

Article

Transformation from Rural Industrialization to Suburban Industrialization in Guangzhou: Pattern and Mechanism

Jing Zhang^{1,2}, Weiye Xiao¹ and Wen Chen^{1,3,*}

¹ Key Laboratory of Watershed Geographic Sciences, Nanjing Institute of Geography and Limnology, Chinese Academy of Sciences, Nanjing 210008, China; zhangjing214@mailsucas.ac.cn (J.Z.); ywxiao@niglas.ac.cn (W.X.)

² University of Chinese Academy of Sciences, Nanjing (UCASNJ), Nanjing 211135, China

³ College of Resources and Environment, University of Chinese Academy of Sciences, Beijing 100049, China

* Correspondence: wchen@niglas.ac.cn; Tel.: +86-136-0140-3567

Abstract: Analyzing the trajectory and mechanism of rural industrial change is important for understanding urban–rural integration and facilitating rural revitalization. Based on the data of industrial enterprises in 1112 administrative villages of Guangzhou, China, from 1978 to 2020, we identify the evolution trend of rural industry by investigating the spatial–temporal dynamics of industrial changes in rural areas. An extended triple-process framework incorporating urbanization and greenization was employed to unravel the underlying mechanism of the trajectory of rural industrialization. The results highlight the transformation from rural to suburban industrialization. In the past twenty years, rapid urbanization has contributed to the establishment of development zones. The agglomeration economy has led to a higher concentration of manufacturing industries in these development zones rather than rural areas. The eco-friendly development has resulted in a green transition in rural areas, further restricting the growth of traditional rural industries. Our analysis provides a nuanced picture of Guangzhou’s spatial–temporal dynamics of rural and suburban industrialization. Meanwhile, it emphasizes the importance of urbanization and greenization in explaining the recent transformation of industrialization in China.

Keywords: rural industry; globalization; urbanization; greenization; Guangzhou



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1. Introduction

Industrialization contributes to the progress of the world and has drawn extensive attention in academic research [1,2]. Rural industry has been highlighted as a critical trigger of rural development and economic transition [2–4]. In the developed countries, such as the UK and USA, manufacturing firms were relocated from urban to rural areas during the 1960s and 1970s [5,6]. Rural industry development in developed countries not only stimulates economic development in rural areas, but it also partially alleviates urban problems, such as transportation congestion [6,7]. Meanwhile, developing countries like Nigeria and India used rural industrialization to anchor and sustain economic growth and security [8,9]. Many empirical studies have suggested that industrial development benefited rural areas, e.g., by creating job opportunities and improving rural communities’ welfare [2,10,11]. These benefits highlight the importance of manufactures to rural development [8–10].

However, there are some debates on rural industrialization [5]. Although rural industry contributes to economic development, negative effects are evident, such as resource wastage and environmental pollution [1,12], which are contrary to the goals of environmental protection. Green transition in rural areas is promoted in many countries under the guidance of the goal of sustainable development [13,14]. On the other hand, post-urbanization and premature de-industrialization are leading the shift in urban structure [15,16]. Such a shift generates outflows of production factors such as labor and capital in rural areas, contributing to uncertainty and instability in rural industry development. At the same time,

temporal heterogeneity exists among rural industrialization in different villages. Some villages have completed the process from industrialization to de-industrialization, but some villages still rely on rural industry for development [6,17]. Thus, it is necessary to track the spatial–temporal trajectory of rural industry.

Rural industrialization is considered to be the foundation of the economic miracle of China, which is the largest developing country in the world. Many developing countries are also trying to mirror the success of China’s rural industrial development to explore the development path [3,18]. From the 1980s to the 1990s, China’s rural industrialization, with township and village enterprises (TVEs) as the carriers, developed rapidly, especially in the Pearl River Delta and the Yangtze River Delta [19,20]. However, rural industrialization did not last long due to the acceleration of urbanization in China. Massive investment and more favored policies have flowed into cities since the mid-1990s, widening the gaps between urban and rural areas [21]. TVEs have lost their comparative advantages in market competition, and their bankruptcies have directly contributed to the decline in rural industrialization [19,22]. In the past two decades, the development of rural industrialization has transcended beyond an economic issue, incorporating additional concerns such as the impact on urban–rural integration and green development. The new urbanization and green transition have been increasingly emphasized, which has accelerated the relocation of industrial enterprises from rural areas to industrial parks or towns, altering the pattern of rural industrial decentralization to some extent [5,20,23]. From reform and opening up to the present, industry development in rural areas in China has undergone significant changes. Understanding these changes’ processes, characteristics, and causes can improve China’s experience and help the Global South find a more sustainable path for rural development.

Despite the substantial body of literature on rural industry, there is an urgent need for more research on the progress and driving mechanisms underlying the evolution of rural industrialization. From the perspective of the development in rural non-agricultural industries, many studies use qualitative methods to analyze the patterns, challenges, effects, and development strategies of rural industry [9,11,24,25]. The perspective of rural entrepreneurship has also been used to conceptualize production efficiency, development strategy, and location selection of small- and medium-sized industrial enterprises in rural areas [26,27]. These studies have enriched the literature on rural industrial changes at the micro-scale; however, the overall trend of the evolution of the rural industry needs to be discussed. As for research on rural industrialization in China, it has significantly declined since the reform of TVEs [5,28]. Scholars have primarily focused on the impacts of urbanization on the development of rural industry, whereas the effects of recent changes, such as green policies, have yet to receive sufficient attention [28]. For example, many studies focus on elucidating factors influencing the rise and decline of rural industries [29–31], exploring the developmental efficiency and transitional pathways of TVEs [23,32], and investigating models and impacts of rural industrialization [33,34]. Some scholars have used data on rural industrial land and TVEs to illustrate the evolutionary process of rural industries. However, more discussion is needed on driving mechanisms that underlie evolution [5,32,33].

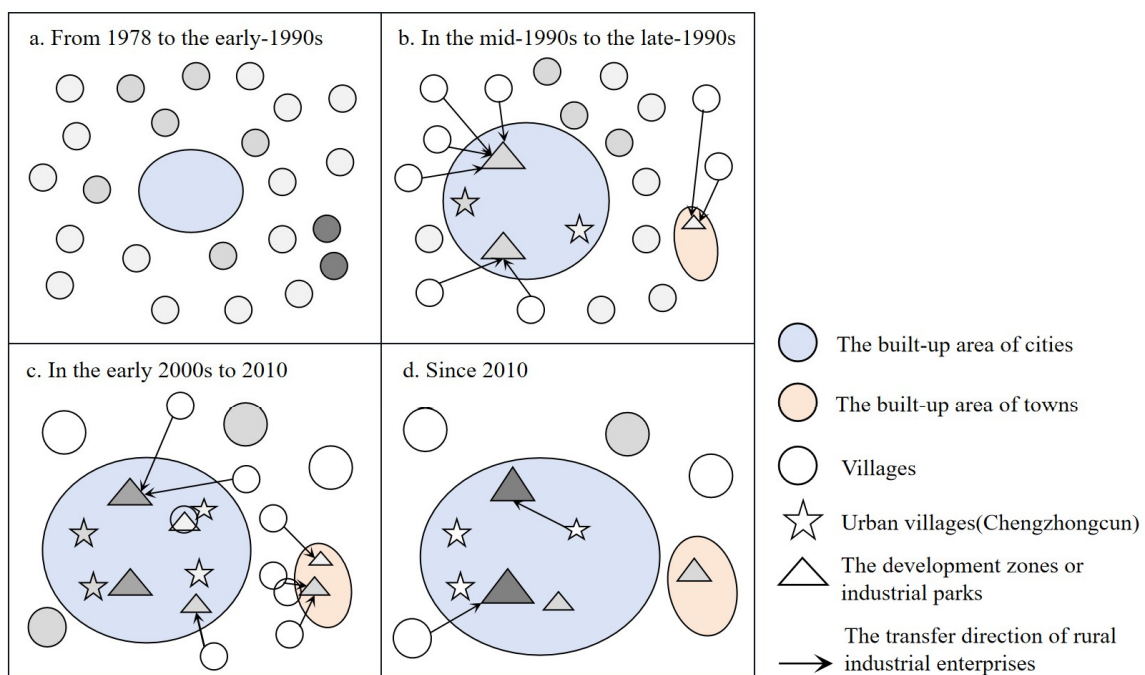
In this paper, we first explore the evolution of rural industrialization in China since 1979 at the macro-level by analyzing the spatial pattern of industrial enterprises in rural areas in the study area. Then, we attempt to understand the evolution of rural industrialization more comprehensively by extending the triple-process framework about Chinese economic transition, including decentralization, globalization, marketization, urbanization, and greenization. We organize the remainder of the paper as follows: Section 2 provides the theoretical basis and research framework. Section 3 introduces the study area, method, and data used in this study. Section 4 presents the results of the spatial analysis. Section 5 tries to explain the mechanism based on the framework. Section 6 contains the conclusions and further discussions.

2. The Theoretical Framework

In this section, we attempt to provide theoretical explanations about the evolution of the spatial pattern and mechanisms of the changes in China’s rural industrialization. The trajectory of rural industry development and the analytical framework are elucidated through discussions of the associated studies.

