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Research on the Relationship between Guangxi's Industrial Structure and Beibu Gulf Port Logistics Development

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Abstract: *This paper uses the shift-share analysis and grey relational analysis to study the relationship between Guangxi's industrial structure and Beibu Gulf Port logistics. The shift-share analysis reveals that Guangxi's industrial development is relatively fast, but there are still problems such as irrational industrial structure and weak industrial competitiveness. The grey relational analysis shows that the secondary industry has the most significant impact on port logistics, followed by the tertiary industry, and the primary industry has the lowest correlation with port logistics. Finally, based on the results of the study, we proposed that the Guangxi government and port authorities should: (1) optimize the industrial structure and improve the competitiveness of leading industries;(2) build a modern port-neighboring industrial system to drive port economic growth; (3) accelerate the integration of port cities to promote coordinated development of industries and port logistics.*

Keywords: *Industrial structure, Beibu Gulf Port logistics, shift-share analysis, grey relational analysis*

1. Introduction

The port logistics industry, as an important part of the port-based economy, can significantly increase the proportion of the tertiary industry in port cities, and promote economic growth and industrial structure optimization in the hinterland. In recent years, the Beibu Gulf Port has shown strong development momentum, and the port logistics industry has become a pillar industry for Guangxi's economic development. Guangxi, as the direct economic hinterland of Beibu Gulf Port, the proportion and scale of its three industries are the key factors affecting the building of Beibu Gulf Port into an international gateway port and an international hub port. Therefore, there is great practical significance in our study on the correlation degree and interaction relationship between Guangxi's industrial structure and the port logistics of Beibu Gulf Port. It can promote their coordinated development and the high-quality development of Guangxi's economy and Beibu Gulf Port.

At present, there are relatively few theoretical studies on the relationship between port logistics and industrial structure, but the research on ports and regional economic development is very rich. In terms of port and urban development, Guo et al. (2022) found that the port network system is subject to obvious geographic constraints, while the city network system shows the characteristic of ‘multiple cores’, and they concluded that the port function is the core element affecting the characteristics of the port-city coupling[1]. By analyzing the development of three European ports, Hamburg, Antwerp and Rotterdam, Vroomans et al. (2022) conclude that shared values such as a strong culture, the political constellation ,and a more business-oriented culture lead to changes in the different relationships between ports and cities[2]. Russo et al. (2023) argue that ports and cities have had a symbiotic relationship since ancient times and use Transport System Models (TSMs) to integrate the port economic system into a city's traffic or transport plan[3].

In terms of port-regional economic interactions, Hargono et al. (2013) used multiple linear regression analysis to explore the correlation and interrelationships between the export activities of Batam Island Port and nine GRDP sectors. It is suggested that the export growth at this sea port will positively influence the economic development of the Batam city[4]. Chang et al. (2014) presented an input–output analysis on how the port sectors impact a concerned economy using the South African case. They considered that the port sector plays an important role in the economic development of South Africa[5]. Cong et al. (2020) used causality tests to confirm the existence of an interactive mechanism between the port city economy and port throughput among 16 port-city pairs in China , and

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that port throughput grows in tandem with the value-added of the secondary industry [6]. Wu et al. (2022) through empirical analyses found that Yangtze River inland ports not only have a non-negligible economic impact on local economic development, but also have a positive spatial spillover effect on regions outside inland port cities[7]. However, it is worth noting that Zhao et al. (2017) found that despite the positive correlation between ports and city networks, there is a significant weakness of port cities in attracting inward FDI, compared with non-port cities. In the future, ports need to further improve their position in the global port network in order to enhance the competitiveness of port cities[8].

To sum up, existing studies have explored the interaction between ports and urban development, ports and regional economy from different angles and methods, which provide an important theoretical basis and empirical evidence for us to deeply understand the relationship between port logistics and industrial structure. However, there is a lack of systematic and comprehensive research on the relationship between Guangxi's industrial structure and Beibu Gulf Port logistics, as well as the impacts of their interrelationships and countermeasures at the policy level. Therefore, this paper adopts the deviation-share analysis and grey correlation analysis to explore the relationship between Guangxi's industrial structure and Beibu Gulf Port logistics. It hopes to provide scientific references and feasible suggestions for achieving their coordinated development, accelerating the upgrading of Guangxi's industrial structure and promoting the high-quality development of Beibu Gulf Port.

