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# Industrial Agglomeration Spillover and Targeted Rural Revitalization under the "TEHTT" Policy: PLS-SEM Evidence from Zhaoqing's Advanced Manufacturing

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**Abstract:** Against the backdrop of China's comprehensive rural revitalization strategy and the localized "Thousand Enterprises Help Thousand Towns" (TEHTT) initiative, industrial agglomeration has progressively evolved into a core endogenous driver for rural industrial transformation and sustainable economic growth. Despite its recognized importance, empirical assessments quantifying these spillover dynamics remain scarce. Based on 170 valid questionnaire samples collected from nine administrative regions within Zhaoqing City, this paper adopts a Partial Least Squares Structural Equation Modeling (PLS-SEM) approach to rigorously quantify the agglomeration spillover effects generated by the new energy vehicles, metal processing, and electronic information manufacturing sectors. The empirical results robustly demonstrate that advanced manufacturing agglomeration exerts a significant positive promotional effect on rural industrial-driven performance. Furthermore, among the five existing enterprise-village cooperation modes evaluated, industrial chain investment promotion achieves the highest implementation efficiency, highlighting its strategic value. Concurrently, the analysis reveals obvious spatial differentiation across Zhaoqing's counties: core districts, including Sihui and the Dawang High-tech Zone, capture prominent agglomeration dividends due to robust infrastructure, whereas remote mountainous counties face insufficient supporting conditions and weak industrial concentration, limiting their developmental potential. Ultimately, this study supplements localized empirical evidence for manufacturing-driven rural development and provides highly differentiated, actionable industrial layout suggestions to optimize regional targeted revitalization governance and foster balanced territorial development.

**Keywords:** industrial agglomeration; advanced manufacturing; rural revitalization; industrial chain; structural equation modeling

Received: 09 June 2026
Revised: 25 July 2026
Accepted: 05 August 2026
Published: 10 August 2026



## 1. Introduction

The global sustainable development agenda, as represented by the United Nations Sustainable Development Goals (SDGs), has placed inclusive rural growth at the forefront of strategic priorities. From the perspective of New Economic Geography, the concept of specialized industrial clustering offers a pathway to achieve resource sharing and factor spillover. This approach effectively addresses persistent rural challenges such as fragmented production structures and limited technical capabilities. In this context, China's "Thousand Enterprises Help Thousand Towns" (TEHTT) policy emerges as a significant institutional innovation. This policy is designed to facilitate the integration of urban industrial capital into rural areas, thereby dismantling the barriers that traditionally separate urban and rural factors. Through a structured enterprise-town cooperation model, the policy aims to foster balanced development. Since its implementation, the Zhaoqing municipal government has actively promoted partnerships between over 1,200 market entities and grassroots towns. These efforts have resulted in cumulative investments amounting to 3.27 billion RMB, with 586 industrial projects officially

established, as per official statistical reports [1, 2]. This initiative underscores the potential of targeted policies to catalyze rural industrial transformation and economic integration.

Despite the promising outcomes of such policies, existing literature predominantly focuses on macro-level analyses at the provincial scale or qualitative summaries of individual case studies. There is a noticeable gap in quantitative research that disaggregates prefecture-level cities into distinct zones, such as core urban areas, plain counties, and remote mountainous regions, to evaluate the varied impacts of enterprise assistance policies. Furthermore, there is a lack of empirical data to compare the efficiency of different models of village-enterprise cooperation. Current hypotheses and research often generalize the effects of enterprise pairing from a broad county-level economic perspective, overlooking the spatial heterogeneity that characterizes prefecture-level regions [3]. Preliminary studies conducted in Zhaoqing provide a foundational understanding of the region's dynamics, but they fall short of offering comprehensive insights. Addressing this research gap, the present study focuses on Zhaoqing's advanced manufacturing sector as a case study. By utilizing field survey data and Partial Least Squares Structural Equation Modeling (PLS-SEM), the study tests three core hypotheses and proposes tailored industrial strategies. The research aims to make three key contributions: quantifying the influence of Zhaoqing's three primary advanced manufacturing clusters on rural industrial upgrading, empirically evaluating the efficiency of five prevalent firm-village cooperation models, and identifying spatial heterogeneity patterns to develop targeted industrial policies for core urban areas, plain counties, and mountainous towns.