2.1. The Changes in the Spatial Pattern of Rural Industry

Scholars mainly analyze the evolution of rural industries in two ways: One approach focuses on rural industrial land data, reflecting the evolution process of rural industries through the distribution, scale, and landscape pattern of industrial land [22,33]. The other approach considers industrial enterprises in rural areas as the research object, reflecting the evolution process of rural industry through the number, type, and spatial distribution of enterprises [23,28]. Compared with rural industrial land data, rural industrial enterprise data can not only demonstrate continuous changes over time but also reveal changes in spatial distribution and industrial structure [23,28]. Therefore, we use industrial enterprises in villages as a proxy to reflect the transformation of rural industrialization in this paper [23]. The transformation of the rural industry will go through three stages: (1) remaining in the villages, (2) integrating into cities and towns, and (3) entering industrial parks at the town level and above, as shown in Figure 1.



Note: The degree of grey in graphics represents the number of industrial enterprises. The sequence of number of industrial enterprises from fewest to most is:

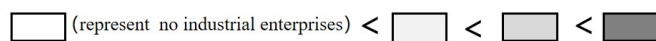


Figure 1. The changes in the spatial pattern of rural industry.

Rural industries developed rapidly from 1978 to the early 1990s due to the establishment of a household contract responsibility system and the relaxation of non-agricultural activities [5,31]. Many labor-intensive industries, such as textile mills, metal mills, and cement plants, sprang up in numerous villages instead of town centers [22,34]. These enterprises fully utilize the advantages of rural areas, such as cheap labor forces and the local markets. In this condition, an intriguing spatial layout of rural industry in China was created, as the factories are mixed with villages [20,32].

Rural industrialization has weakened since the mid-1990s. The rapid expansion of urban areas has contributed significantly to the development of cities and towns [23,35]. There were massive urban–rural migrations in China, causing rural areas to lose their advantage in labor costs [35]. Urbanization has created ample open space for further development, especially designated development zones and industrial parks to support the agglomeration economy [36]. The development zones and industrial parks have shown advantages in cheap labor forces and industrial land supply, attracting many industries from rural areas [22,23]. The villages in remote areas experienced industrial closures and reverted to agricultural villages [32,37]. However, some villages had a good basis for industrial development and could still be able to attract some industries. Compared to the higher land rent costs in urban areas and the higher entry thresholds of industrial parks, villages in or around urban built-up areas have contributed to the accumulation of labor-intensive industries [34,38].

Since the early 2000s, rural industries have been criticized for severe pollution, low productivity, and waste of land resources [39]. The industrial land supply in rural areas was reduced, and an eco-friendly development strategy became a more influential approach [5,20]. Meanwhile, the “Three Concentration” strategy (“Three Concentration” strategies: Farmers concentrate on the community, industry concentrates on the industrial parks, and land on the scale) forced the local governments to transfer rural industrial enterprises to township industrial parks [40]. Only some villages with advantages in location and industrial base could form village-level industrial clusters [41].

Since 2010, with the implementation of environmental policies like the ecological red line becoming more stringent, the survival of the manufacturing industry in rural areas has become increasingly challenging. In addition, urban renewal in recent years has led to the relocation of more industrial enterprises from urban villages or urban fringe villages to industrial parks [23,39]. Thus, many village-level industrial parks, and even town-level industrial parks, have been closed, further reducing rural industrial spaces [5,42].

2.2. The Mechanism of Rural Industrial Transformation

The rural industrial transformation, a complex process, is the result of the cooperative effect of endogenous and exogenous factors [43]. Many studies have shown the effects of policy, systems, social culture, and rural entrepreneurs on transforming rural industry [9,29,41,44]. At the same time, some theoretical hypotheses, such as the constrained location hypothesis and the filter-down hypothesis, are used to explain the reasons for the development of rural industry [4,45]. These studies delineate the mechanism of rural industrial transformation from a micro-perspective, primarily highlighting the factors that contribute to the differences in rural industrial transformation. However, these studies focus on specific cases and cannot draw general conclusions. We aim to analyze the reasons for the decline of rural industry under the framework of economic transition [46]. This framework is popular in describing the change in China’s manufacturing pattern through analyzing the effects of decentralization, marketization, and globalization [47]. Some scholars have used this framework to analyze the reasons for the change in China’s manufacturing pattern [36,47]. Furthermore, China’s rapid urbanization has created more space for industrial development in suburban areas, attracting an influx of many rural industries in recent years. Eco-friendly development strategies require the green upgrading of rural industries, going beyond the economic benefits and leading to the relocation of industries. Therefore, we extend the triple-process analysis framework by integrating urbanization and greenization to explain the development of rural industrialization (Figure 2).

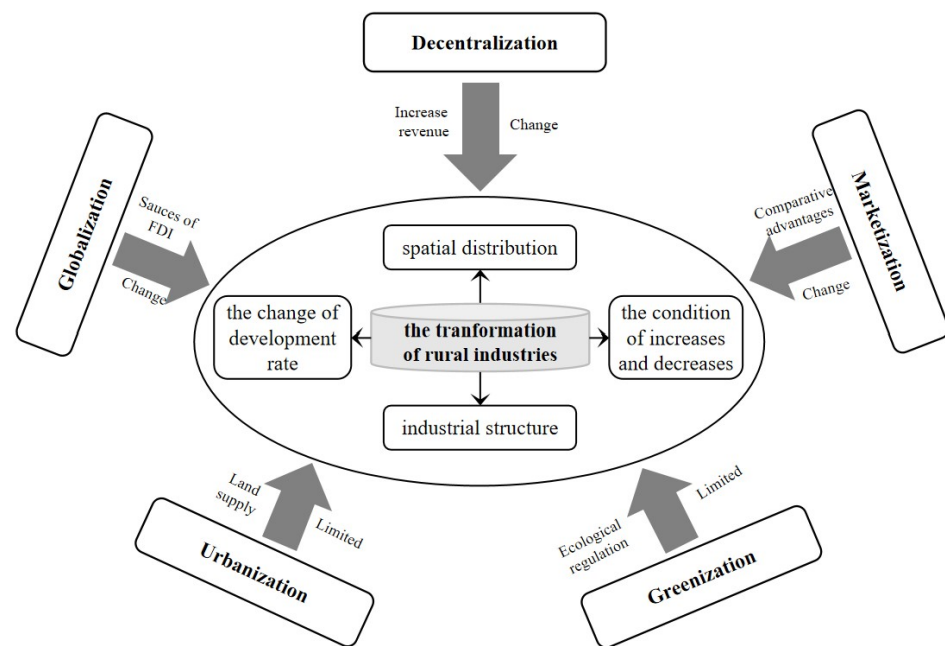


Figure 2. The analytic framework of rural industrial transformation.

2.2.1. Triple Processes and Rural Industrialization

The triple process refers to decentralization, marketization, and globalization, which follow the steps of economic reforms in China. Decentralization broke the state control of economic activities, including fiscal, financial, and investment resources, giving local governments more rights to develop the economy [46]. The choices and actions by local governments directly affect the destinies of industry development in rural areas [48]. During the late 1970s and early 1980s, local governments were allowed to retain the residual revenue after fulfilling the tax quota [31]. Thus, local governments developed a significant incentive to promote local enterprises in rural areas due to the available space and cheap labor force. During that period, the taxes paid by these enterprises became the primary source of local revenue, and the rural industry becomes a critical contributor to China's economic growth [30]. However, the tax reform in 1994 made land sales become the main source of revenue for the local government [30]. The local government attaches great importance to attracting foreign investors through strategies such as building development zones, improving infrastructure, and reducing taxes for businesses located in development zones [30,36]. Many villages were urbanized to create more urban land for sale, accelerating the transformation from rural industrialization to suburban industrialization [29,49].

The core of marketization is to introduce competition mechanisms into economic development, emphasizing the role of comparative advantages and competition [46]. At the early stage of reform and opening up, the market mechanism is imperfect, the urban development is limited, and rural areas have obvious comparative advantages in the low-cost labor forces and the weakened bureaucratic forces [22,29]. However, as marketization progressed in China, the huge rural–urban gaps in infrastructure and economic development have led to huge migration flows from rural to urban areas since the 1990s [21,35]. Under the guidance of the market mechanism, population, capital, and factors continue to gather from rural to urban areas. The comparative advantages in labor forces and capital have shifted to the newly established industrial parks and development zones regarding infrastructure construction, technology acquisition, and market accessibility [36,47]. Therefore, suburban industries became more competitive than rural industries.

Many scholars believe that Chinese success is the result of a radical integration into global capitalism [50]. Among them, foreign direct investment (FDI) is considered to be an essential impetus of economic growth after the open-door policy [51]. The early FDI in China mainly came from Hong Kong, Macao, or overseas Chinese, and it was usually

small and preferred cheap labor and lower production costs [52]. Kinship connections between overseas investors and their hometowns can provide opportunities for rural areas to develop industries [52]. Further globalization brings more investments from many Western countries like the United States and Britain, which are more market-oriented. Their investment would pay more attention to factors such as infrastructure; preferential policies; accessibility to external transportation, like airports or ports; and economic development [53,54]. Therefore, the more agglomerated regions, such as the development zones, are more likely to be the destinations of FDI, while rural industries declined under the challenge of globalization [54].