2. Analysis of the Current Situation of Guangxi's Industrial Structure and Beibu Gulf Port logistics

2.1 Current Situation of Guangxi's Industrial Structure

In recent years, Guangxi has taken the initiative to serve major national strategies, such as the "Belt and Road" initiative and the construction of the Guangdong-Hong Kong-Macao Greater Bay Area. It has actively undertaken the transfer of industries from developed coastal regions and accelerated the development of strategic emerging industries. It has also implemented the strategy of scientific and technological development and the strategy of talent introduction, continuously optimizing the allocation of resources and cultivating high-tech industrial clusters. The rationalization and advanced level of its industrial structure are constantly rising. Figure 1 shows the added value of Guangxi's three industries and their proportion in the national economy from 2009 to 2022.

From the Figure 1, it can be seen that, except for the decline in the added value of the secondary industry in 2018 and 2019 due to external economic cycles and industrial structure adjustments, the added value of Guangxi's three industries showed an upward trend from 2009 to 2022. Specifically, from 2009 to 2017, the added value of the secondary industry was the highest, followed by the tertiary industry, with the primary industry in the last place. In 2018, the added value of the tertiary industry surpassed that of the secondary industry. By 2022, the added value of the tertiary industry had firmly held the top position, reaching 1,309.249 billion yuan. Although the primary industry still ranked last, its added value had increased by 284.4 billion yuan compared to 2009.

In terms of each industry's share of gross domestic product (GDP), the proportion of the primary industry's added value to GDP has been decreasing year by year, from 18.80% in 2009 to 16.23% in 2022. The proportion of the added value of the secondary industry, which includes industry and construction, has shown a slow decline. The tertiary industry showed a process of initial decline followed by a gradual rise: it fell from 37.62% in 2009 to the lowest point of 34.11% in 2011, and then rose to 49.78% by 2022. This indicates that Guangxi's economic structure and industrial structure are continuously being optimized and upgraded. The mode of economic growth has gradually shifted from labor-intensive to capital-intensive, from extensive to intensive, and from quantitative external expansion to qualitative internal development.

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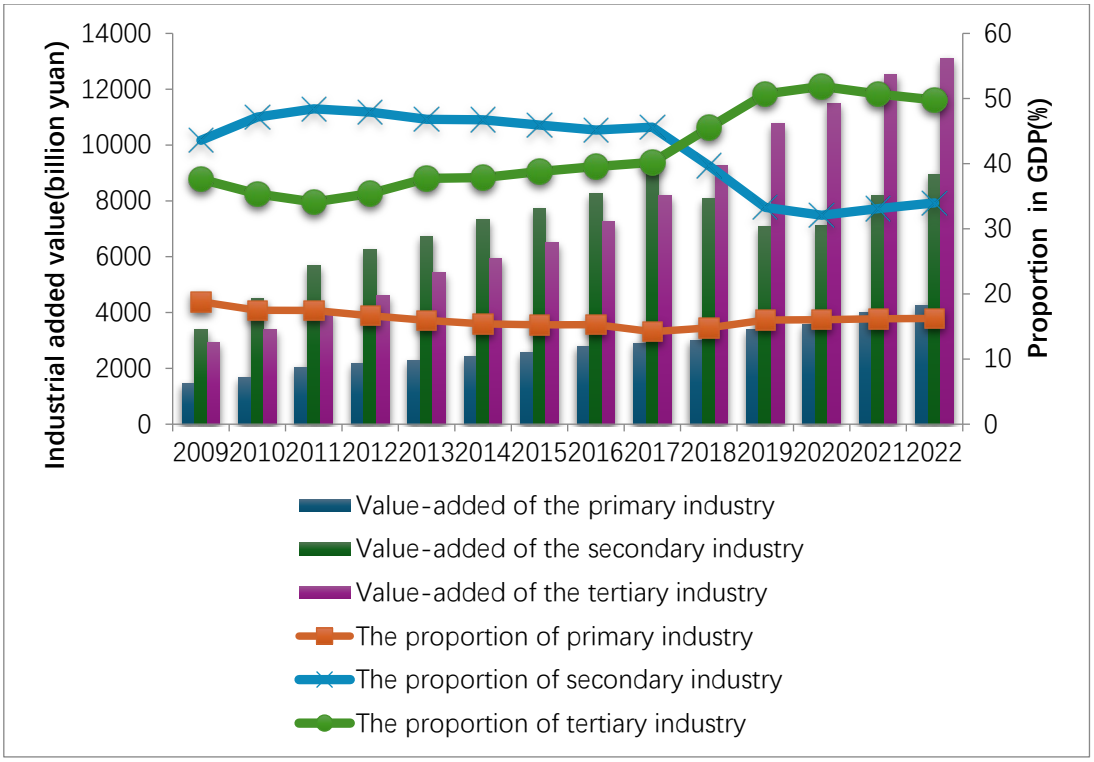