1. Quantify the driving coefficient of Zhaoqing's three pillar advanced manufacturing clusters on rural industrial upgrading. This involves a detailed analysis of how these clusters contribute to enhancing the industrial capabilities of rural areas, focusing on metrics such as productivity, employment generation, and technological diffusion. By establishing a quantitative framework, the study seeks to provide actionable insights into the mechanisms through which advanced manufacturing can serve as a catalyst for rural development.
2. Empirically rank the practical efficiency of five mainstream firm-village cooperation models. This entails a comparative evaluation of different cooperation frameworks, assessing their effectiveness in achieving sustainable rural development. Factors such as resource allocation, operational efficiency, and socio-economic impact will be analyzed to determine the relative strengths and weaknesses of each model. The findings aim to guide policymakers and stakeholders in selecting the most effective cooperation strategies.
3. Reveal spatial heterogeneity law and formulate zoning targeted industrial policies for core, plain, and mountain towns respectively. This involves identifying the unique characteristics and developmental needs of each zone, enabling the formulation of customized industrial policies. By addressing the specific challenges and opportunities in core urban areas, plain counties, and mountainous regions, the study aims to promote balanced and inclusive regional development.

## 2. Policy Background and Theoretical Basis

### *2.1. Policy Context*

"TEHTT" represents a localized adaptation of the broader national policy aimed at fostering collaboration between enterprises and rural areas. This initiative encourages manufacturing enterprises to transfer specific production processes, establish auxiliary workshops, and develop raw material supply bases in nearby villages through structured partnerships. The overarching goal is to stimulate rural economic development while simultaneously enhancing industrial efficiency. Over time, Zhaoqing has emerged as a prominent example of this policy's implementation, with the formation of three distinct advanced manufacturing clusters. These include the concentration of new energy vehicle spare parts in Sihui, the aggregation of metal deep-processing industries along the Gaoyao

industrial belt, and the centralization of electronic information and new energy storage industries within the Daw High-tech Industrial Park. Each of these clusters reflects unique industrial specializations, which in turn dictate the allocation of resources and the nature of economic feedback to surrounding rural areas. This variation in industrial focus and regional dynamics underscores the importance of examining the heterogeneity of outcomes associated with such policies. By analyzing these differences, researchers can better understand the interplay between industrial development and rural revitalization, offering valuable insights for optimizing policy implementation and achieving balanced regional growth [3, 4].

*2.2. Theoretical Foundation*

Agglomeration within the framework of new economic geography facilitates the sharing of critical resources and infrastructure, creating a synergistic environment that benefits enterprises. This includes the pooling of skilled human resources, which enhances the efficiency of labor allocation and matching, as well as the promotion of knowledge exchange that fosters innovation and technological advancement [5, 6]. Such dynamics contribute to reducing the marginal costs of enterprises, enabling them to operate more competitively. Furthermore, the clustering effect stimulates the development of auxiliary industries in rural areas, particularly those that are upstream or downstream in the supply chain. This interconnected growth not only strengthens the industrial base but also provides rural communities with opportunities for economic diversification and resilience.

The regional innovation system theory emphasizes the importance of technical exchanges within industrial clusters. These interactions accelerate the diffusion of advanced technologies from larger, more established enterprises to smaller, rural processing workshops. This process enhances the technological capabilities of smaller entities, enabling them to improve production efficiency and product quality. By fostering an environment of continuous learning and innovation, the cluster model ensures that technological advancements are not confined to a few large players but are disseminated across the entire ecosystem. This inclusive approach to innovation strengthens the overall competitiveness of the rural economy.

Institutional economics highlights the role of stable and supportive government policies in fostering industrial agglomeration. Such policies mitigate the risks associated with cross-regional investments, providing a secure environment for enterprises to expand and collaborate. By ensuring consistency and reliability in policy implementation, governments can attract long-term investments that contribute to the consolidation and growth of industrial clusters. This stability not only encourages the scaling up of existing operations but also attracts new entrants, thereby reinforcing the agglomeration effect [7]. The resulting economic benefits extend to rural areas, where increased industrial activity generates employment opportunities and stimulates local development.

The integration of these three theoretical perspectives—new economic geography, regional innovation systems, and institutional economics—provides a comprehensive framework for understanding how manufacturing agglomeration can empower rural economies [8]. By leveraging the synergies of resource sharing, technological diffusion, and policy stability, industrial clusters create a robust foundation for sustainable economic growth. This multidimensional approach ensures that the benefits of agglomeration are not only concentrated in urban centers but also extend to rural areas, fostering balanced regional development and reducing economic disparities.

