianyang consists of a county-level city (Jiangyou), 3 districts (Fucheng, Youxian, Anzhou), and 5 counties (Beichuan, Pingwu, Zitong, Yanting, Santai) (Figure 1). Located in the upper reaches of the Yangtze River, Mianyang has a complex geography including mountains, hills, and tablelands, with an altitude range from 300 m to 5000 m sloping from northwest to southeast, of which 61.0% are mountainous areas, 20.4% are hilly areas and 18.6% are flat dams. The area has a subtropical monsoon climate and the annual precipitation average is over 10,000 mm. In 2020, the permanent population of Mianyang exceeded 4.86 million spread over an area of 20,257 km<sup>2</sup> (seventh national census of PRC). 2 million of these live in rural areas. This indicate that what we mean by a city is administratively defined. Mianyang city is this a region labeled a city for administrative purposes. By the end of 2020, 1.382 million rural laborers had left Mianyang, of which 753,000 moved within Sichuan province and 629,000 migrated outside the province (Statistical Bulletin of Human Resources and Social Security Development in Mianyang City in 2020. <http://www.my.gov.cn/public/491/27094601.html>, accessed on 8 March 2023). Mianyang is a multi-ethnic city, with Tibet and Qiang ethnic minorities concentrated in the northwest counties, Pingwu and Beichuan. The complex natural conditions, multi-ethnic congregation, and rural labor drain have resulted in rural depletion and large urban-rural disparities, typical of the mountainous area of southwest China.



**Figure 1.** Location of the study area.

### 3.2. Data and Methods

This study provides a quantitative analysis of the spatial characteristics of rural entrepreneurship in order to quickly capture the basic facts about rural entrepreneurship in Mianyang. For the purpose of data standardization and quantitative analysis, rural areas are understood as “administrative villages” in this paper, i.e., self-governance units in China established by law. An administrative village is besides self-governance in terms of the scope of management under the jurisdiction of a village committee elected by the villagers, in our study area characterized by with open space, mainly agricultural activities and low population settlement density. By absorbing experiences of qualitative case studies, combining correlation analysis and spatial statistical methods, which have proven useful when wanting to identify the temporal and spatial distribution of entrepreneurship and regional development [86,87], as well as the determinants behind the distribution of entrepreneurship [76,88], this research reveals trends in the development of regional rural entrepreneurship over the decade, explores the entrepreneurial context in the physical, social and policy condition of rural southwest China.

Origin data used in this research are the registration information of all business entities established in Mianyang from 1 January 2011 to 31 December 2020 provided by the Administration for Market Regulation in Mianyang. The data contains address, time of establishment, industry code, business scope, etc. from all nine sub-administrative area. Cleaning the data through Python programming and manual proofreading, we extracted all entities located in rural areas based on the address containing the word “Cun (村)” (village) and the land-use code according to the 13th digit of the urban-rural classification code. We obtained 23,905 rural enterprises that met the requirements. Application Programming Interface (API) helps acquire open-access geographical data that represents spatial geographic entities recorded in virtual space. Generally characterized by large volumes of data, fast updates, and public availability, online geographical data are now widely used in measuring socioeconomic activities [89–91]. To transfer registration data into geographical data, we used Geocoding via the API interface of both Baidu and Gaode (Chinese web mapping, navigation, and location-based services providers). In doing this, we turned an enterprise’s address into point data with coordinates. We then digitally mapped the points and attached attribute information such as administrative area, year of establishment, and industry category. This gave us a spatial database of 23,905 data

entry points concerning rural entrepreneurship in Mianyang. Some points overlapped due to duplicate addresses (e.g., address at the same location). The industry category (i.e., Forestry, Fishing, Catering, etc.) of all entities were categorized according to the industry code registered based on the Industrial classification for national economic activities of China ([http://www.stats.gov.cn/tjsj/tjbz/hyflbz/201710/t20171012\\_1541679.htm](http://www.stats.gov.cn/tjsj/tjbz/hyflbz/201710/t20171012_1541679.htm), accessed on 8 March 2023). Spatial statistical approach including density toolset, measure geographic distribution toolset, and spatial autocorrelation tool from ArcGIS, together with correlation analysis were carried out to explore the spatial-temporal distribution at sub-administrations and in different industrial types.

#### Kernel density analysis

This method has been widely used to obtain spatial layout in point shapefile data analysis [91,92]. It takes a certain regular area around a point in space as the calculation range of density and analyzes the spatial distribution of observation objects by calculating the density of observation data within the area. Points close to the center are given a higher weight than points further from the center. The estimated density of each point is the weighted average density of all points in the area.

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

where  $F(x)$  denotes the kernel density of a certain point  $x$  in the area (space)  $n$  denotes the amount of rural entrepreneurship,  $K$  refers to the non-negative function kernel, and  $h$  is the bandwidth determined by the area of the study area. Difference between  $x$  and  $x_i$  is the distance from the central top point to any other point.

#### Orientation Distribution (standard deviation ellipse)

The directional distribution tool creates standard deviational ellipses (SDE). This summarizes the spatial characteristics of rural enterprises points including their central tendency, dispersion, and directional trends (Equation (2)).

$$SDE_x = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{X})^2}{n}} \quad SDE_y = \sqrt{\frac{\sum_{i=1}^n (y_i - \bar{Y})^2}{n}} \quad (2)$$

where  $x_i$  and  $y_i$  denote the coordinates of a certain point of rural entrepreneurship,  $\{\bar{X}, \bar{Y}\}$  is the mean center of all points in each of the nine sub-administrations and  $n$  denotes the sum amount of all points.