Figure 1: Value-Added and Proportions of the Three Industries in Guangxi

2.2 Current Situation of Beibu Gulf Port logistics Development

The Beibu Gulf Port is a crucial gateway for southwestern China's opening up to the outside world and a convenient outlet for the New Western Land-Sea Corridor. It serves as an international gateway and hub connecting 12 western provinces of China with the 10 ASEAN countries and the Pacific economic circle. Leveraging its unique geographical advantages, the Beibu Gulf Port has received preferential policy subsidies and strategic support from the state. In recent years, the infrastructure of the Beibu Gulf Port has been continuously improved, logistics efficiency has been significantly enhanced, and the port has entered a phase of rapid development. Figure 2 shows the throughput of the Beibu Gulf Port from 2009 to 2022.

Overall, the cargo throughput and container throughput of the Beibu Gulf Port have shown a rapid development trend. In 2009, the cargo throughput of the Beibu Gulf Port was less than 100 million tons. By 2012, the port throughput had reached 174.37 million tons, an increase of 13.8% over the previous year, marking a historic breakthrough. In 2013, the Beibu Gulf Port achieved a cargo throughput of 187 million tons, with container throughput exceeding 1 million TEUs for the first time. In 2019, the National Development and Reform Commission positioned the Beibu Gulf Port as an international gateway port. In 2021, the State Council included the Beibu Gulf Port along with the Shanghai Port, Shenzhen Port, and Guangzhou Port among 10 international hub seaports, signifying stronger regional driving power and enhanced shipping service capabilities for the Beibu Gulf Port. In 2022, the container throughput of the Beibu Gulf Port surpassed 7 million TEUs, and the cargo throughput reached 371.34 million tons, both ranking among the top 10 coastal ports in the country. As of 2022, the Beibu Gulf Port has been ranked first in port throughput growth for five consecutive years among the main coastal ports in the country. It is also the only port among the 11 international hub seaports in the country that has maintained double-digit growth. The development of the Beibu Gulf Port has reached a new level.

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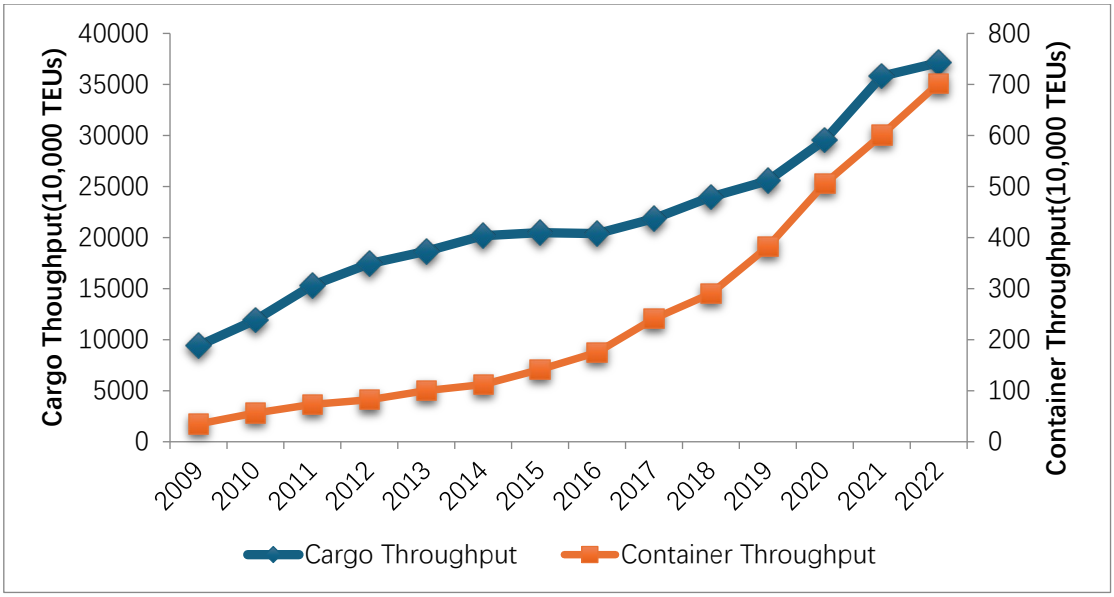

Figure 2: Cargo Throughput of Beibu Gulf Port

3. Model Construction

3.1 Shift-share analysis

The Shift-Share Analysis method uses the economic development of a larger region where a specific area is located or the entire national economy as a reference standard. It divides the changes in a regional economy over a period of time into three parts:

$$G_{ij} = N_{ij} + P_{ij} + D_{ij} \quad (1)$$

In Equation (1), G_{ij} represents the total economic change value of a certain industry in a specific region, N_{ij} represents the national growth effect, P_{ij} represents the industrial mix effect, D_{ij} represents the competitive effect.