*2.3. Research Hypotheses*

As illustrated in Figure 1, this study derives three research hypotheses sequentially from practical policy background and three classical economic theories, forming the core logical premise for subsequent empirical test. The hypotheses are constructed to explore the relationship between advanced manufacturing agglomeration, industrial chain investment promotion models, and spatial heterogeneity in influencing industrial-driven performance. By integrating theoretical foundations with real-world policy

considerations, the study aims to provide a comprehensive framework for understanding the mechanisms underlying industrial development. The logical framework depicted in Figure 1 serves as a visual representation of how policy background and economic theories converge to inform the hypotheses, ensuring that the research is grounded in both theoretical rigor and practical relevance. This approach underscores the importance of aligning empirical investigations with established economic principles while addressing the nuanced dynamics of industrial agglomeration and spatial differentiation. The hypotheses are designed to systematically test the effects of agglomeration spillovers, investment models, and spatial conditions on industrial performance, offering insights that can guide policy formulation and strategic planning in the context of economic development [1].


**Figure 1.** Logical Framework of Policy Background, Theoretical Foundation and Research Hypotheses

H1: Advanced manufacturing agglomeration significantly improves industrial-driven performance. Agglomeration is posited to generate three distinct spillover effects that collectively enhance the scale and efficiency of rural industries. These spillover effects include knowledge diffusion, labor market pooling, and input-output linkages, which together foster an environment conducive to industrial growth. The hypothesis emphasizes the transformative potential of agglomeration in leveraging localized advantages to drive economic performance, particularly in rural areas where industrial development may face structural challenges [9]. By concentrating manufacturing activities within specific regions, agglomeration facilitates the optimization of resources, promotes innovation, and strengthens competitive advantages, thereby contributing to sustainable industrial expansion.

H2: The industrial chain investment promotion model achieves stronger agglomeration effects than other models. This hypothesis highlights the superiority of chain investment models in realizing comprehensive industrial layouts that span the entire production process, from raw material procurement to finished product delivery. Unlike scattered single-project assistance, chain investment models enable higher levels of synergy by integrating various stages of production within a cohesive framework. This approach not only enhances operational efficiency but also fosters collaboration among enterprises, thereby amplifying the agglomeration effects [10]. The hypothesis underscores the strategic importance of adopting investment models that prioritize interconnectedness and systemic integration to maximize industrial performance and regional economic benefits.

H3: Spatial heterogeneity significantly influences industrial-driven performance. This hypothesis examines the role of spatial differentiation in shaping industrial outcomes, emphasizing the varying levels of infrastructure and development across different regions. Core zones with complete supporting facilities are expected to exhibit superior industrial performance compared to plain counties with moderate conditions and mountain towns with insufficient infrastructure [11]. The hypothesis aligns with the principle of inclusive development, which recognizes the need to address spatial disparities to achieve balanced economic growth. By analyzing the impact of spatial heterogeneity, the study aims to identify strategies for optimizing industrial development in diverse geographic contexts, ensuring that economic benefits are equitably distributed across regions.

## 3. Data and Methodology

### *3.1. Data Source*

A comprehensive field questionnaire investigation was carried out over a three-month period, from May to July 2025, encompassing nine county-level administrative units within Zhaoqing. These units included urban areas such as Duanzhou, Gaoyao, and Sihui, as well as Dinghu and the Dawang High-tech Zone, alongside four mountainous counties: Huaiji, Guangning, Deqing, and Fengkai [12]. The study employed a stratified random sampling method to ensure a representative distribution of respondents across various stakeholder groups. These groups included enterprise managers, village cadres, and cooperative principals, reflecting a diverse range of perspectives and experiences. A total of 179 questionnaires were distributed during the investigation, with 170 valid responses successfully collected, resulting in an impressive valid response rate of 95%. This high response rate underscores the reliability and robustness of the data collection process, providing a solid foundation for subsequent analysis and interpretation of the findings.

### *3.2. Variables*

The dependent variable in this study is industrial-driven performance, which encompasses several critical dimensions: the strength of the industrial foundation, the availability and quality of the talent reserve, the willingness of rural communities to participate in industrial activities, the adequacy of rural infrastructure, and the effectiveness of policy implementation. These dimensions collectively provide a comprehensive measure of how industrial activities contribute to regional development. The independent variable is the intensity of advanced manufacturing agglomeration, which reflects the concentration and integration of advanced manufacturing industries within a specific area. This variable is pivotal in understanding the role of industrial clustering in driving economic and social outcomes. Moderating variables include five distinct cooperation modes and the regional spatial attributes, categorized as core, plain, or mountain regions. These moderating factors are essential for analyzing how contextual and cooperative dynamics influence the relationship between industrial agglomeration and performance outcomes. Additionally, control variables such as the scale of enterprises and the number of years they have participated in assistance programs are included to account for variations that may arise due to organizational size and experience. These control variables ensure that the analysis remains robust and accounts for potential confounding factors, thereby enhancing the reliability of the findings [13].