#### Median center

The median center tool uses an iterative algorithm to find the point that minimizes the Euclidean distance between all features (Equation (3)). Where  $t$  denotes each step in the algorithm, and  $(X^t, Y^t)$  is the candidate median center found then refined until it represents the location that minimizes the Euclidean distance  $d$  toward all points  $i$  in each of the nine sub-administrations.

$$d_i^t = \sqrt{(X_i - X^t)^2 + (Y_i - Y^t)^2} \quad (3)$$

#### Global Moran's I

By calculating the Global Moran's Index (Equation (4), which ranges from  $-1$  to  $1$ ) we describe the spatial autocorrelation of township-level rural enterprise distribution, to see if the distribution of points has spatial proximity.

$$Moran's\ I = \frac{n \sum_{i=1}^n \sum_{j=1}^n w_{ij} (x_i - \bar{x})(x_j - \bar{x})}{\sum_{i=1}^n \sum_{j=1}^n w_{ij} (x_j - \bar{x})} \tag{4}$$

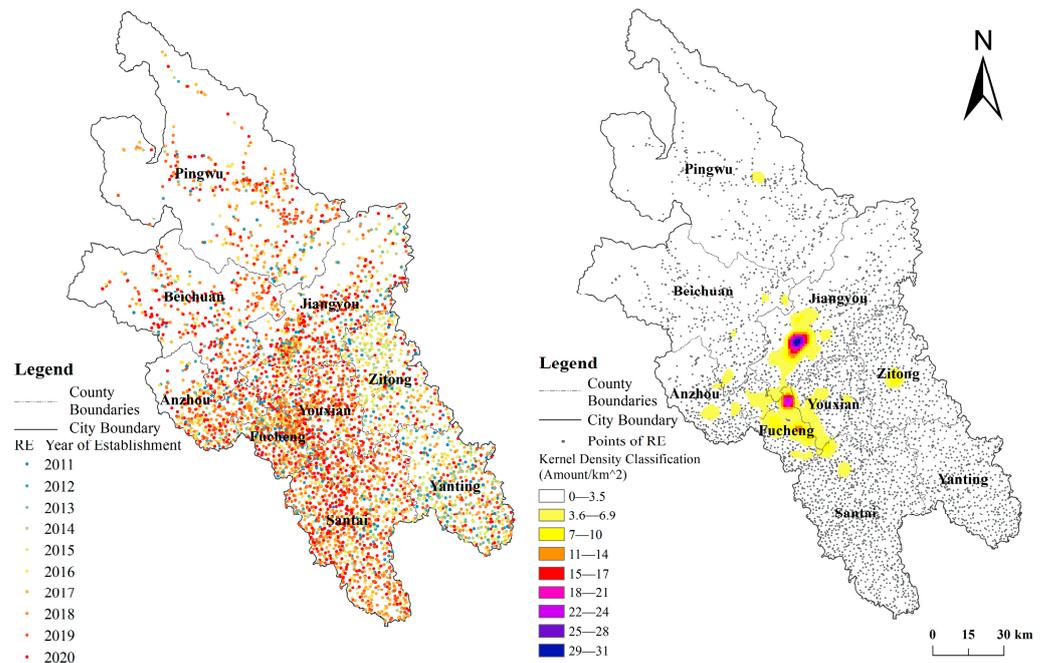
where  $x_i$  and  $x_j$  denotes the rural enterprise number in township  $i$  and township  $j$ ,  $\bar{x}$  is the average amount of the rural enterprise in township scale,  $w_{ij}$  is the spatial weight of  $i$  and  $j$ ,  $n$  is the amount of all townships. The larger the value of Moran's Index, the stronger the distribution autocorrelation, and the greater the distribution similarity.

#### 4. Results

##### 4.1. Overview of the Spatial-Temporal Pattern of Rural Entrepreneurship

##### 4.1.1. Overall Distribution

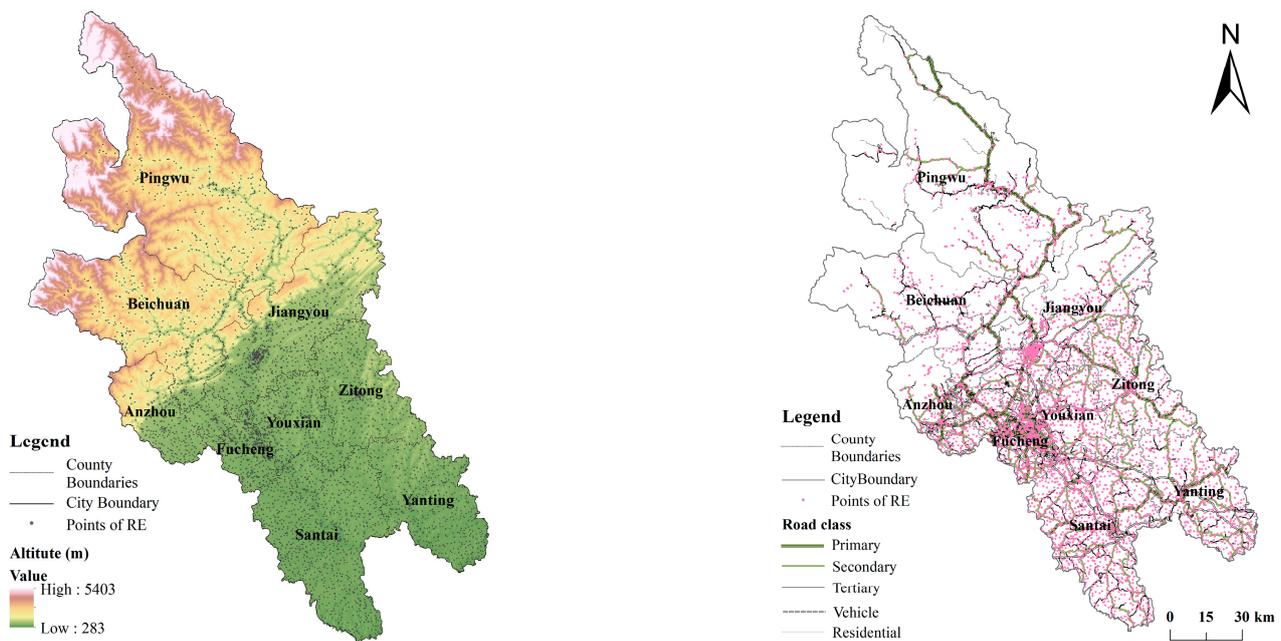
Looking at the spatial distribution of rural entrepreneurship (Figure 2, left panel), a growth trend from 2011 to 2020 can be detected. Overall distribution presents a trend decrease from southwest to northeast. The agglomerations of enterprises are first detectable in the southwestern area but eventually spread to all the southern parts of Mianyang. Less agglomeration increase is detectable in Pingwu, Beichuan, and northeast Jiangyou. 2011–2020, represents thus a situation of concentration in the south with more scattered activities in the north. Based on the mapping results, we used Kernel Density Estimation (Equation (1)) to measure the density of the rural entrepreneurship distribution (Figure 2, right panel).