On the whole, the triple process contributes to the rapid development of China's economy, while also affecting and reshaping the rural areas, causing rural industries to respond and adjust actively or passively [43,46]. Facing the shortage of land resources and the threat of environmental crisis, we have turned to intensive development [55]. In recent years, eco-friendly development strategies, such as cultivated-land protection policies and ecological red lines, have garnered significant attention and have reshaped the development strategy in rural areas. Therefore, it is necessary to revise these triple processes to explain the recent transformation of industrialization in China, and the discussions on urbanization and greenization are expected to provide deeper insights.

2.2.2. Urbanization and Rural Industrialization

Rural industry is the result of the interaction between urban and rural areas, and the development of them is related to the urban cycle [56]. The urbanization effect has an impact on the development goal and demand for rural industry during each stage of the urban cycle [57]. Since the mid-1990s, urbanization in China has been city-based and land-centered, which has established the leading position of large cities [58]. Suburban areas acquired more industrial land by converting agricultural land to meet the demand for establishing development zones [22,58]. The rapid expansion of urban construction land based on development zones or industrial parks has eroded rural areas. Many rural villages transformed into urban villages (Chengzhongcun) and urban fringe villages (Chengbiancun) to accommodate rapid industrial development [55]. At the same time, the "Land Administration Law of China" prohibited the circulation of rural collective construction land [29]. Rural construction land can only enter the market by government expropriation. Under the background of urban bias development, local government has highlighted numerous benefits related to industrial land supply and taxes, tending to give more resources to urban areas or development zones to develop industry [29,33]. The entry threshold to develop non-agricultural industries on collective land has also been greatly improved [29], which became a major barrier to the further development of rural industries.

New-type urbanization was proposed in 2014, introducing new patterns of urban and rural land use [37,55,59]. On the one hand, intensive land use was encouraged to maximize economic benefits with lower costs and higher efficiency [39,42]. Thus, policymakers should decrease the utilization of low-efficient industrial land in rural areas to exchange for developed areas in suburban regions [16,22,33]. A series of policies, such as "linking the increase in urban construction land with the decrease in rural construction land" and the "Three Concentration" strategies, were created to solve the constant shortage of urban construction land and ensure the people's livelihoods based on the land [33,40]. The development zones could maximize agglomeration effects, leading to the concentration of industries. On the other hand, people increase the demand for functions such as food production and environmental protection of rural areas [59]. Natural resources are highlighted in recent developments, and a high percentage of cultivated land is expected in rural areas according to land use regulations in China [29,59]. Rural industry is no longer the priority in rural economic development.

2.2.3. Greenization and Rural Industrialization

The trends in ecological and environmental protection have made China increasingly focused on green development in recent years, elevating it to a national strategy to address the impact of resource and environmental bottlenecks on economic and social development [60]. Government regulation is a key factor in green development, and many scholars agree that government regulations have reshaped the regional industrial structure [61]. Rural areas usually have better natural environments and become the focus of green development [14,48]. Governments are highly sensitive to any risk of pollution in rural areas and publish a series of environmental control policies and supervisory strategies [61]. For example, China has established a “redline” paradigm for protecting ecological environment space. Most of the ecological redline is delimited in rural areas, where built-up land is not allowed, and any pollution emissions are forbidden in the surrounding area [62,63]. Such a phenomenon contributed to the consolidation of rural construction land, which restricted the expansion of rural industries. At the same time, the implementation of industrial pollution control in rural areas has been increasing, for example, implementing the environment monitoring and remediation in rural (EMR-rural) project [64]. These regulations have increased the cost of developing industry in rural areas, particularly the polluting industries like dyeing and paper-making, which provide many job opportunities and high benefits [62,64].

2.3. The Analytical Framework

Synthesizing the literature in Sections 2.1 and 2.2, we find that, under the processes of globalization, marketization, decentralization, and urbanization, rural areas lose the advantages of labor force and land cost and cannot compete with the scale and agglomeration effects brought by urban industries in development zones. With the development of new-type urbanization and greenization, rural areas no longer rely on rural industry, and protecting the ecological environment is emphasized. These factors jointly promote the trajectory of rural industry from rapid development to recession and relocation. Thus, an analysis framework is proposed in Figure 2. Here, we identify four perspectives on the trajectory of rural industrialization, including the annual number of enterprises, the spatial distribution, the distribution of new and closed enterprises, and the types of industries. The underlying mechanism are analyzed in terms of decentralization, marketization, globalization, urbanization, and greenization. More specifically, decentralization mainly refers to the impact of changes in local government behavior, globalization mainly refers to the impact of changes in FDI sources, marketization mainly refers to the impact of changes in urban–rural comparative advantages, urbanization mainly refers to the impact of changes in land use in rural areas, and greenization mainly refers to the impact of ecological regulation.

3. Data and Methods

3.1. Study Area

Guangzhou, the core city of the Pearl River Delta region, is a crucial manufacturing production base with several billion-level industrial clusters, including automobiles, electronics, and petrochemicals. We selected Guangzhou as the study area for the following reasons. First, rural industries used to play an essential role in Guangzhou’s industrial development. As a pioneer in economic reform and one of the most opening-up regions, Guangzhou introduced numerous manufacturing and processing industries. Such a great development in industry is owing to its strategic location adjacent to Hong Kong and Macao, as well as the benefits from the policy preference of “three supplies and one compensation” (sanlai yibu). This initiative significantly contributed to the development of TVEs in the 1980s [52]. In 1999, the industrial output of township enterprises accounted for 47.6% of the total industrial output. On the other hand, Guangzhou has experienced rapid urbanization. Between 1982 and 2022, the total population of Guangzhou increased from 683,900 to 18,734,100, and the urbanization rate increased from 38.8% to 86.48%. Now, it is

highly urbanized. Therefore, studying Guangzhou could provide a comprehensive picture of the transformation from rural to suburban industrialization.

Overall, Guangzhou's development has progressed through three stages [65]. From 1978 to 1990, the urban and rural areas of Guangzhou were relatively distinct, and the development zone was established within the urban area. From 1991 to 2010, Guangzhou underwent suburbanization and successively established 51 development zones and industrial parks at the county level and above. Establishing these development zones has significantly promoted the transformation of rural areas, and de-industrialization was evident in rural Guangzhou [66]. After 2010, urban expansion significantly slowed, and many industrial parks in urban and rural areas have been integrated.

In many village-scale studies of China, scholars treat the scope of administrative villages as rural areas [67]. We took 1122 administrative villages as research units based on the data from Guangzhou's third village planning survey. These villages are mainly distributed in Baiyun, Panyu, Huadu, Nansha, Huangpu, Zengcheng, and Conghua Districts (see Figure 3). Under the development strategies of "expanding in the south, optimizing in the north, advancing in the east, connecting in the west, and adjusting in the middle", the Baiyun, Huadu, Panyu, Huangpu, and Nansha Districts became key areas for transferring traditional industries and cultivating new industries. Meanwhile, the Zengcheng and Conghua Districts were designated as main areas for protecting the ecological environment and developing agriculture.

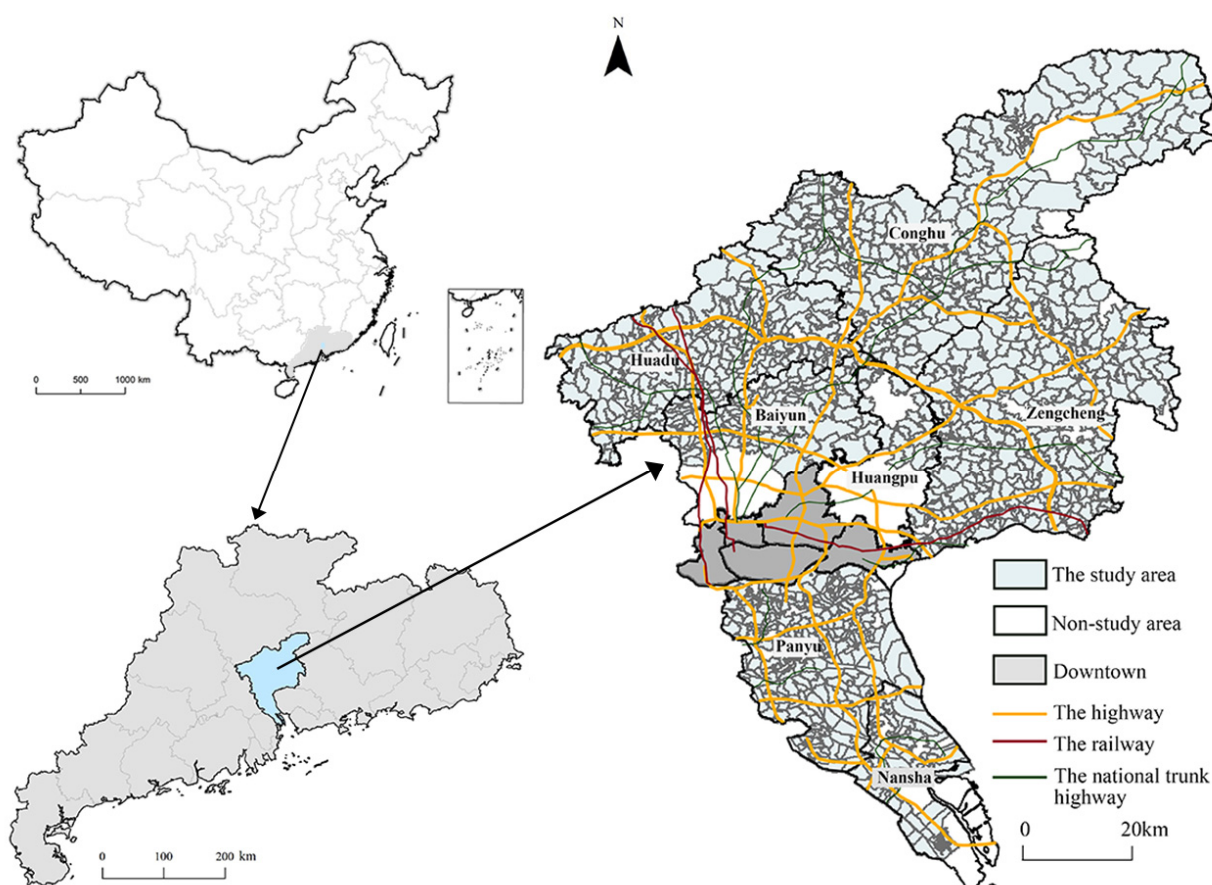


Figure 3. The study area.