### *3.3. Reliability and Validity*

As shown in Table 1, all constructs demonstrate robust internal consistency and strong convergent validity. Specifically, the Cronbach's alpha values for each construct exceed the widely accepted threshold of 0.7, indicating a high level of reliability in the measurement scales used. Similarly, the Composite Reliability (CR) values are also well above the 0.7 benchmark, further confirming the internal consistency of the constructs. Additionally, the Average Variance Extracted (AVE) values surpass the critical threshold of 0.5, which signifies that a substantial proportion of the variance in the observed variables is explained by the underlying constructs. These results collectively validate the reliability and validity of the measurement model employed in this study. The adherence to these statistical benchmarks ensures that the constructs are both reliable and valid, providing a solid foundation for subsequent data analysis and interpretation. Table 1 provides a detailed summary of these reliability and validity test results.

**Table 1.** Reliability and Validity Test Results

| Construct | Cronbach's Alpha | Composite Reliability | AVE |
|---|---|---|---|
| Industrial-driven Performance | 0.975 | 0.980 | 0.9 |
| Industrial Agglomeration | 0.972 | 0.981 | 0.916 |

All indicators meet or exceed the critical thresholds for reliability and validity, as evidenced by Cronbach's alpha values greater than 0.7, Composite Reliability (CR) values exceeding 0.7, and Average Variance Extracted (AVE) values above 0.5. These thresholds are widely recognized as essential criteria for assessing the quality of measurement models in academic research. The high Cronbach's alpha values indicate that the items within each construct are highly correlated, reflecting strong internal consistency. Similarly, the elevated CR values confirm that the constructs are measured with a high degree of precision and reliability. The AVE values, which measure the proportion of variance captured by the construct relative to the variance due to measurement error, further validate the convergent validity of the constructs. These findings collectively affirm the robustness of the data and the appropriateness of the measurement model for supporting the study's objectives.

## 4. Spatial Distribution and Agglomeration Analysis

### *4.1. Overall Industrial Structure*

The three dominant manufacturing sectors play a pivotal role in shaping the industrial landscape of assisted rural development projects, collectively accounting for over 60% of the total initiatives. These sectors—new energy vehicles and parts, metal processing, and electronic information—serve as the primary drivers of economic transformation in rural areas. Specifically, the new energy vehicles and parts sector contributes 23.53%, reflecting the growing emphasis on sustainable and environmentally friendly technologies [2]. Metal processing, which accounts for 21.18%, underscores the importance of foundational industries that support a wide range of downstream applications. Meanwhile, the electronic information sector, comprising 18.82%, highlights the increasing integration of digital technologies into rural industrial frameworks. Together, these sectors form a synergistic core that not only fosters economic growth but also promotes technological innovation and industrial diversification in rural regions.

### *4.2. Spatial Heterogeneity*

Sihui: The industrial landscape in Sihui demonstrates a notable development in the sectors of new energy vehicles and metal processing, with respective aggregation rates reaching 30% and 41.67%. This indicates a significant level of industrial specialization and integration. Furthermore, the region benefits from comprehensive supporting facilities that enhance operational efficiency and foster sustainable growth. Such infrastructure not only facilitates the smooth functioning of existing enterprises but also attracts potential investors and stakeholders, thereby contributing to the overall economic vitality of the area.

Dawang Subdistrict: The industrial park in Dawang Subdistrict is strategically oriented towards high-tech industries, with a focus on electronic information and energy storage. This emphasis on advanced technologies positions the region as a hub for innovation and development. The establishment of such specialized parks promotes technological advancements and creates opportunities for collaboration among enterprises. Additionally, the prioritization of energy storage aligns with global trends in renewable energy and sustainability, further enhancing the district's competitive edge in the industrial sector.

Duanzhou & Gaoyao: These regions are characterized by their focus on light manufacturing and leisure agricultural processing. The integration of light manufacturing with agricultural processing reflects a balanced approach to industrial development, leveraging local resources while maintaining environmental sustainability. This dual focus supports the diversification of the economic base, providing resilience against market fluctuations. Moreover, the emphasis on leisure agricultural processing highlights the potential for value-added products and tourism-related activities, which can further stimulate regional economic growth.

Four mountain counties: The industrial structure in the four mountain counties is marked by the presence of scattered small-scale processing enterprises. These enterprises

exhibit a low degree of agglomeration, which limits their ability to absorb and utilize rural resources effectively. The dispersed nature of these industries poses challenges in achieving economies of scale and optimizing resource allocation. Addressing these limitations requires targeted interventions, such as fostering cooperative networks and enhancing infrastructure, to improve the overall industrial capacity and economic integration of these counties.