**Figure 2.** Spatial distribution (left panel) and Kernel density distribution (right panel) of rural entrepreneurship in Mianyang from 2011 to 2020.

To have a suitable bandwidth, we use the spatial variable of Silverman's "rule of thumb" to calculate the bandwidth and analyze the density of all the rural enterprises registered in the past 10 years (Figure 2, right panel), which shows the overall scatter with a high density in the southwest and some smaller agglomerations scattered around. For the whole city of Mianyang, the highest density center shows at the west end of Jiangyou while there is a dual center at the junction of Fucheng and Youxian forming a more concentrated and contiguous situation. Several sub-centers lie in Anzhou, Beichuan, Pingwu, and Zitong, no density center shows in Yanting.

Based on our understanding of the complex terrain in Mianyang, we overlaid digital elevation model (DEM) and traffic road network data with point data, a clear geographical divide from northwest to southeast is significantly consistent with the steep increase in elevation. The majority (92.6%) of rural entrepreneurship is distributed below 1000 m above sea level, mostly at the foothills and flat valley areas on the south side of these. Specifically, 9549 enterprises are found under 500 m; 12,576 from 500 to 1000 m, 1528 from 1000 to 2000 m, and 252 over 2000 m. All of the 252 rural entrepreneurships distributed over 2000 m are located in Pingwu county. (Figure 3, left panel). Areas with complex terrain conditions, such as Beichuan and Pingwu counties, are characterized by the distribution of rural entrepreneurship sites along transportation routes (Figure 3, right panel).

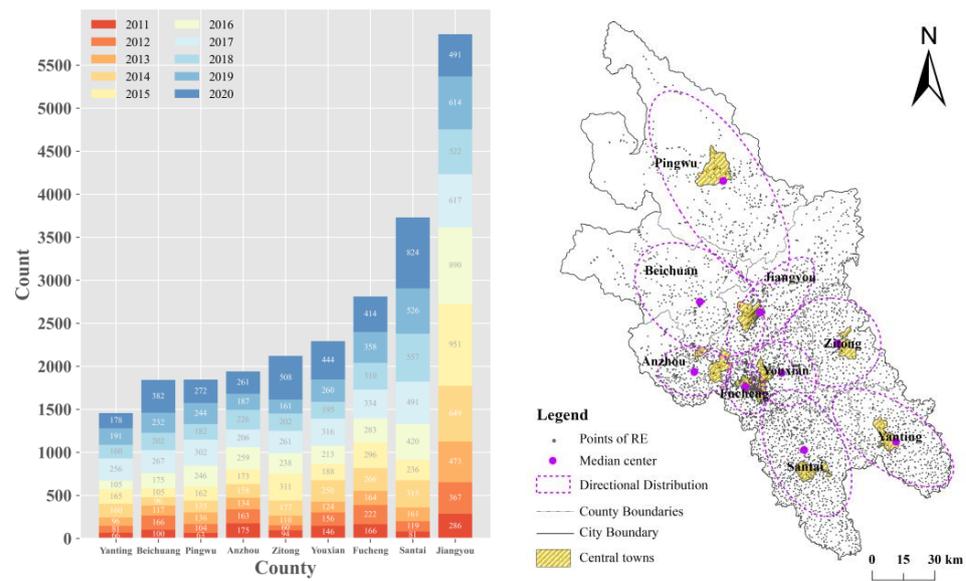


**Figure 3.** Distribution of rural entrepreneurship based on the Digital Elevation Model of Mianyang (**left panel**) and the road network of Mianyang (**right panel**).