3.2. Methods

3.2.1. The Buffer Analysis

The buffer analysis can clearly reflect the differences between different distances. We utilized the buffer analysis method to determine the circle division, illustrating the trajectory of the spatial distribution of rural industrialization by comparing the proportion

of rural enterprises in different distance circles. Liu and Cao studied the layout of the manufacturing industry and found that clear patterns emerge when analyzing every 10 km [68]. Therefore, we use the centroid point of Tianhenan Street as the city center and divide the villages of Guangzhou into multiple circles with the threshold of 10 km. In this research, 0~10 km is the main urban area. The inner suburbs are 10–40 km, including most of the industrial parks and urban development zones [65]. The outer suburbs are 40~120 km, mainly rural areas [65].

3.2.2. The Hot and Cold Spot Analysis

We ventured to explore the spatial changes in rural industries in suburban areas by analyzing the cold and hot spots of new and reduced industrial enterprises in different periods. The 1 km × 1 km grid was used as the basic unit to identify cold and hot spots [69]. We calculated the numerical value of G^* for each research unit and analyzed the distribution characteristics with the numerical value to identify the changes in spatial distribution of rural industry. The calculation formula is as follows:

$$G_i^* = \frac{\sum_{i=1}^n w_{ij} X_i}{\sum_{i=1}^n X_i} \quad (1)$$

Standardizing G_i^* for comparative analysis results as follows:

$$Z(G_i^*) = \frac{G_i^* - E(G_i^*)}{\sqrt{Var(G_i^*)}} \quad (2)$$

where X_i is the attribute value of each grid; W_{ij} is the spatial adjacent weight value of grid i and grid j ; and $E(G_i^*)$ and $Var(G_i^*)$ are the mathematical expectation and variance of G_i^* . When $Z(G_i^*)$ is positive, this means that the grid belongs to the hot-spot area; otherwise, it means that the grid belongs to the cold-spot area.

3.3. Data Sources

3.3.1. Rural Manufacturing Enterprise Data

The manufacturing industry plays a crucial role in industrialization and is the primary sector driving rural industrial development in Guangzhou [35]. The data from manufacturing enterprises are easy to obtain, and the time span of the data is longer. In order to comprehensively illustrate the consecutive process of rural industrial transformation, we analyzed the distribution of manufacturing enterprises from 1978 to 2020 at the village scale to demonstrate spatial–temporal changes. First, we utilized the enterprise investigation platform (<https://www.qcc.com>, accessed on 1 February 2024) to gather information on all manufacturing enterprises registered in Baiyun, Huadu, Panyu, Zengcheng, Conghua, Nansha, Huangpu, and Luogang (which merged into Huangpu District after 2014) before 31 December 2020. We then removed any duplicate or missing data. Then, using these enterprises' names and registered addresses, we utilized Python coding to obtain each enterprise's latitude and longitude coordinates through the Baidu Map API open platform (<https://lbsyun.baidu.com>, accessed on 10 February 2024). Finally, we imported the enterprise data into ArcGIS 10.8 software and used the Guangzhou village vector map for spatial correction and identification.

3.3.2. Other Data

The research in this paper also identifies the scope of urban development areas and industrial parks. Based on Hao's research, we define the 1 km buffer zone of urban construction land as the urban development areas [70]. Because the 1 km buffer zone reaches the maximum 15-min life cycle at the boundary of the largest urban construction area, this area is closely connected to the town. The data on urban construction land from 1978 to 2020 were obtained from the National Tibetan Plateau Scientific Data Center [71]

(<https://poles.tpd.c.cn/en/data>, accessed on 5 March 2024). Meanwhile, based on Ma's research [65] and the Guangzhou Industrial Map, we delineate the spatial scope and spatial location of town-level and above industrial parks in different years. In addition, the data involved in the mechanism analysis mainly come from the statistical yearbooks of each year (<https://data.cnki.net/yearBook/single?nav=%E7%BB%9F%E8%AE%A1%E5%B9%B4%E9%89%B4&id=N2024040008&pinyinCode=YKDNA>, accessed on 15 March 2024).

4. Result

4.1. The Industrial Development Process at the Village Scale of Guangzhou Suburbs

When studying the process of rural industrial change in Southern Jiangsu, Sun and Weng identified three different paths according to the spatial location of rural areas: transferring into industrial parks, integrating into towns, and remaining in the countryside [23]. Among them, transferring into park industrial parks and integrating into towns are part of suburban industrialization [23]. Based on this, we categorized the enterprises in Guangzhou village into three types: (1) in the industrial park at the town level and above (IP), (2) in the urban construction and development area (UD), and (3) staying in the rural area (RI). Among them, IP and UD belong to the category of suburban industrialization, while RI belongs to the category of rural industrialization.

Figure 4 shows the variation in the number and proportion of these three types of enterprises. From 1978 to 2020, the total number of enterprises continued to increase, but the changes in the three types are different from each other. Between 1978 and 1994, the number of enterprises in rural areas accounted for more than 70% of the total enterprises, while the other two types of enterprises began to increase since 1988. Thus, rural industry was prosperous in Guangzhou before 1994. After 1994, the proportion of RI decreased, but the number of IP and UD increased rapidly. From 1994 to 2004, the proportion of RI decreased from 76.8% to 57.4%, while IP and UD increased from 3% and 20.2% to 11% and 31.6%, respectively. From 2004 to 2010, there was a rapid growth in UD, with its proportion reaching 62.9%, while the proportion of RI fell to 26.5%. From 2010 to 2020, the proportion of IP increased from 10.5% to 37.6%, while the proportion of UD decreased. The ratio of enterprises in rural areas remained stable but slightly increased from 2017 to 2020. In general, industrial development has gradually been dominated by suburban industrialization since 1994.

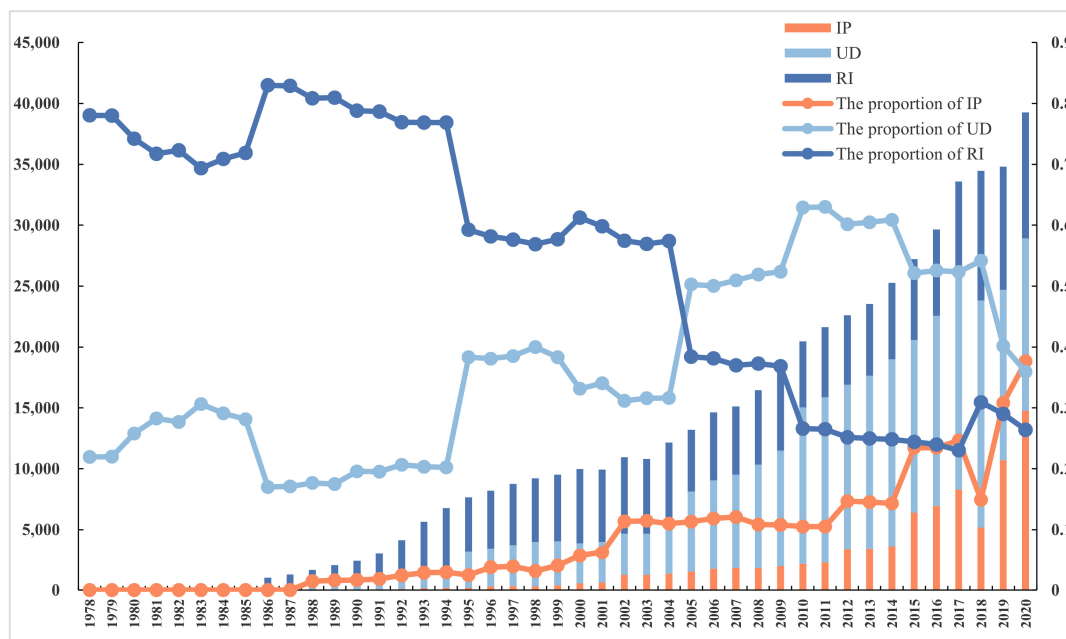


Figure 4. The changes in the number and proportion of three types of enterprises at the village level in Guangzhou suburbs from 1978 to 2020.