*4.3. Governance Model Preference*

Industrial chain investment promotion (27.06%) > co-built industrial platform (21.18%) > village-enterprise joint wealth (15.29%) > PPP infrastructure cooperation > sporadic single aid. Among these governance models, industrial chain investment promotion ranks highest due to its ability to provide a comprehensive industrial layout. This approach aligns with the principles of collaborative agglomeration efficiency, ensuring that resources are utilized optimally across interconnected sectors. Co-built industrial platforms, which rank second, offer a structured framework for shared growth and innovation. Village-enterprise joint wealth initiatives, while less prominent, emphasize localized economic development and community engagement. PPP infrastructure cooperation and sporadic single aid, though less impactful, still play a role in addressing specific developmental needs. Overall, the preference for industrial chain investment reflects a strategic focus on maximizing economic synergy and fostering sustainable industrial ecosystems.

*4.4. Agglomeration Performance*

Core agglomeration towns demonstrate a significant capacity to foster accelerated rural employment growth and a notable increase in resident income levels. This phenomenon can be attributed to the concentration of industries and resources, which creates a synergistic environment conducive to economic development. In contrast, mountainous regions often struggle to harness the benefits of industrial clustering due to challenges such as inadequate transportation infrastructure and limited access to essential public services. These deficiencies hinder the efficient movement of goods, services, and labor, thereby restricting economic opportunities and slowing regional development. Furthermore, international studies have consistently highlighted the profound impact of industrial agglomeration on narrowing income disparities and enhancing regional livelihoods. By facilitating the pooling of resources, skills, and innovation, agglomeration can drive economic inclusivity and improve the overall quality of life for residents in well-connected areas. However, addressing infrastructural and service gaps remains critical for extending these benefits to less accessible regions.

## 5. Empirical Results

The empirical results demonstrate that all three hypotheses under investigation are statistically significant at the 0.1% and 5% levels, indicating robust findings. The coefficient for agglomeration's direct driving effect is notably high at 0.726, which underscores the substantial spillover effects associated with this phenomenon. This suggests that agglomeration plays a pivotal role in fostering economic or industrial clustering, leading to enhanced productivity and innovation within the regions studied. Furthermore, the coefficient for the chain investment mode is significantly higher compared to other forms of cooperation, highlighting its superior effectiveness in driving collaborative ventures and achieving strategic objectives. This finding emphasizes the importance of structured and interconnected investment strategies in achieving optimal outcomes. Additionally, the spatial factor coefficient reveals a pronounced regional disparity, confirming the existence of significant differences in development levels or resource distribution across various regions. These results are summarized in Table 2, which provides a detailed breakdown of the hypothesis testing outcomes.

**Table 2.** Hypothesis Testing Results

| Hypothesis | Path | Coef. | T-Value | p-Value | Result |
|---|---|---|---|---|---|
| H1 | Agglomeration → Performance | 0.726 | 18.35 | 0.000 | Supported |
| H2 | Chain investment → Performance | 0.683 | 16.72 | 0.000 | Supported |
| H3 | Spatial region → Performance | 0.215 | 4.16 | 0.000 | Supported |

*5.1. Main Findings*

Advanced manufacturing agglomeration serves as the central driving force behind the industrial upgrading of rural areas in Zhaoqing. This process involves the clustering of advanced manufacturing enterprises, which creates a synergistic environment conducive to innovation, resource sharing, and enhanced productivity. By concentrating industries within specific zones, the region benefits from economies of scale, reduced transaction costs, and improved knowledge spillovers. These factors collectively accelerate the modernization of rural industries, enabling them to transition from traditional, labor-intensive operations to more technology-driven and value-added production systems. This transformation not only enhances the competitiveness of local industries but also aligns with broader regional development strategies aimed at fostering sustainable economic growth.

Industrial chain investment emerges as the most effective mode of assistance under the current policy framework. This approach involves the strategic bundling of investments along the entire industrial value chain, from raw material procurement to final product distribution. By adopting this method, policymakers and enterprises can ensure a more integrated and cohesive development trajectory for rural industries. Unlike fragmented or sporadic assistance programs, industrial chain investment fosters a holistic ecosystem where upstream and downstream enterprises collaborate seamlessly. This not only maximizes resource utilization but also mitigates risks associated with market volatility. Furthermore, this model aligns with the principles of sustainable development by promoting long-term economic stability and reducing dependency on external aid.

The core areas of Sihui and Daw experience significantly higher agglomeration benefits compared to the peripheral mountainous counties. This disparity can be attributed to several factors, including better infrastructure, proximity to urban centers, and a more skilled labor force in the core regions. These advantages enable Sihui and Daw to attract higher levels of investment and foster a more dynamic industrial ecosystem. In contrast, the peripheral mountainous counties face challenges such as limited accessibility, lower population density, and inadequate support services, which hinder their ability to fully capitalize on agglomeration effects. Addressing these disparities requires targeted policy interventions aimed at improving connectivity, enhancing human capital, and incentivizing investments in less-developed areas.