#### 4.1.2. Regional Distribution

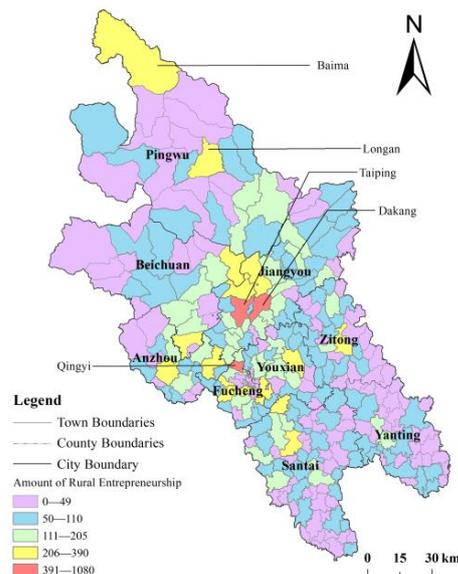
Figure 4 (left panel) shows the annual rural entrepreneurship statistic for the nine counties and districts of Mianyang over the period 2011–2020. Jiangyou possesses the highest proportion of all sub-administrative areas with a growth that first rises and then falls from 2017. Santai and Fucheng show rapid growth over the last five years while counties such as Pingwu, Beichuan, and Yanting have comparatively little activity. To compare how rural entrepreneurship is distributed in each sub-administration and how their location is connected to the central towns, we applied the directional distribution and median center analysis to the point shapefile (Figure 4, right panel).

Doing this showed that distribution patterns in the nine sub-administrations are diverse, especially Pingwu and Jiangyou, which possess significant northwest-southeast vertical extension and southeast-northwest horizontal extension. While most of the regional centers lie close to the central town of each sub-administration, Beichuan and Anzhou showed differences. This can be due to the political central town moving after the earthquake in 2008, and the new central town fails to play the role of market attractiveness.



**Figure 4.** Annual rural entrepreneurship in the sub-administrative area of Mianyang from 2011 to 2020 (left panel) and median center and directional distribution of rural entrepreneurship in 9 sub-administrations of Mianyang (right panel).

Downscaling the statistical regions into smaller areas (categorizing total rural entrepreneurship at town level administrative area) (Figure 5), more than 200 towns appear on the map as regional distribution cubes of entrepreneurship. By dividing rural entrepreneurship into five classes by a natural break, the distribution pattern from 2011 to 2020 can be seen. There is a trend decrease from the central area towards surrounding areas, with some extreme points scattered. Two of the three main areas lie in Sanhe and Taiping of Jiangyou, which is where the central town of Jiangyou lies. The other peak cluster is Qingyi of Fucheng which is the peri-urban area of the central urban area of Mianyang. Looking at the three counties with the least entrepreneurial activities, Yanting has a general low entrepreneurial level, Beichuan showed an increase towards the southeast boundary, while Pingwu has two perceptible clusters in the middle and northernmost towns. Among these, Long’an is the central town of Pingwu while Baima is a Tibetan autonomous township with rich ethnic tourism resources and natural landscapes.