The three components can be used to measure the rationality of the industrial structure and the competitiveness of economic development in a specific region, helping to determine the direction of adjustments for the industrial structure and economic development. Suppose that during the period [0.t] the initial total economic volume of 'region i' is $b_{i,0}$, and the final total economic volume is $b_{i,t}$; the initial added value of 'industry j' in 'region i' is $b_{ij,0}$, and the final added value is $b_{ij,t}$; the initial total economic volume of a larger region or the nation is B_0, and the final total economic volume is B_t; the initial added value of 'industry j' in a larger region or the nation is $B_{j,0}$, and the final added value is $B_{j,t}$. The growth rates of 'industry j' in 'region i' and a larger region or the nation on during this period are r_{ij} and R_j, respectively. The specific formulas are as follows:

$$r_{ij} = \frac{b_{ij,t} - b_{ij,0}}{b_{ij,0}} \quad (2)$$

$$R_j = \frac{B_{j,t} - B_{j,0}}{B_{j,0}} \quad (3)$$

To standardize the share of each industry's value-added in the total economy for a larger region or the whole country, we use the formula: $b_{ij}' = \frac{b_{ij,0} \times B_{j,0}}{B_0}$. The expressions for the three components of the shift share are as follows:

$$N_{ij} = b_{ij}' \times R_j \quad (4)$$

$$P_{ij} = (b_{ij,0} - b_{ij}') \times R_j \quad (5)$$

$$D_{ij} = b_{ij,0} \times (r_{ij} - R_j) \quad (6)$$

In the above formula, N_{ij}represents the average growth effect for a larger region or the whole

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country, indicating the share that each industry's value-added in the region should change according to the average growth rate of a larger region or the whole country. P_{ij} represents the industrial structure effect, indicating the shift share caused by the difference between the proportion of value-added in 'industry j' in 'region i' and its proportion in a larger region or the whole country. This effect excludes the growth rate differences and analyzes the contribution of the industry to economic growth. A larger P_{ij} indicates a greater contribution of the industry to the total economic output of the country or region, and a more advantageous industrial structure. D_{ij} represents the local share effect, indicating the economic change value caused by the difference in growth rates between 'industry j' in 'region i' and 'industry j' in a larger region or the whole country. This reflects the competitiveness of 'industry j' in 'region i' relative to a larger region or the whole country. A larger D_{ij} signifies stronger competitiveness in the whole country or larger region.

3.2 Grey Relational Analysis Method

The grey relational analysis method determines the relationship between factors based on the similarity of their changing trends. If two factors exhibit convergence and consistency in their changing trends, they are considered to have a high degree of association. Therefore, this paper uses the grey relational analysis method to study the correlation and interactive relationship between Guangxi's three industries and Beibu Gulf Port logistics.

Firstly, nondimensionalize the original data:

$$X_k = \frac{X_k}{\frac{1}{n}\sum_{k=1}^{n} X_k} \tag{7}$$

$$\mathrm{Y_k} = \frac{\mathrm{Y_k}}{\frac{1}{\mathrm{n}}\sum_{\mathrm{k=1}}^{\mathrm{n}} \mathrm{Y_k}} \tag{8}$$

In the above formula, Y_k represents the reference series, reflecting the characteristics of system behavior; X_k represents the comparison series, which consists of data sequences formed by factors affecting system behavior.

Secondly, formulaically calculate the correlation coefficient:

$$\delta_{\mathrm{k}}(\mathrm{t}) = \frac{\Delta\mathrm{min}+\rho\Delta\mathrm{max}}{|\mathrm{Y_k(t)}-\mathrm{X_k(t)}|+\rho\Delta\mathrm{max}} \tag{9}$$

In formula (9), $\delta_{\mathrm{k}}(\mathrm{t})$ represents the correlation coefficient between the reference series and the corresponding elements of the comparison series; $\Delta\mathrm{min}$ represents the minimum difference between levels, and $\Delta\mathrm{max}$ represents the maximum difference between levels; ρ represents the resolution coefficient.