4.2. The Change in Industrial Spatial Distribution at the Village Scale of Guangzhou Suburbs

Based on the results of the industrial development process analysis, we selected 1978, 1988, 1994, 2004, 2010, and 2020 for further analysis. According to the result of the buffer analysis, the distance attenuation characteristics of industrial spatial distribution gradually became evident (Table 1). From 1978 to 1994, the industrial distribution expanded from 30 km to 120 km, and the proportion of enterprises within 50~120 km continued to increase. These changes in spatial distribution indicate the rise of rural industrialization. Between 1994 and 2020, the increasing proportion was only found within 10~40 km, where there was a concentration of industrial parks or urban development areas. The proportion of enterprises within 40~120 km decreased, manifesting as the decline in rural industry. The industrial enterprises of Guangzhou at the village more and more gather in inner suburbs.

Table 1. The proportion of industrial enterprises in buffer zone from 1978 to 2020.

The Distance from the City Center (km)	1978	1988	1994	2004	2010	2020
10	0	0	0	0	0	0
10–20	0.317	0.176	0.157	0.213	0.247	0.255
20–30	0.415	0.398	0.348	0.352	0.355	0.341
30–40	0.268	0.268	0.297	0.299	0.299	0.296
40–50	0	0.070	0.075	0.059	0.053	0.070
50–60	0	0.079	0.104	0.070	0.041	0.035
60–70	0	0.007	0.011	0.005	0.004	0.003
70–80	0	0.002	0.005	0.002	0.001	0
80–120	0	0	0.003	0	0	0

Figures 5 and 6 show the results of cold- and hot-spot analyses on the new and closed enterprises in each period for more details on the spatial–temporal changes. As Figure 5 shows, the hot spots of new enterprises were gradually disappearing from rural areas and concentrated in industrial parks. Specifically, the changes are as follows: Between 1978 and 1994, most of the hot spots were scattered in rural areas, mainly distributed in the junction of Baiyun and Huadu District, the northern part of Huadu District, and the southern part of Zengcheng District. From 1994 to 2020, the hot spots in rural areas continued to decrease and mostly disappeared between 2004 and 2020. This change indicated that the rural areas are no longer the growth areas of industrial development. Meanwhile, the hot spots were mainly distributed in urban development areas between 2004 and 2020. Since 2010, however, they have been more concentrated in industrial parks. In summary, the growth of industries shows a tendency to concentrate in industrial parks.

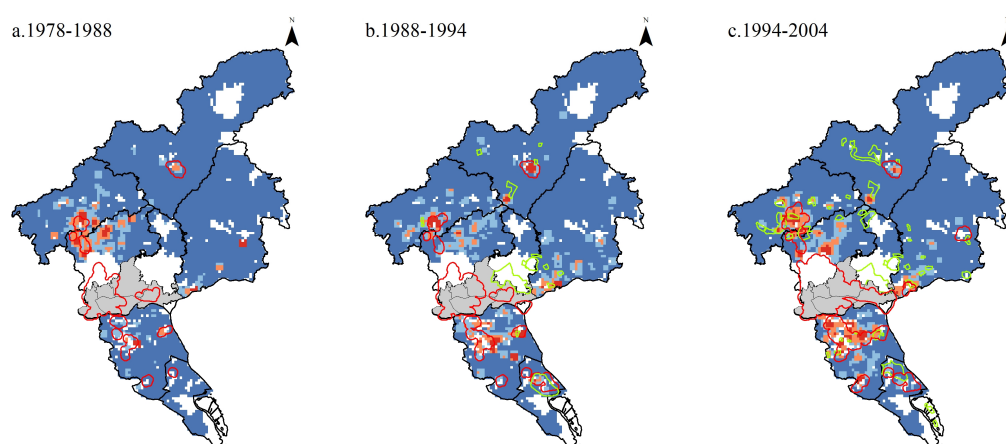


Figure 5. Cont.

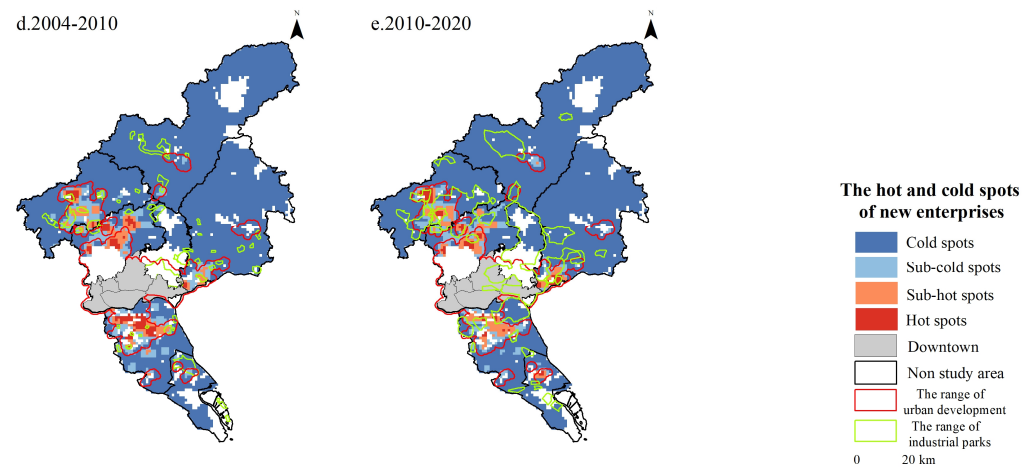


Figure 5. The hot and cold spots of new industrial enterprises in 1978–1988, 1988–1994, 1994–2004, 2004–2010, and 2010–2020.

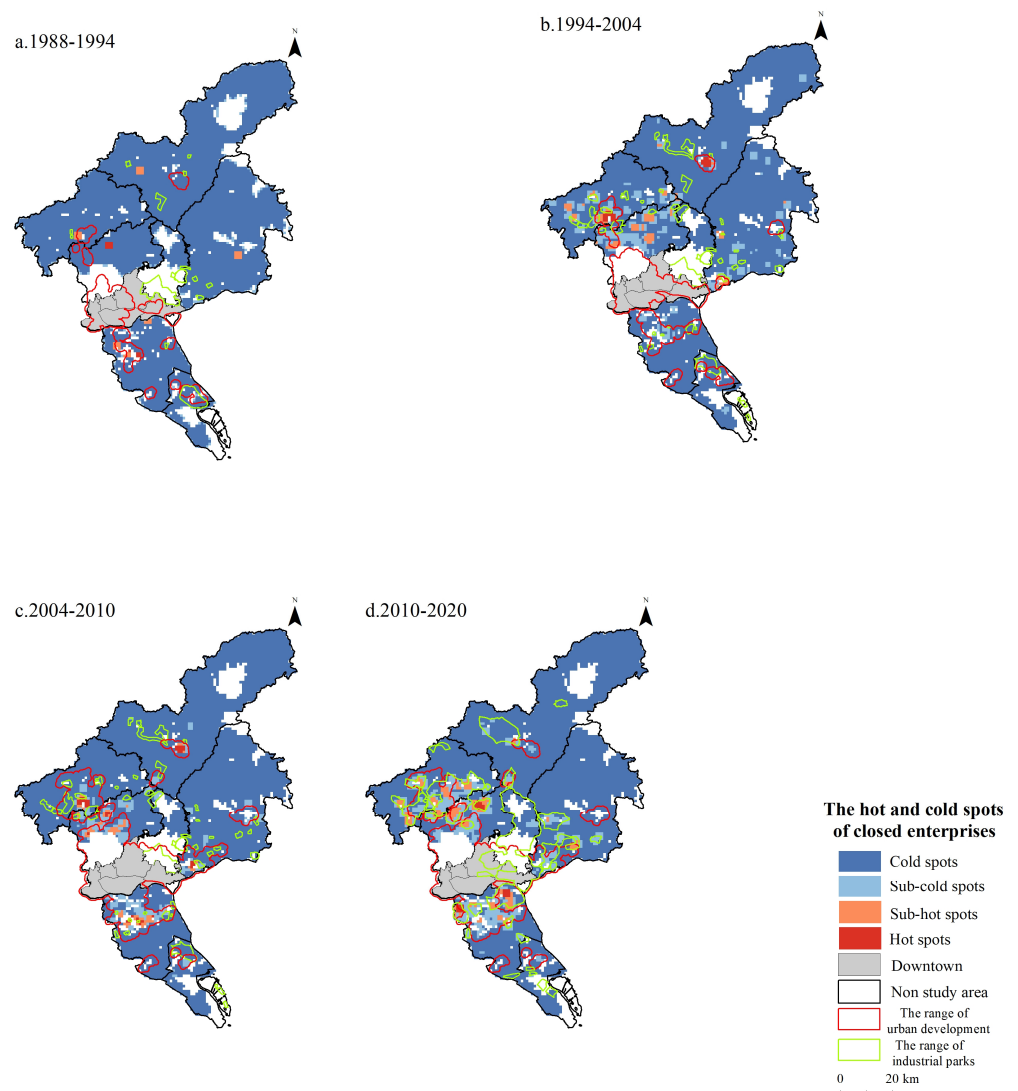


Figure 6. The hot and cold spots of closed industrial enterprises in 1988–1994, 1994–2004, 2004–2010, and 2010–2020.