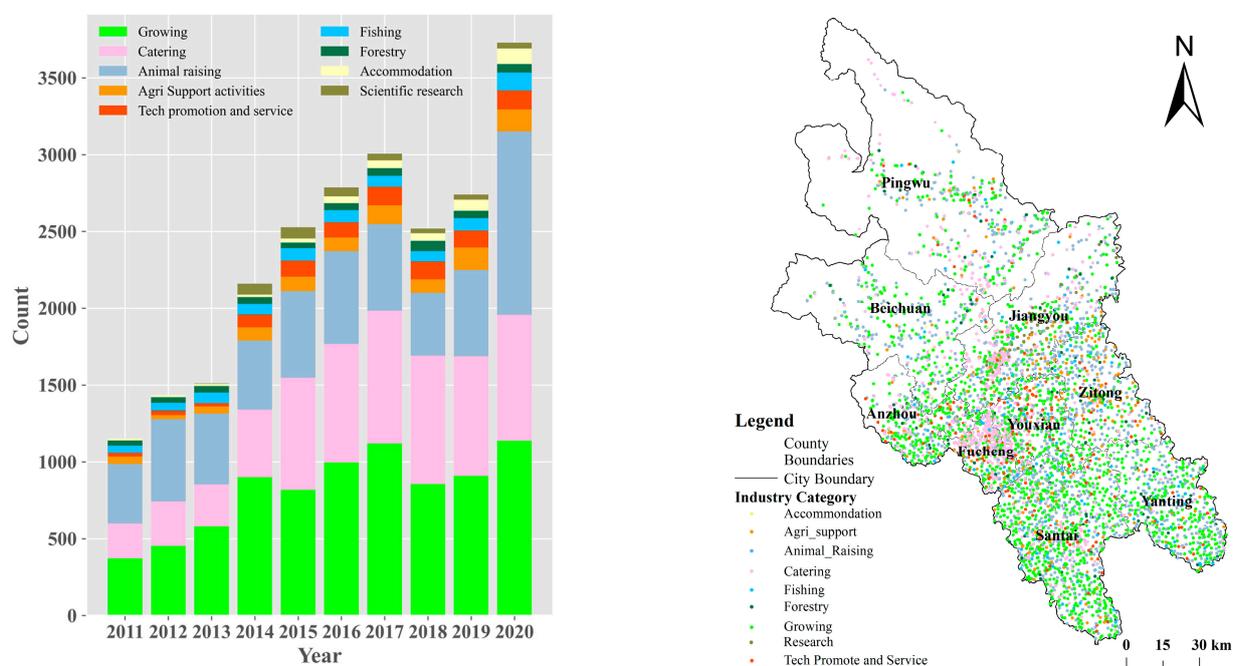


**Figure 5.** Classification of rural entrepreneurship in township administrative area of Mianyang.

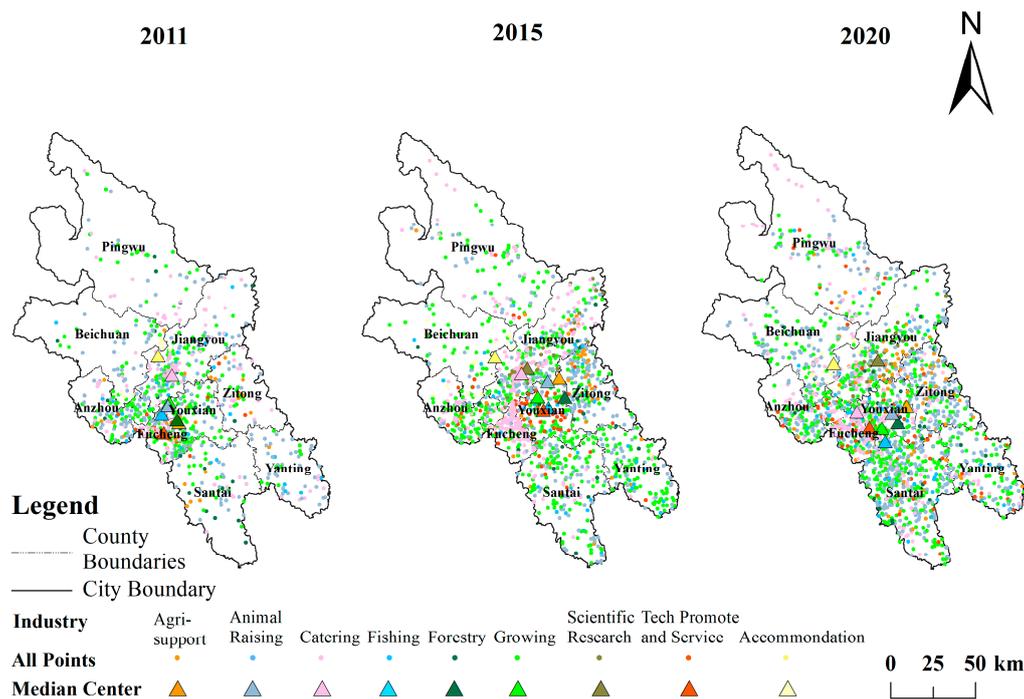
The result shows the Moran's Index equals 0.208117, Z-score equals 6.196709 and,  $p$ -value is less than 0.000001, the possibility of data aggregation is much greater than the possibility of random distribution, and the null hypothesis can be significantly rejected. This result represents the spatial distribution of rural entrepreneurship at the township level which possesses significant clustering characteristics and a positive spatial correlation pattern.

#### 4.1.3. Distribution of Industries

We categorized the rural enterprises by industry type and use the same categories as Industrial classification for national economic activities of China. In the whole city of Mianyang from 2011 to 2020, industry types with a total of entities below 100 over the 10 years were not included, but the industries shown in Figure 6 (left panel) capture 98.5% of the total rural entrepreneurship recorded. The agriculture sector represents the main rural industry type and consists of Growing, Animal raising, Fishing, Forestry, and Agri-support activities accounting for 66.7% of the total industry distribution. 6027 catering businesses were started over the past 10 years. Accommodation is also in the top industries over this period. These latter two trends might reflect the development of the rural tourist sector providing service industry. It is noticeable that Scientific research, although it only appeared in 2014, is developing fast in recent years. By mapping industry type results up to 2020 (Figure 6, right panel), it is apparent that the Growing industry is present in every county but especially in the south. Some agglomerations such as catering can be seen at the edge of Fucheng, Youxian, and Jiangyou, which is the peri-urban area of the central urban of Mianyang. We also calculated the median center of each industry in 2011, 2015, and 2020 based on equation 3 above, to see how and if they moved through the years (Figure 7). An overall trend towards the east and then south is detected, as is a concentration of enterprises near the median west close to the central urban area of Mianyang. The center of the Growing sector moves to the south while the Catering sector moved from west to east.



**Figure 6.** Industry category (left panel) and distribution of industry type (right panel) of rural entrepreneurship of Mianyang from 2011 to 2020.



**Figure 7.** Median center of industry type of rural entrepreneurship in Mianyang in 2011, 2015 and 2020.

#### 4.2. Dynamics of Rural Entrepreneurship Context in Mianyang

Based on the measurement factors identified in previous rural entrepreneurship research (Table 1), this study developed a conceptual framework (Figure 8) with determinants (Table 2) to guide our determinants detection. Physical conditions are represented by natural resources endowment which consists of annual average temperature (Tair.) and precipitation (Prec.) in each different sub-administration of Mianyang. To capture the socio-economic condition, we chose regional GDP (GDP) and the permanent population (Pop.). In combination, these two represent regional labour level and macroeconomic environment, as well as market size capturing investment potential and consumers. The transportation condition was calculated by measuring the road mileage per unit area (km/km<sup>2</sup>) and used to evaluate the accessibility of a region. Electricity consumption in rural areas was also captured. This help captures the level of activity as well accessibility to key infrastructure. Entrepreneurs are sensitive to preferential policies in local areas. Supporting entrepreneurial enterprises can attract more entrepreneurs and local areas with strong policies and support do attract more entrepreneurship [93]. Institutional support can be represented by the presence of local policy and regulations focused on rural entrepreneurship. Focusing on policy support also helped us analyze the development of policies for rural entrepreneurship over time. In this study, we collected regulations published on the websites of local government and rural and agriculture departments related to entrepreneurial content (including policies, regulations, training, services, and financial support) from 2011 to 2020. Local governments respond differently to the policy calls issued by the central government, the increase detected in the number of entrepreneurial policy documents issued represents the government’s emphasis on entrepreneurial activities and support. The last indicator used as a determinant, annual entrepreneurs’ awards, refers to the annual name list of winners of rural entrepreneurial competitions by local area, and the demonstration name list includes role models and pioneers in the development of rural entrepreneurship, rural cooperatives entities, family farms, etc. In China, projects and subsidies related to the agricultural and rural areas are tilted toward demonstration and pioneer units, so the awards were established to encourage local public financial funds and social capital to participate in rural investment. Enterprises on the name list exem-

plify the local entrepreneurial atmosphere and encouragement of entrepreneurship, the more the awards, the higher the level of local government support for rural entrepreneurship. Rural entrepreneurship competitions have been carried out since 2015. The correlation coefficient between rural entrepreneurship and dynamic indicators was calculated by Pearson’s r to reveal how dynamic indicators affect rural entrepreneurship in the form of numerical quantification.