Thirdly, calculate the relational degree between the comparison series and the reference series:

$$\mathrm{r_k} = \frac{1}{\mathrm{n}}\sum_{\mathrm{k=1}}^{\mathrm{n}} \delta_{\mathrm{k}}(\mathrm{t}) \tag{10}$$

In formula (10), $\mathrm{r_k}$ represents the relational degree; the larger the $\mathrm{r_k}$ value, the higher the degree of association between the reference series and the comparison series.

3.3 Data Sources

This paper selects the added value of Guangxi's three industries and the cargo throughput and container throughput of Beibu Gulf Port from 2009 to 2022 as the research objects. The added value data of Guangxi's three industries are sourced from the Statistical Bulletins of National Economic and Social Development of Guangxi in the corresponding years. The cargo and container throughput data of Beibu Gulf Port are sourced from the Guangxi Department of Transportation and the Guangxi Statistical Yearbook.

4. Empirical Analysis

4.1 Shift-share analysis

The shift-share analysis is used to evaluate the rationality and competitiveness of the industrial

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structure in Guangxi from 2009 to 2022. The specific results are shown in Table 1.

Table 1: Deviation-Share Analysis Results of Guangxi's Industrial Structure

category	G	N	P	D
primary industry	2811.32	1213.9526	959.49642	637.87102
secondary industry	5557.03	7490.327	-462.4684	-1470.829
tertiary industry	10173.36	11384.077	-1257.667	46.949951
sum	18541.71	20088.357	-760.6392	-786.0077

Firstly, the national growth effects (N) of Guangxi's primary, secondary, and tertiary industries are all positive, indicating that the development speed of Guangxi's three industries is higher than the national GDP average growth rate. The national growth shares of Guangxi's primary, secondary, and tertiary industries are 1213.9526 billion yuan, 7490.327 billion yuan, and 11384.077 billion yuan, respectively. The N values, sorted from largest to smallest, are tertiary, secondary, and primary industries. The results suggest that Guangxi's economic development mainly relies on secondary and tertiary industries. The primary industry occupies a smaller proportion in the national economy and its support and driving role are insignificant.

Secondly, the total industrial mix effect (P) of Guangxi is negative, showing that compared with the national level, the rationalization and quality of Guangxi's industrial structure are still lagging, which will affect the speed of economic development. As shown in the Table 1, the industrial mix effects for Guangxi's secondary and tertiary industries are both negative, with values of -462.4684 and -1257.667, respectively. This indicates that the development advantages of Guangxi's secondary and tertiary industries are relatively low, and there is still a significant room for improvement in their impact and contribution to the growth of the total economy. Overall, the development quality of Guangxi's current secondary and tertiary industries is not high, the proportion of emerging industries and high-tech industries is too small, and the economic structure is not entirely reasonable.

Thirdly, the total competitive effect (D) of Guangxi is negative, indicating that the overall industrial development competitiveness of Guangxi is lower than the national average level. Specifically, the competitive effects of primary and tertiary industries are positive, which shows strong growth momentum and competitiveness in these industries. However, the competitive effect of the secondary industry is -1470.829. It indicates that there are still many problems in the development of the secondary industry, such as an irrational system and policy environment, a low quality of labor force, and insufficient technological innovation ability, which have seriously weakened the overall industrial competitiveness of Guangxi.

Finally, the total economic change value (G) of Guangxi's industries is positive, suggesting a high overall industrial development level in Guangxi. This is because the national growth effect compensates for the negative contributions of the industrial mix effect and the competitive effect to economic growth. It shows that the total economic growth of Guangxi is relatively fast, but the rationality of the industrial structure and industrial competitiveness still need to be further improved.

4.2 Grey Relational Analysis

Based on the grey relational analysis method, the correlation coefficient matrix between the added value of Guangxi's three industries and the logistics of Beibu Gulf Port is obtained, as shown in Table 2.

Table 2: Grey Relational Coefficient Matrix of Industrial Structure and Port Throughput

	primary industry	secondary industry	tertiary industry	sum	average
Cargo throughput	0.69796	0.77702	0.69956	2.17454	0.724847
Container throughput	0.70660	0.72565	0.73144	2.16369	0.72123
sum	1.40456	1.50267	1.43100	4.33823	1.44608
average	0.70228	0.751335	0.71550	1.44608	0.72304

Firstly, the correlation coefficient between Guangxi's primary industry and Beibu Gulf Port throughput is 0.70228, the smallest among the three industries. This is because, although Guangxi's agricultural products have high output and a wide variety, their export markets are mainly concentrated in Asia and have not yet formed an export advantage in other regions. Moreover, Guangxi's agricultural exports mainly consist of primary agricultural products, with a small proportion of deep processing,

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low technological content, and low added value, which to some extent restricts agricultural exports. Therefore, the impact of Guangxi's primary industry on port logistics is minimal.