As Figure 6 shows, there were no cases of enterprise closures in 1978–1988. From 1988 to 2004, the hot spots mainly appeared in rural areas, mostly in the north of Conghua

District, the middle of Baiyun District, and the northwest of Huadu District. Meanwhile, the distribution of hot spots has changed from 2004 to 2020, mainly near the city center. These hot spots were detected in the urban development areas without industrial parks, especially in the middle of Huadu District and the northern part of Panyu District. The close of industries at the village scale was complex and tended to be closer to the city center.

4.3. The Changes in Industrial Structural at the Village Scale of Guangzhou Suburbs

Other than the changes in spatial distribution, industrial structure also experienced dramatic changes in these years, which might be associated with the transition from rural to suburb industrialization. Thus, we analyzed the industrial structure of IP, UD, and RI, respectively (Figure 7a–c). According to the existing research [72], we divide the industries into labor-intensive (C13–15 and C17–24), capital-intensive (C16, C25–26, C28–33, and C24), and technology-intensive (C27, C34–41, and C43) on the basis of the Classification of National Economic Industries (in the version of GB/T4754-2017).

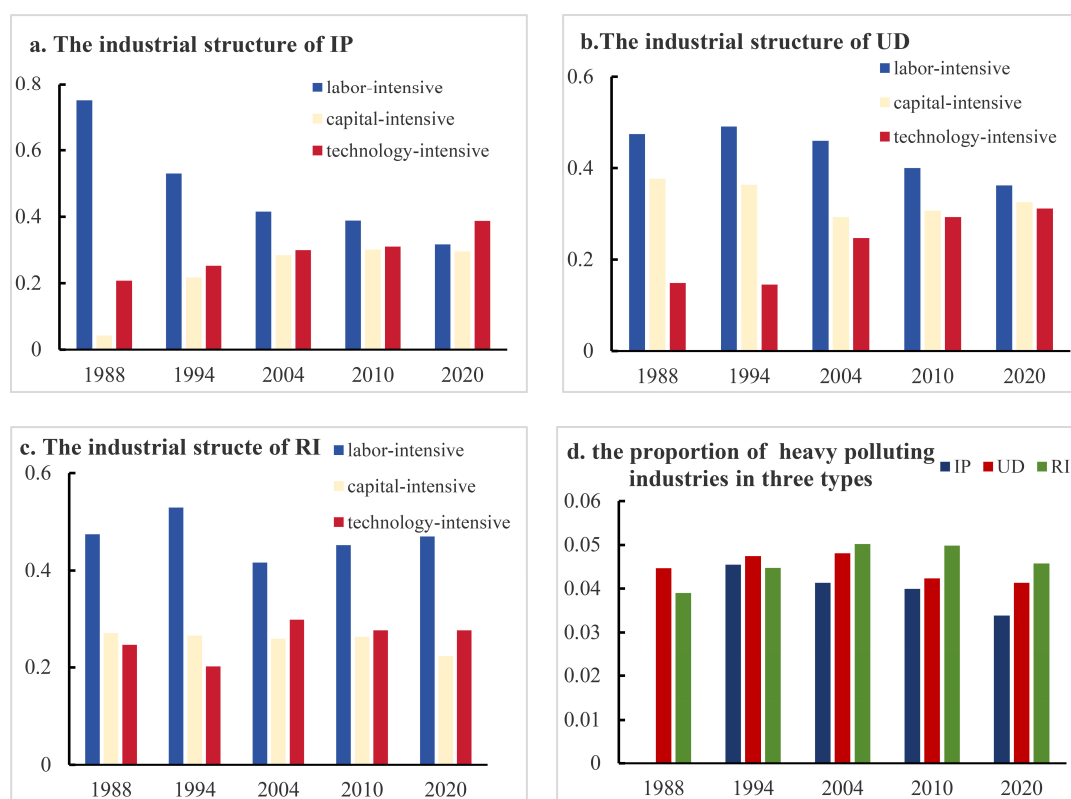


Figure 7. The industrial structural of three types in 1978, 1988, 1994, 2004, 2010, and 2020.

Although labor-intensive industry was the leading one, its share among these three types declines. Among these three types, labor-intensive industry in rural areas declines slowly, while the industrial parks one declines fast. The proportion of technology-intensive and capital-intensive industries increased rapidly in industrial parks and urban development areas, indicating a transformation in industrial structure. Overall, the industry in high-tech parks gradually shifted from labor-intensive to technology-intensive, mainly related to the development of automobile industries. In the suburban region out of the high-tech parks, these three types of industries become balanced. In rural areas, labor-intensive manufacturing industries are still the dominating ones, including textile, leather, and furniture manufacturing, which are prominent. In addition, the number of agricultural and sideline products processing enterprises in rural areas increased after 2010.

In addition, we focused on the changes in the heavy polluting industries (including paper-making, petrochemical, and metal smelting) in three different regions. According to

Figure 7d, we can see that the proportion of heavy polluting industrial enterprises in the three types has shown a downward trend. The proportion of heavy polluting industries decline faster in the high-tech parks than others.

5. The Underlying Mechanisms for Changes in Guangzhou

5.1. The Effect of Triple Processes

Decentralization makes the city government more responsible for economic development [47]. We summarize a series of policies issued by the Guangzhou government to promote economic development (Table 2). From 1978 to 2020, the government's focus on economic development shifted from rural to urban industry. Before 1990, several actions were taken by the Guangzhou government, such as reducing tax revenue to develop township enterprises and establishing the "Spark Plan" to support rural industrial projects. These policies promoted the development of local rural industries in the villages. After the tax-sharing reform, the Guangzhou government focused on city development, which led to a shift in industrial development from rural to urban regions [38,65]. Since 1990, the Guangzhou government has prioritized providing policy support for large-scale enterprises and technology-intensive industries via establishing the development zones, followed by several policies (Table 2). These strategies bring an increase in the number and proportion of IP, as outlined in Section 4.1, and also drive the rise in technology-intensive industries, as discussed in Section 4.3.

Table 2. Some governmental documents for fostering economic development.

Implement Objects	Documents' Name	Year	Main Targets
Industry in rural areas	"Notification on mitigating the income tax burden of collective ownership enterprises"	1980	Reducing the tax of rural industrial enterprises
	"Supplementary regulations about the adjustment of tax burdens on industrial and commercial activities for rural community enterprises"	1982	
	"The interim provisions about reforming the economic management system of collectively owned industrial and commercial enterprises and enhancing production and operational autonomy"	1984	Supporting rural industrial projects
	"The regulations pertaining to the multifaceted development of suburban and township industries"	1987	
	"Notification on publishing and implementing specific regulations for leveraging the scientific and technological advantages of the Guangzhou area and facilitating cross-sector collaboration"	1987	Providing technological support for rural industries
	"Trial measures for developing horizontal economic union in Guangzhou"	1987	
Industry in urban areas	"The 14th city master plan"	1982	Reallocating industries from urban to suburban areas and establishing industrial parks in the suburbs
	"The master plan of the Guangzhou Economic and Technological Development Zone"	1984	
	"The 15th city master plan"	1993	
	"Decision to promote the advancement of reforms and opening-up of the Guangzhou Economic and Technological Development Zone"	1991	Offering policy incentives to industrial parks
	"The fifteen preferential policies aimed at expediting the advancement of the Nansha Economic Zone"	1991	
	"Several Provisions on streamlining administration and decentralization of the Nansha Economic Zone"	1991	
	"Some provisions on further supporting the development of high-tech industries"	1998	Supporting the development of large-scale technology-intensive enterprises
	"Notification of encouraging the development of integrated circuit industry"	2001	
	"Industrial technology policy in Guangzhou"	2003	
	"Opinions about accelerating the cultivation of large backbone enterprises and industry leading enterprises"	2014	
"Opinions on accelerating the innovative development of advanced manufacturing industry"	2016		

We used the proportion of manufacturing FDI to represent the degrees of globalization and conducted a correlation analysis with the proportion of rural industrial enterprises in rural areas [29]. Figure 8 reveals a negative correlation between them. Under the policy of “three supplies and one compensation” (sanlai yibu) and the geographical advantage of being adjacent to Hong Kong and Macao, rural areas in Guangzhou have gained numerous opportunities to develop the processing industry [52]. There were massive labor-intensive manufacturing industries with FDI mainly from Hong Kong and Macao in the early years [52,53]. Thus, labor-intensive industries became the leading manufacturing industry in rural industries between 1978 and 1994, as stated in Section 4.3. Since the late 1990s, Guangzhou has attracted more than 50% FDI from other countries, such as Europe and the United States. These investments contribute to the shift from light industry to heavy industry in Guangzhou [73]. They demand larger space and better infrastructures, mainly flowing into the development zones and industrial parks in the suburbs [74,75]. The villages in these areas have achieved industrial upgrading due to the spillover effect of FDI [22]. Therefore, the industrial structures of UD and IP have clearly changed, with an increasing number of capital-intensive and technology-intensive enterprises (Figure 6a,b), even though the industries in rural areas are still labor-intensive, as shown in Figure 6c.