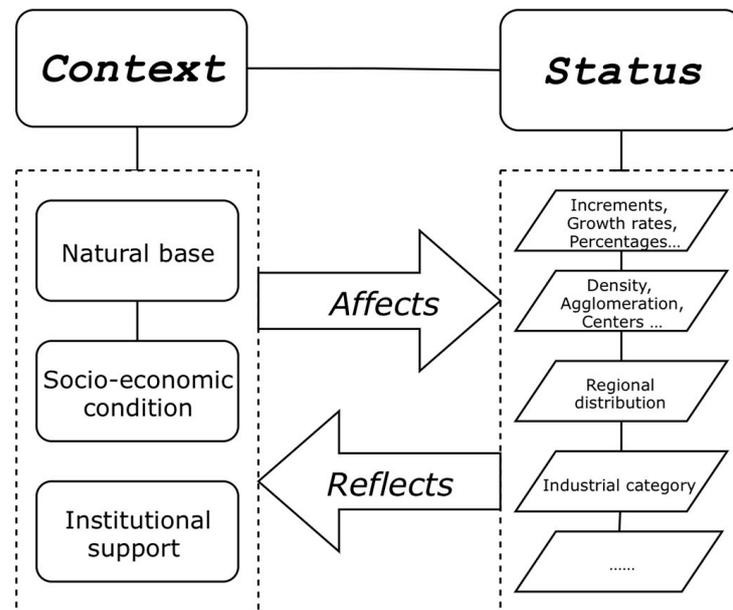


Figure 8. Conceptual framework of determinants detecting spatial context of rural entrepreneurship.

Table 2. Indicators of spatial context rural entrepreneurship.

Indicators	Format	Source
Annual average temperature (Tair)	Natural Base	Statistic Yearbook from 2010 to 2019
Annual precipitation (Prec.)	Natural Base	Statistic Yearbook from 2010 to 2019
Regional GDP (GDP)	Socio-economic Condition	Statistic Yearbook from 2010 to 2019
Permanent population (Pop.)	Socio-economic Condition	Statistic Yearbook from 2010 to 2019
Mileage per unit area (km/km <sup>2</sup> ) (Mile.)	Socio-economic Condition (Infrastructure)	Statistic Yearbook from 2010 to 2019
Rural electricity usage (10 kWh) (Ele.)	Socio-economic Condition (Infrastructure)	Statistic Yearbook from 2010 to 2019
Policy support (Pol.)	Institutional Support	Discourse mining
Annual Entrepreneurships’ Award (Dem.)	Institutional Support	Discourse mining

Correlation differences between the nine sub-administrative areas and overall Mi- anyang, as well as in the top nine industry types are shown in the left and right panel, respectively (Figure 9). Regional GDP is the foremost index that has a positive influence on rural entrepreneurship in all nine sub-administrations, while annual precipitation showed a significantly negative effect. This may reflect the dominant position of the agriculture sector in entrepreneurship as is shown in the right panel. The results showed that the relationship between regional precipitation changes on rural entrepreneurship in 2011–2020 was not significant, the reason for this may lies in that both the temporal and spatial scales of our study are insufficient to capture the impact of climate change on agricultural production. Annual entrepreneurship awards show nonsignificant correlation to any industry in the right panel but significant correlation to some sub-administrations. This implies that

there is little difference in the support of incentive policies among entrepreneurial industries, but there is a difference in the support of pioneer and demonstration competitions of rural entrepreneurship among districts and counties. Especially the negative correlation in Fucheng, Youxian and positive correlation in Zitong and Santai stand out. Fucheng and Youxian are the central city area with large populations, market, and consumer demands where institutional support performed less affect than economic determinants. Yet Zitong and Santai, possesses more national and local awards than other sub-administrations. Fucheng, from the left panel, where there is apparently a strong effect shown by the four socio-economic indicators, benefit largely from its advanced infrastructure system. It also acquired more investments as this district contains important government offices of Mianyang. The positive effect of socio-economic indicators also showed in the Accommodation and Catering industry from the right panel. It is also noteworthy that policy support shows significant correlation to in the Accommodation and Catering industry. The most outstanding indicator correlated to Jiangyou, Population, is the least correlated indicator of Pingwu. This is because Jiangyou is a county-level city with the largest population in all 9 sub-administrations while Pingwu, due to the relatively harsh natural conditions, has experienced a population loss over the past decade.