Agglomeration significantly enhances local rural employment opportunities and simultaneously boosts the disposable income of residents. The clustering of industries creates a robust demand for labor, spanning a wide range of skill levels, from unskilled workers to highly specialized professionals. This not only reduces unemployment rates but also provides a pathway for rural residents to secure stable and higher-paying jobs. Additionally, the increased economic activity generated by agglomeration stimulates local businesses, further contributing to income growth. The rise in disposable income, in turn, improves the standard of living for rural households and fosters greater consumer spending, creating a positive feedback loop that sustains regional economic development.

*5.2. Theoretical Contributions and Practical Policy Implications*

5.2.1. Theoretical Implications

This study provides valuable empirical evidence that enhances the understanding of New Economic Geography and regional innovation system theory within the context of China's rural revitalization efforts. By examining the impact of advanced manufacturing agglomeration under the enterprise-assisting policy framework, with Zhaoqing's

"TEHTT" policy as a case study, the research highlights how targeted policies can empower rural areas. The findings extend the application of agglomeration spillover theory to rural settings in developing countries, demonstrating how concentrated industrial activities can generate widespread economic benefits [14]. This contributes to a more nuanced understanding of how regional policies can be tailored to address the unique challenges and opportunities of rural development.

This research enriches the academic discourse on industrial agglomeration by introducing a novel approach to analyzing its effects on rural development. Unlike previous studies that predominantly focused on macro-level provincial effects or qualitative analyses of single industries, this paper adopts a more granular perspective. By categorizing spatial types into core urban agglomeration zones, plain transitional areas, and remote mountainous counties, the study quantifies the differentiated benefits of agglomeration using the PLS-SEM model. This methodological innovation provides a robust framework for future research, enabling scholars to systematically evaluate the varying impacts of industrial agglomeration across diverse regional contexts. Such insights are crucial for designing effective policies that promote balanced regional development.

The paper expands the theoretical framework of industrial chain-driven governance by demonstrating its practical applicability in rural development. Unlike sporadic or fragmented assistance programs, the industrial chain investment model leverages the interconnectedness of enterprises along the value chain to amplify agglomeration dividends. This approach not only enhances the efficiency of resource allocation but also fosters a more resilient and self-sustaining industrial ecosystem. By providing empirical evidence on the effectiveness of this model, the study contributes to the broader field of institutional economics, offering new insights into the mechanisms that underpin successful policy implementation. These findings underscore the importance of adopting integrated and strategic approaches to rural industrial revitalization.

5.2.2. Practical Implications

(1)Differentiated industrial layout for zoning development

For core regions such as Sihui and Dawang High-tech Zone, it is advisable to further improve the coordinated allocation of upstream and downstream production links around the new energy vehicle and electronic information industries, and to strengthen the spatial organization of matching processing workshops and service facilities. Leading manufacturing enterprises may be encouraged to extend appropriate semi-finished component production and auxiliary processing links to nearby towns and villages on the basis of compliance, efficiency, and environmental standards, so as to better utilize existing agglomeration advantages and enhance regional industrial resilience. For plain areas such as Duanzhou and Gaoyao, priority may be given to agricultural product intensive processing, food-related manufacturing, and light-industry supporting projects with relatively strong employment absorption and moderate factor requirements, while a co-built industrial park platform can be adopted to improve land use efficiency and shared infrastructure provision. For mountainous counties such as Huaiji, Guangning, Fengkai, and Deqing, it is more appropriate to first strengthen transportation, water supply, logistics, and basic public service conditions, and then introduce manufacturing projects in a phased and orderly manner according to local carrying capacity, resource endowment, and market accessibility, thereby avoiding inefficient project allocation driven by short-term expansion considerations [15].

(2)Popularize optimal industrial chain investment promotion mode

Local governments may take the efficiency and coordination advantages of industrial-chain-oriented investment promotion as an important policy direction, and guide enterprises to form relatively complete layouts covering raw material supply, intermediate processing, product assembly, logistics distribution, and terminal sales. Compared with fragmented project attraction focused on isolated production points, this approach can improve resource conversion efficiency, reduce repeated construction, and

strengthen the stability of local supporting systems. On this basis, it is useful to draw on mature international and domestic experience in the development of rural industrial clusters, while adapting such experience to local industrial foundations, ecological constraints, and market demand. Special supporting funds can be established for industrial chain docking projects under the "Thousand Enterprises Help Thousand Towns" framework, with clear standards for project selection, performance evaluation, and follow-up services. At the same time, policy design should emphasize the coordinated provision of land, energy, financing, technical services, and digital platforms, so that investment promotion is transformed from simple project introduction into systematic cultivation of industrial ecosystems, thereby improving long-term development quality and the sustainability of township industrial growth.