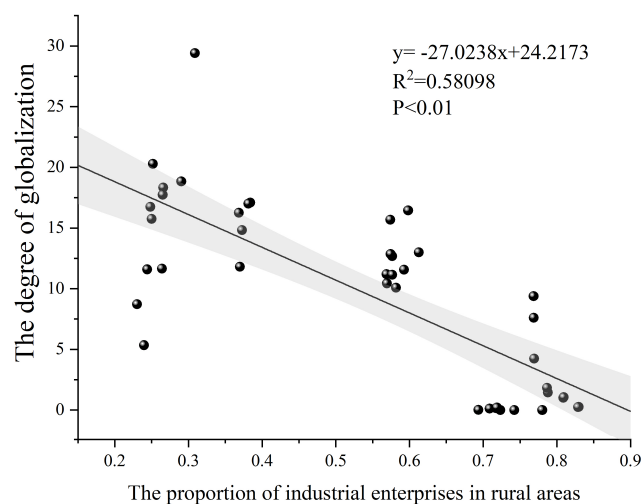


Figure 8. The correlation analysis between the proportion of rural industrial enterprises and the degree of globalization.

The Guangzhou government has actively promoted the construction of numerous development zones to attract larger-scale FDI and technology-intensive and capital-intensive manufacturing industries [76]. Meanwhile, the government has moved some beneficial policies from rural areas to development zones, such as reducing taxes for industrial enterprises in development zones [73]. Therefore, there was a rapid increase in industries from 1994 to 2004 within the 10–20 km buffer area, while the proportion of rural industries in the outer urban area gradually decreased after 2004 (Table 1).

We chose the proportion of private employees to represent the degrees of marketization [29] and also made a correlation analysis with the proportion of rural industrial enterprises in rural areas. The result suggested that they were negatively correlated (Figure 9). Guangzhou’s marketization can be considered the beginning of the reform of state-owned enterprises and township enterprises in 1992, making them more market-oriented [77]. Facing competitive pressure in the market, the enterprise’s investment and location decisions would tighten budget constraints and prioritize profitability [77,78]. Some prominent township enterprises have evolved into group companies and relocated to industrial parks to access new technologies and benefit from agglomeration effects [79]. The movement of TVEs also led to the increased development of industrial parks, as shown in Figure 5. Meanwhile, some villages with a strong foundation for rural industrialization will spontaneously develop industrial clusters to enhance their competitiveness, eventually evolving into large

industrial parks or even new towns [41,75]. In the northern part of Huadu District and the southern part of Zengcheng District, the hot spots shown in Figure 5, industrial parks and new towns were formed through the development of rural industrial clusters [76].

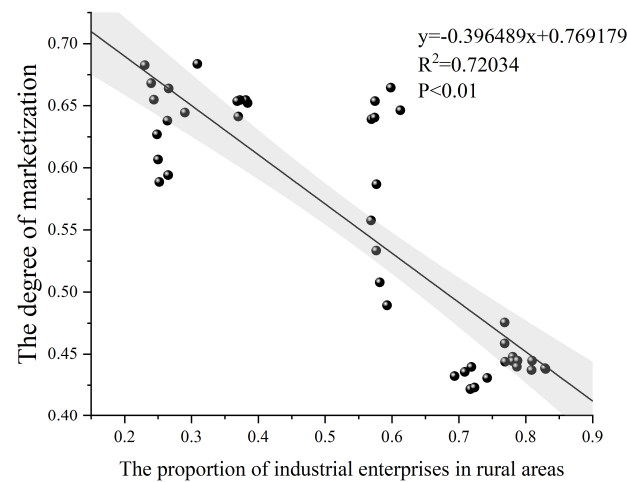


Figure 9. The correlation analysis between the proportion of rural industrial enterprises and the degree of marketization.

The triple processes explained the transformation of rural industries in the early years, elucidating the closure of businesses in rural areas and the emergence of industrial parks. However, some new phenomena cannot be explained using this framework. For example, hot spots for closed enterprises also occur in urban construction and development areas. Thus, we incorporate urbanization and greenization to explain the transformation of rural industries since 2004.

5.2. The Effect of Urbanization

In the early stages, Guangzhou also limited the development of the city. For example, the Guangzhou government issued a rigorous regulation in 1983 to control the influx of rural labor into the city, allowing the surplus labor to remain in the countryside (Table 3). At the end of the 1990s, Guangzhou underwent rapid urban expansion and began suburbanization, leading to the transformation of urban and rural spaces [80]. From 1980 to 2000, the urban built-up area of Guangzhou increased by 159 km², which was twice the area in 1980. Because of dramatic land prices, capital- and technology-intensive enterprises have relocated from central urban areas to local industrial parks in suburban areas. This phenomenon contributed to the urbanization of nearby rural settlements [65]. Meanwhile, there was a significant influx of floating population into the urban area that gathered in the villages around the development zones or built-up areas, promoting the rapid transformation of these villages and rural industry [81]. By 2010, Guangzhou had over 30 villages with populations exceeding 100,000, indicating a clear trend towards urbanization in terms of economic development. Such a transformation of the village's nature has also accelerated the shift from rural to suburban industrialization [23]. The outcomes in Sections 4.1 and 4.2 suggest that the distribution of industrial enterprises shifted from being scattered in rural areas to being concentrated in suburban areas after 1994. Rural areas have become hot spots for the closure of industrial enterprises (see Figure 6). At the same time, more and more enterprises are congregating in urban construction areas, especially in industrial parks (see Figure 5).

Table 3. Some policies implemented in Guangzhou after the new urbanization.

Type	Documents' Name	Year	Main Targets
Controlling rural land use	"Notification on strengthening the management of idle land for non-agricultural construction"	1999	Limiting rural construction land use
	"Regulations on the construction and management of villages and towns in Guangzhou"	2001	
	"Village Planning in Guangzhou"	2009	
Reducing rural land supply	"The plan of implementation regarding trial of intensive land use"	2009	Supplying land mainly to industrial parks
	"The plan of general land use (2016–2030)"	2013	
	"The plan of intensive land use"	2014	
Centralizing rural industrial enterprises	"Three old renewals"	2009	Promoting rural industrial enterprises concentrated to in industrial parks
	"The administration of retained rural collective land"	2018	
	"The police of improving the village-level industrial parks"	2019	
Upgrading rural industries	"Three-year Action Plan for Beautiful Villages in Guangzhou (2016–2018)"	2016	Developing green industry in rural areas
	"The three-year action plan for the construction of a new socialist countryside in Guangzhou (2016–2018)"	2017	
	"Guangzhou Rural Revitalization Strategic Plan (2018–2022)"	2018	

The new-type urbanization strategy has contributed to the adjustment of urban and rural development; it not only accelerates the recession of rural industry but also brings spatial recomposition of rural industry [23,55]. From 2002 to 2008, only 1248 hectares of industrial land increased in rural areas, accounting for 6.2% of the total land supply in Guangzhou [82]. The implementation of the "three old renewals" promotes the transformation of old villages into industrial parks [83], corresponding to the areas with the hot spots of closed enterprises in the middle of Huadu District and the northern part of Panyu District (see Figure 6). "Increase–Decrease Linkage" is a policy that allows the government to exchange industrial land in rural areas for industrial land in suburbs. Such a strategy helps transform fragmented industrial land in rural areas into larger industrial lots in the suburbs to promote better agglomeration. Further policies (Table 3), such as the "Guangzhou Rural Revitalization Strategic Plan (2018–2022)", aim to support the upgrading of rural industries, including leisure agriculture, tourism, and culture. According to Section 4.3, the number of agricultural and sideline product-processing enterprises has increased since 2010. Traditional manufacturing is no longer the primary driver of rural development.

5.3. The Effect of Greenization

Since the 2000s, the Guangzhou government has focused on zoning and protecting ecological function areas and realizing green development (Table 4). On the one hand, Guangzhou has defined the scope and development requirements of ecological control areas through various planning efforts. A total of 80% of the ecological control areas are located in rural areas, further accelerating the closure of rural industrial enterprises. The middle of Baiyun District, the northern part of Conghua District, and the northwest of Huadu District are the hot spots shown in Figure 6 between 2004 and 2020 because they are part of the ecological protection areas. Overall, the scope of environmental protection in Guangzhou is expanding. At present, the area of ecological protection areas that prohibit all kinds of production and economic activities has reached 1059.66 km², accounting for 14.25% of the city's land area. On the other hand, regional development emphasizes the establishment of green industries. For example, Zengcheng District and Conghua District have positioned themselves as ecological and livable areas in the "14th Five-Year Plan" and planned to establish multiple rural green industrial belts. Many villages in Guangzhou have transitioned from rural industrialization to engaging in agricultural production and

developing tourism. For example, Shangjiulongpi Village in Zengcheng District, which used to have over 200 quarries and cement plants in the 1990s, has been transformed into a model village for rural tourism. This also corresponds to the cold-spot areas that consistently occur in Zengcheng District and Conghua District, as shown in Figures 5 and 6.

Table 4. The environmental protection and supervision documents in Guangzhou.