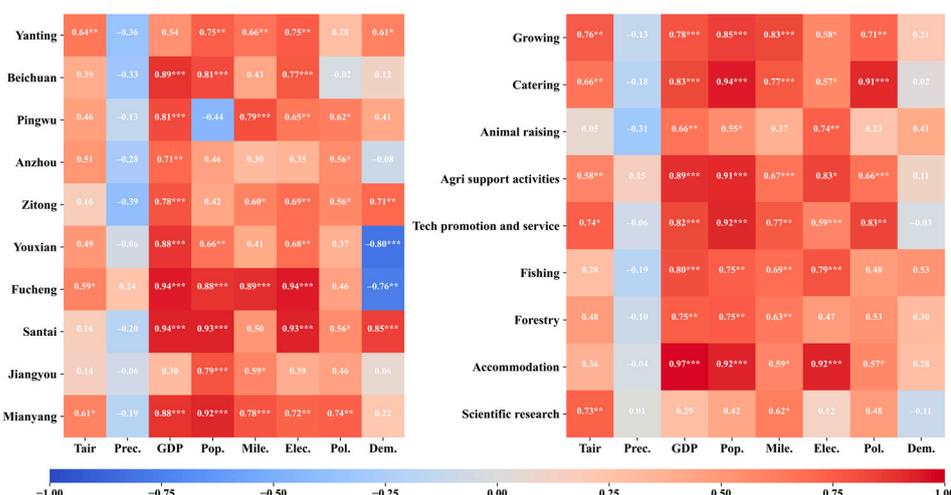


Figure 9. Correlation coefficients of the dynamic indicator of rural entrepreneurship evolution in different sub-administrative areas (left panel) and industries (right panel) Mianyang from 2011 to 2020 (\* indicates  $p$  value < 0.1, \*\* indicates  $p$  value < 0.05, and \*\*\* indicates  $p$  value < 0.01).

### 5. Discussion

Using spatial analysis and correlation analysis methods, this research visualizes the spatial-temporal differences in rural entrepreneurship evolution in Mianyang from 2011 to 2020. From 2011 to 2020, rural entrepreneurship spatially distributed show a decrease from southwest to northeast and showed regional and industrial differentiations, which are mainly attributable to the influence of economic factors and policy support. Based on our analysis above, three major empirical points regarding rural entrepreneurship stand out.

#### 5.1. Infrastructure and Physical Condition

Physical resources such as climate, landscape, and infrastructure are found to be important for rural entrepreneurs [34,52,53] and physical resources such as landscape drives entrepreneurial decisions [94]. Our results on the distribution of rural entrepreneurship at prefectural-level city scale illustrate this. The entire rural entrepreneurial situation in Mianyang is largely defined by the physical terrain. That the majority of enterprises is located in areas less than 1000 m above sea level illustrates this trend. There farming, animal husbandry and catering are the main types of rural entrepreneurship. However, a challenging physical environment also provides opportunities. The study area’s natural resources

represent tourist destinations and provide opportunities for rural entrepreneurship. Impacts of infrastructure on regional start-ups including highways, railways, knowledge and broadband, has been shown in research [95], and in our study where transportation infrastructure reduces market distance and unlock unique resources such as mountain landscape for tourism. This is evident by the significantly higher enterprise clustering seen in Baima compared to the surrounding area (Figure 5) as these are distributed along roads (Figure 3, right panel). Among all 227 rural enterprises started during the last 10 years in Baima, more than 78% of them belongs to the Catering industry, reflecting the tourism resources of Baima-Tibet villages and the presence of the Wanglang National Nature Reserve there. Consistent with this, the most correlated determinant in Pingwu was the Road mileage per unit area (Figure 9). This confirms previous research that the improvement of traffic infrastructure and especially road networks can reduce the negative influence of climate and landscape features on rural entrepreneurship [96].

### 5.2. Necessity of Institutional Support

Economic development policies have been shown to influence rural entrepreneurship [97]. This is seen in Nebraska [98], Romania [99], Uganda [100], and also in Mianyang. Adjusting policies to locally found conditions such as human capital, landscapes, climate, and infrastructure is important for the success of such policies [39,101]. In Europe, rural enterprises have benefited from spatially targeted institutional support via for example the EU's Common Agricultural Policy [102], especially the community-based funding supports for entrepreneurial action from the LEADER approach [103,104]. In Mianyang, the Scientific research industry, which only emerged in 2014, had by 2021 become one of the top nine industry types (Figure 9). This can be strongly associated with policy supporting scientific innovation as well as sustainable development in the agricultural sector. Especially the No.1 policy document from 2012 issued by the Central Committee of the State Council underlined the importance of scientific innovation and development for rural and agriculture entrepreneurship. The No. 1 Document from 2017 pushed this further emphasizing the importance of sustainable production methods. A series of national subsidies for agricultural science and technology projects followed with a focus on new fertilizers, high-efficiency pesticides, soil restoration, water-saving irrigation, etc. In Mianyang, policy support and subsidies for rural entrepreneurship under the slogan of "Mass Entrepreneurship and Innovation" were initiated in 2014. The rise in the Scientific research industry illustrates this general literature point that policy matters for rural entrepreneurship.

Institutional support was also a major driver behind the engagement of migrant workers in rural entrepreneurial activities. Starting from 2015, migrant workers could receive 10,000 yuan as a business subsidy. In 2020, this support was spread out to all types of entrepreneurs in Mianyang [105]. In response to the national call for rural revitalization, Mianyang City started to hold the "Rural Local Talent Innovation and Entrepreneurship Competition" in 2018 to encourage rural entrepreneurship. Indeed, the most correlated factor regarding the whole city of Mianyang is Policy support (Figure 9).