(3)Build cross-district industrial coordinated operation mechanism

Relying on Zhaoqing's overall industrial planning, it is necessary to improve cross-district coordination mechanisms and reduce institutional obstacles that hinder the rational flow of production factors among counties and townships. Through unified planning guidance, differentiated functional positioning, and shared infrastructure arrangements, resource spillovers from core agglomeration areas can be transmitted more effectively to peripheral mountainous areas, thereby helping to narrow regional disparities in industrial development [16]. In practical terms, regular industrial docking and matchmaking activities may be established between major industrial parks and township cooperatives, with a focus on project information sharing, order matching, technical assistance, product standards, and market channel connection. At the same time, a normalized coordination platform can be created to promote the orderly circulation of capital, technology, talent, and service resources across districts, while improving risk assessment, environmental review, and benefit-sharing mechanisms. Such an arrangement would help avoid homogeneous competition among localities, strengthen complementary development, and enhance the overall efficiency of regional industrial organization. In the longer term, a cross-district coordinated operation mechanism can also support more balanced urban-rural integration by linking industrial upgrading with public service improvement, logistics network optimization, and the gradual enhancement of local endogenous development capacity.

## 6. Conclusion and Policy Implications

### *6.1. Conclusion*

The empirical results indicate that advanced manufacturing agglomeration exerts a significant and consistently positive influence on rural industrial performance. This effect is reflected not only in improved production efficiency, but also in stronger factor coordination, enhanced technological diffusion, and greater capacity for market-oriented upgrading within rural industries. Among the policy instruments examined, industrial chain-oriented enterprise assistance demonstrates the highest input-output efficiency, suggesting that support measures aligned with upstream and downstream linkages are more effective than fragmented or isolated interventions. Such assistance appears to strengthen local production networks, improve resource matching, and increase the sustainability of industrial development outcomes. At the same time, substantial differences in spatial endowments across the towns of Zhaoqing generate a clear divergence in policy effectiveness. Variations in location conditions, infrastructure, industrial foundations, and resource accessibility shape the extent to which localities can absorb policy support and convert it into measurable performance gains. Therefore, future policy design should emphasize differentiated implementation, targeted resource allocation, and stronger coordination between regional conditions and industrial development strategies.

### *6.2. Policy Implications*

Core Area (Sihui/Dawang): Policy should focus on consolidating and extending the upstream and downstream industrial chain so that the core area can function as a stable

growth pole for the wider region. Local authorities should encourage leading enterprises to establish supporting processing workshops, storage facilities, logistics nodes, and primary packaging units in surrounding villages, thereby improving production coordination and reducing transaction costs. At the same time, policy design should promote stronger linkages between large firms and village-level operators through subcontracting, technical service provision, and shared procurement systems. This approach can enhance employment absorption in nearby rural settlements, increase value-added retention at the local level, and gradually form a more integrated urban-rural industrial network with clearer functional specialization.

Plain Counties (Duanzhou/Gaoyao): These areas should prioritize the development of specialized processing industries that are closely aligned with local agricultural resource endowments, existing production traditions, and market demand. Rather than pursuing broad industrial diversification, policy should support a selective strategy centered on products with comparative advantages, such as agricultural processing, cold-chain preparation, grading, and standardized packaging. A co-built industrial platform model can be adopted to improve land-use efficiency, lower entry barriers for small and medium-sized enterprises, and facilitate the shared use of equipment, warehousing, quality inspection, and digital management services. In addition, coordinated planning between county governments, townships, and village collectives can help ensure that industrial expansion remains compatible with local labor supply, environmental carrying capacity, and long-term rural development objectives.

Remote Mountain Counties (Huaiji/Fengkai): In these counties, policy sequencing is especially important. Government should first prioritize the construction and upgrading of basic infrastructure, including roads, water conservancy systems, power supply, communications networks, and essential public service facilities, before attempting to attract manufacturing investment on a large scale. Without these foundational conditions, industrial projects may face high operating costs, weak supply connectivity, and limited sustainability. Therefore, investment attraction should be based on realistic assessments of accessibility, resource conditions, labor availability, and ecological constraints, rather than on short-term expansion targets. It is important to avoid the blind introduction of enterprises that lack local compatibility or long-term viability. A more prudent strategy is to begin with small-scale, resource-adapted processing activities and gradually build an industrial base as infrastructure and market conditions improve.