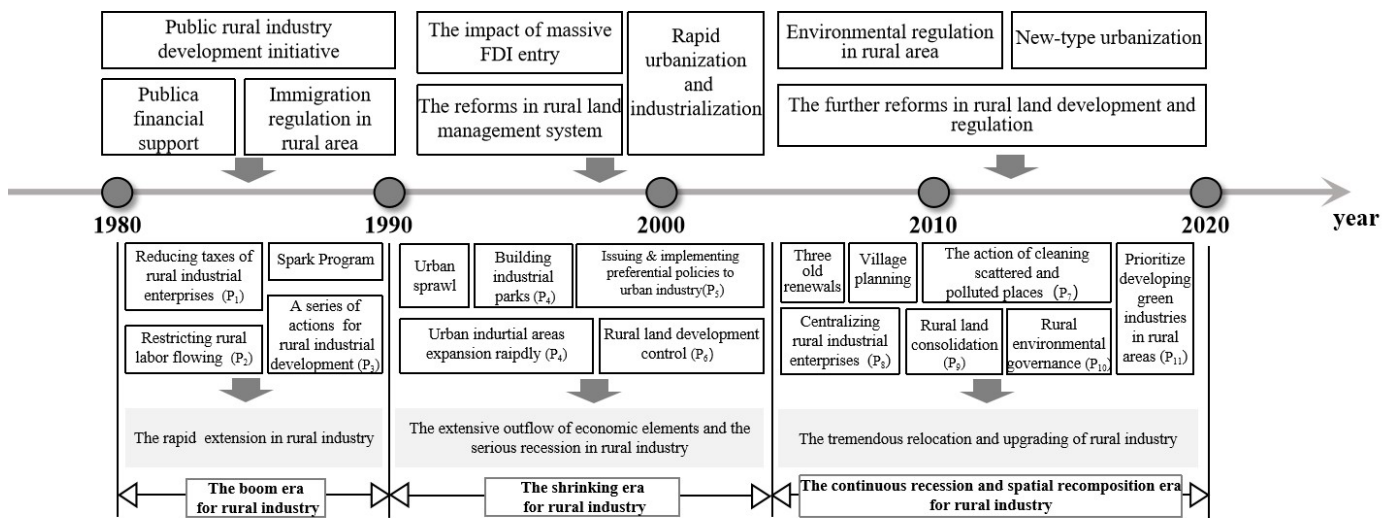
Implement Object	Documents' Name	Publish Time	Main Content	Outcome
Urban District	"Regulations of Guangzhou City on Environmental Noise Management"	1986	<ul style="list-style-type: none"> Prohibiting addition of new enterprises with pollution Relocating the existing polluting enterprises 	➤ Polluting enterprises are transferred from urban to rural areas
	"Regulations of Guangzhou on Prevention and Control of Smoke Pollution"	1986		
The whole City	"Guangzhou Environmental Protection Plan (1996–2010)"	1998	<ul style="list-style-type: none"> Delineating the spatial pattern of ecological protection areas in Guangzhou, mainly distributing in Conghua District and the north of Zengcheng District Drawing the scope of ecological protection Encouraging the development of eco-friendly industries in rural areas 	➤ Adjusting the spatial layout of rural industry ➤ Changing the industrial structure of rural industry
	"The plan for building a national model city of environmental protection in Guangzhou"	2005		
	"Guangzhou's 12th Five-Year Plan for Environmental Protection"	2013		
	"Guangzhou's 13th Five-Year Plan for Environmental Protection"	2016		
	"Guangzhou Ecological Civilization Construction Plan (2016–2020)"	2016		
	"Guangzhou City Environment Master Plan (2014–2030)"	2017		
Rural Area	"The work plan for the implementation of the rural environmental protection action plan in Guangzhou (2018–2020)"	2018	<ul style="list-style-type: none"> Establishing working groups to be responsible for pollution supervision Using big data to monitor the pollution of rural and industrial parks 	➤ Changing the industrial structure of rural industry ➤ Increasing the cost of developing industry in rural areas
	"Guangzhou rural pollution control plan (2018–2020)"	2018		
	"The action plan of Guangzhou City on Strengthening 'Scattered and polluted' places cleaning and rectification"	2018		

Guangzhou has significantly enhanced its environmental supervision of rural areas (Table 4). Before the 1990s, Guangzhou primarily focused its environmental monitoring efforts on its urban areas, while polluting enterprises concentrated in rural areas. This brought the development of polluting township enterprises, such as printing, dyes, papermaking, and metal-smelting industries [79,84]. The Guangzhou government has implemented a series of environmental regulation policies to control industrial pollution in rural areas (Table 4). These policies explicitly prohibited polluting enterprises, particularly the printing, dyeing, and metal-smelting industries. It has led to a decrease in heavy-pollution industries in rural areas. Figure 7 shows that the proportion of heavy-polluting industrial enterprises in rural areas has decreased. In recent years, the government has significantly increased its responsibility for pollution supervision. For example, the "Guangzhou rural pollution control plan (2018–2020)" highlights the government's crucial role in environmental supervision in rural areas and outlines strict punishment measures. These policies have increased the cost of developing industries in rural areas. Only a few township enterprises could meet environmental requirements, while others in rural areas have to relocate to industrial parks for upgrades. It contributes to the rapid decline of rural industrial enterprises, as indicated by Figure 5. In addition, some policies, such as "The action plan of Guangzhou City on Strengthening 'Scattered and polluted' places cleaning and rectification" and "The work plan for the implementation of the rural environmental protection action plan in Guangzhou (2018–2020)", as shown in in Table 4, put more attention on the environmental supervision on industrial parks, especially in rural areas. We can clearly see the trend of village-scale industry closures moving closer to the city center in Figure 6.

6. Conclusions and Discussion

Identifying the evolution and characteristics of rural industry in different regions is significant to the sustainable development of rural areas worldwide. In this research, rural industrialization in Guangzhou serves as a model for understanding the transformation of rural industrialization in China. We investigated the relocation of rural industries and the changes in rural industrial structure from 1978 to 2020. We also developed a five-process framework, which is an extension of the triple-process analysis framework about China’s economic transition [45]. This paper aims to understand the transformation of rural industrialization in China by a case study in Guangzhou at the village level.

In our analysis, we found that the rural industry in Guangzhou has undergone several stages of development, with different influencing factors for each (Figure 10). The rapid development of rural industrialization in Guangzhou mainly occurred between 1978 and 1990, benefiting from the support of the local government. After 1990, the development of rural industry entered a period of decline. The proportion of industries in suburbs was higher than in rural areas in 2004. The development of suburban industrialization was highly related to globalization and marketization, as well as Guangzhou’s urban expansion. Specifically, changes in land-supply strategies are making rural areas lose their competitive advantages in labor and land costs. Agglomeration effects and the increasing significance of connectivity with the main urban center have made the suburbs more suitable for the growth of modern industries. Therefore, we found many hot spots of new enterprises in the development zones in the suburbs, while the hot spots of enterprise closure were predominantly located in rural areas. Since 2010, the declining characteristics of rural industries have changed. On the one hand, we have identified numerous clusters of manufacturing-enterprise closures in urban villages in recent years. On the other hand, traditional labor-intensive manufacturing is no longer suitable for rural areas, and the green transition requires more technology-intensive manufacturing in rural areas. These changes mainly are related to the implementation of intensive land-use strategies and eco-friendly development strategies.



Note: ① P₁ represents the most important policy, where P₁ is “Supplementary regulations about the adjustment of tax burdens on industrial and commercial activities for rural community enterprises (1982)”; P₂ is “Notification for the stringent regulation of rural labor migration to urban areas(1983)”; P₃ is “Trial measures for developing horizontal economic union in Guangzhou(1987)”; P₄ is “The 15th city master plan”; P₅ is “The fifteen preferential policies aimed at expediting the advancement of the Nansha Economic Zone(1991)”; P₆ is “Notification on strengthening the management of idle land for non-agricultural construction(1999)”; P₇ is “The action plan of Guangzhou City on Strengthening “Scattered and polluted” places cleaning and rectification”; P₈ is “The plan of general land use(2016-2030)”; P₉ is “The plan of intensive land use”; P₁₀ is “The work plan for the implementation of the rural environmental protection action plan in Guangzhou (2018-2020)”; P₁₁ is “Guangzhou Rural Revitalization Strategic Plan (2018-2022)”.

Figure 10. The changing process and main reasons in Guangzhou.

Over the past two decades, China’s development has experienced a transition from the original extensive development to the current resource-saving, high-quality development [58,59,61]. Actions from many local governments now focus on optimizing and

adjusting rural industries to address resource shortages in development [32,39]. Implementing de-industrialization in rural areas is suitable for economic benefits and environmental protection, but it also increased the development risk of rural areas [48,56,85]. Particularly, some villages that are not fully urbanized or lack distinctive agricultural and tourism resources still need the industrial sector to foster development [56,85]. However, the majority of policies continue to prioritize the transfer of rural industrial enterprises and the consolidation of rural industrial land, as demonstrated in Section 5. Future policies should pay attention to how to leverage the existing industrial base to identify new comparative advantages [85].

Still, some deficiencies in this paper need to be improved in subsequent research. First, emerging transformations such as deglobalization, the rise of the platform economy, and the effects of the global pandemic are modifying the development of rural industry [86,87]. We can improve the analytical framework for a more comprehensive explanation. Second, the paper tries to investigate the process of rural transformation at the macro-level. However, village-level analyses are still challenging due to the limitation of data availability. We will collect first-hand data through questionnaires and other forms in the future, showing the impact of decentralization, marketization, globalization, urbanization, and greenization. Finally, the development of rural industry is more complex than urban regions, which is influenced by different actors, such as local government, villagers, and investors [44,45]. In future research, more fieldwork is expected to unravel the impacts of these actors' behavior in depth under the progress of economic transition.

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