### 5.3. Potential of Rural Tourism

Tourism is a force and tool in rural revitalization. It spurs the local economy by creating employment, generating income, and can help maintain ways of living keeping people in their home regions [106,107]. It has also been of great importance in China since 1980 [108]. This is, as elsewhere [50,109,110], related to the ability of this sector to revitalize and develop the rural economy. Over the study period, tourism was seen as the driving force of economic development in so-called traditionally villages [111], and has been getting more and more support from all levels of governments in China [112]. Visibly growth displayed by the Catering and Accommodation industry reveals in our study a prospering rural tourism sector. More than 62% of Catering entrepreneurship happens in Jiangyou and Fucheng, together with the agglomeration peri-urban area of Mianyang (Figure 5). The latter reflects a type of multifunctional agriculture landscape that fulfills

consumer demands of rural tourism while in close proximity to urban areas [113]. A typical Sichuan consumer preference for leisure agriculture, including ‘Agritainment’ and, so-called ‘Nongjiale’ (farmhouse joy) appeared in the late 1990s and is often engaged in by consumers from urban areas [114,115]. This also echoes the previous point about the need for policy support for rural entrepreneurship. Since 2012, Sichuan Province, recognizing its own decades of “Nongjiale” foundation, has issued a policy named “Opinions on accelerating the development of leisure agriculture and rural tourism, (<https://www.sc.gov.cn/10462/10883/11066/2012/10/23/10233655.shtml>, accessed on 8 March 2023)” investing in institutional support from rural planning, infrastructure investment, etc. Something that also very likely explains our findings from the agglomeration peri-urban area of Mianyang (Figure 5).

The median center of the Accommodation industry located on the relatively northern side of Mianyang indicates likewise tourist developments in Pingwu, Beichuan and Anzhou. “Bed and breakfast’ style tourism appeared in these rural areas. During fieldwork in 2020, we witness the flourishing of rural homestays and the discussion of both difficulty and opportunity by local entrepreneurs in this regard (Figure 10). Consistent with evidence from farms in the US, agritourism shows greater sustainability than other entrepreneurship in terms of job creating, profits increase, natural resource conservation, and benefits to surrounding communities [116].



**Figure 10.** Seminar of rural homestay branch of tourism association in Mianyang and the rural homestay in Pingwu and Anzhou in Mianyang (Photo by author).

Our insights give thus a good overview of rural entrepreneurship as it played out in time and space in Mianyang 2011–2020. Such findings can help policymakers identify trends, support successful development, and identify the factors that either enable or constrain rural entrepreneurship [34]. As China is increasing policy support for this process, such findings are crucial but data from rural areas concerning entrepreneurship is often poor or lacking, also outside China [117]. The data sets and methods used in this paper might help alleviate this issue. Big data has indeed facilitated related research such as rural-urban commuting [118] and rural functions identification [119]. Geocoding of registration data is a useful first step when wanting to understand the distribution and dynamics of business entities [120,121]. Doing this allowed us to explore the importance of social, economic, political, and physical spatial contexts for rural entrepreneurship [52] as well as the development and dynamics of rural entrepreneurship over time and in space. Something that in turn enables targeted policy support adapted to local opportunities and constraints.

Such policy support could focus on infrastructure investments. Based on the undulating terrain within Mianyang, emphasis should be placed on improving the transportation and energy infrastructure in more remote regions like Pingwu and Beichuan. This would enable better market accessibility for various rural businesses there. As for the suburban areas represented by Fucheng, Youxian, Anzhou and Jiangyou, attention should be paid to environmental sanitation infrastructure such as river cleaning and garbage recycling to protect the very environment that distinguishes them from the urban areas of the region and make them attractive for visitors and investors. At the same time, the government could engage in new and innovative ways to encourage private capital, especially entrepreneurial capital, to participate in infrastructure construction.

A better and more differentiated communication, implementation and support of government policies targeting rural revitalization at all levels is needed. The city governments of Mianyang should assess the implementation of entrepreneurship policies in each district and county and organize regular trainings of agricultural science authorities and universities in towns and villages to build a general awareness of entrepreneurial activities available for and successful among rural residents. District and county governments should take the lead in local rural entrepreneurship projects, highlighting advantageous industries and give targeted financial support to entrepreneurial activities. Township governments, as the lowest level government and most knowledgeable about local context, should nominate outstanding local rural entrepreneurs as pioneers and increase the role of successful entrepreneurs in demonstrating and leading rural entrepreneurship.

A quality upgrade of the rural tourism industry that both grasps market trends and maintains cultural values and the natural environment could facilitate further growth in this sector. Mianyang has the foundation of the suburban leisure agriculture industry, as well as the natural landscape and ethnic folk culture to support further tourism. In the face of the current central government's rural revitalization strategy which facilitate the inflow of capital into rural areas, local government's approval of rural tourism project must be based on the protection of the natural environment and local culture as these aspects makes the area attractive for tourism.

Although there is a need to improve indicator selection, calculation methods, and the fact that the data is specific to China, the data sets and methods used in our research thus indicate a general approach to help gain a better understanding of rural entrepreneurship in poorly researched areas and how doing so might at the same time help identify policy recommendations based on local needs, skills and attributes.

## 6. Conclusions

This study provided spatial-temporal insights into rural entrepreneurship in Mianyang, southwestern China. It examined the determinants of rural entrepreneurship distribution in this prefectural-level city over time and in space. Using the registration information of all business entities established in rural Mianyang from 1 January 2011 to 31 December 2020, we explore entrepreneurial developments in this city and found strong differentiation between sub-administrations and various industry types. From our results, the natural environmental background constrains the type of rural entrepreneurship, but the improvement of regional infrastructure alleviates this constraint to a certain extent; policy support including entrepreneurship subsidies has a significant supportive effect on rural entrepreneurship; rural tourism, as the type of entrepreneurship with the fastest rising momentum, both meets the demand for rural industrial integration and responds to the local custom of leisure agriculture, and has obvious development potential. Indeed, spatial-temporal analysis captured the contextual factors influencing rural entrepreneurship in an area that has not yet been analyzed and lay the foundation for a deeper understanding. In doing so, we illustrated the potential and capability of mega data in regional perspective of rural entrepreneurship studies.

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