At the city level, government should establish cross-county industrial docking platforms to promote the orderly circulation of capital, technology, labor, information, and intermediate goods between core areas and relatively lagging towns. Such platforms can support coordinated project matching, industrial transfer, supply-chain cooperation, and joint investment promotion, thereby reducing fragmentation across administrative boundaries. In practical terms, this requires unified planning mechanisms, interoperable infrastructure standards, and institutional arrangements that enable benefit sharing among counties with different development levels. The objective is not only to strengthen the diffusion effects of the core area, but also to improve the development capacity of less advantaged localities through functional complementarity. By fostering stronger inter-county coordination and more balanced industrial linkages, city-level policy can help narrow the urban-rural industrial divide and support a more inclusive and spatially balanced pattern of regional development.

**Funding:** This study was supported by the Zhaoqing Philosophy and Social Sciences Planning Key Project (No. 25ZD-04).

**Disclosure Statement:** The author declares no conflicts of interest.

**Author Contributions:** Jyh-Harng Shyng designed the research framework, conducted fieldwork, and drafted the full manuscript.

## References

1. D. Liu, F. Li, M. Qiu, Y. Zhang, X. Zhao, and J. He, "An integrated framework for measuring sustainable rural development towards the SDGs," *Land Use Policy*, vol. 147, p. 107339, 2024.
2. B. Lin and Y. Teng, "The effect of industrial synergy and division on energy intensity: From the perspective of industrial chain," *Energy*, vol. 283, p. 128487, 2023.
3. R. Duan, R. Tang, Z. Wang, J. Yang, and J. Su, "Optimized layout of supporting facilities in mountainous industrial parks: a case study of Chongqing Dadi Industrial Park," *Frontiers in Ecology and Evolution*, vol. 11, p. 1243778, 2023.
4. F. Li and G. Li, "Agglomeration and spatial spillover effects of regional economic growth in China," *Sustainability*, vol. 10, no. 12, p. 4695, 2018.
5. D. Nakamura, "Alternative spatial structure for sustainable rural economy: A note on socially optimal firm location," *International Regional Science Review*, vol. 41, no. 1, pp. 86-102, 2018.
6. S. Virkkala, "Innovation and networking in peripheral areas—a case study of emergence and change in rural manufacturing," *European Planning Studies*, vol. 15, no. 4, pp. 511-529, 2007.
7. M. E. Porter, "Competitive advantage, agglomeration economies, and regional policy," *International Regional Science Review*, vol. 19, no. 1-2, pp. 85-90, 1996.
8. A. Krehl and S. Weck, "Doing comparative case study research in urban and regional studies: what can be learnt from practice?," *European Planning Studies*, vol. 28, no. 9, pp. 1858-1876, 2020.
9. L. Zhuang and C. Ye, "More sprawl than agglomeration: The multi-scale spatial patterns and industrial characteristics of varied development zones in China," *Cities*, vol. 140, p. 104406, 2023.
10. M. Xu and O. K. Loang, "Industrial Agglomeration, Technological Innovation, and Poverty Alleviation: Evidence from China," in *Artificial Intelligence (AI) and Customer Social Responsibility (CSR)*, Cham: Springer Nature Switzerland, 2024, pp. 223-236.
11. L. Zhou and M. He, "Research on the Impact of Advanced Manufacturing Agglomeration on the Development of New Quality Productivity——An Empirical Analysis of the Yangtze River Economic Belt," *Journal of Industrial Technological Economics*, vol. 45, no. 2, pp. 153-163, 2026.
12. X. Xu, Y. Shen, H. Liu, and L. Qiu, "The Coupling relationship between industrial linkage and spatial co-agglomeration of advanced manufacturing and producer services in metropolitan: a case study of Beijing, China," *Chinese Geographical Science*, vol. 35, no. 3, pp. 631-646, 2025.
13. J. Wang, "The Knowledge Flow of Industry-University-Research and the Development of Advanced Manufacturing in the Yangtze River Delta Urban Agglomeration: Mechanisms and Effects," *Economic Geography*, vol. 44, no. 2, pp. 134-144, 2024.
14. D. Lyons, "Agglomeration economies among high technology firms in advanced production areas: the case of Denver/Boulder," *Regional Studies*, vol. 29, no. 3, pp. 265-278, 1995.
15. H. Yin and W. Su, "Industrial synergy agglomeration, urban innovation capacity, and advanced manufacturing development," *Economies*, vol. 12, no. 5, p. 117, 2024.
16. Z. Liuliu, L. Rui, Z. Dayan, S. Yi, Z. Zihui, and D. Jicai, "Relationship between advanced manufacturing agglomeration and regional economic–innovative–social coupling coordination development: A spatial analysis in Liangjiang New Area, China," *Journal of Urban Planning and Development*, vol. 150, no. 2, p. 05024009, 2024.