Secondly, the pulling effect of Guangxi's secondary industry on Beibu Gulf Port logistics is the most obvious and significant, with a correlation coefficient of 0.751335. On the one hand, the Beibu Gulf Economic Zone's eight major port-near industries, including petrochemical, electronic information, and equipment manufacturing, show a trend of clustered development. These port-near industries rely on the port for raw material input, cargo transshipment, and commodity export, significantly promoting port development. On the other hand, the more developed the secondary industry in port cities, the more imports and exports of goods there will be. Guangxi's secondary industry, particularly industry, plays a dominant role in economic development and may increase demand for the port. Consequently, the cargo and container throughput of Beibu Gulf Port will continue to expand.

Thirdly, the contribution of Guangxi's tertiary industry to Beibu Gulf Port logistics is second only to the secondary industry, with a correlation coefficient of 0.71550. In recent years, Guangxi has increased investment in modern service industries, continuously optimizing the transportation service structure and improving regional logistics service levels, significantly impacting port logistics. Simultaneously, the development of industries, capital, and technology around the port accelerates the contribution of financial, real estate, and other industries to Beibu Gulf Port logistics

5. Conclusion and Suggestions

5.1 Research Conclusions

This paper uses the Shift-Share Analysis method and the Grey Relational Analysis method to study the relationship between Guangxi's industrial structure and Beibu Gulf Port logistics. The Shift-Share Analysis reveals that while Guangxi's industrial development speed is relatively fast, there are issues such as an unreasonable industrial structure and weak industrial competitiveness, particularly in the low-quality development of the secondary and tertiary industries. Additionally, the low competitiveness of the secondary industry significantly weakens Guangxi's overall economic competitiveness. The Grey Relational Analysis shows a good interactive relationship between Guangxi's three industries and Beibu Gulf Port logistics, with the secondary industry having the most significant impact, followed by the tertiary industry, and the primary industry having the lowest correlation with port logistics.

5.2 Countermeasures and Suggestions

(1) Optimize Industrial Structure and Improve Leading Industry Competitiveness

On one hand, the Guangxi government should leverage its resource advantages, fully unleash the development potential of the primary industry, and promote the integration of the tertiary industry with advanced industries and modern agriculture. On the other hand, Guangxi's industrial sector must continuously advance new-type industrialization to enhance the competitiveness of Guangxi's secondary industry. Efforts should be made to eliminate outdated production capacities, promote the transition of Guangxi's industry from quantity-driven to quality-efficiency driven, and quickly cultivate strategic emerging industries. Increased policy support for industries such as new energy and new materials is necessary to promote Guangxi's sustainable economic development.

(2) Build a Modern Port-Adjacent Industrial System to Drive Port Economic Growth

Firstly, Beibu Gulf Port is required to scientifically integrate coastal port shoreline resources for development, build a modern port cluster, and actively develop marine transportation, marine fisheries, marine pharmaceuticals, marine tourism, and other marine industries to promote marine economic development. Secondly, Beibu Gulf Port should transition from single-loading operations to developing modern port services. In addition, the port also needs to accelerate the construction of platforms integrating shipping, logistics, and trade, advancing the digital and intelligent upgrades of port and shipping services to build an international port and shipping service center.

(3) Accelerate Port-City Integration to Promote Coordinated Development of Industry and Port Logistics

On one hand, the Guangxi government should increase financial investment in its advantageous and

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characteristic industries, and increase innovation in technology and management. On the other hand, it is necessary to fully exert the service function of the port logistics industry to other industries, and make full use of the hub advantage of the port to stimulate the leading role of the tertiary industry. Guangxi's industrial adjustment should place greater emphasis on the integrated development of traditional and modern services, and promote the balanced and coordinated development of the urban economy and port logistics industry

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References

[1] Guo J, Qin Y. Coupling characteristics of coastal ports and urban network systems based on flow space theory: Empirical evidence from China[J]. Habitat International, 2022, 126: 102624.
[2] Vroomans J, Geerlings H, Kuipers B. The energetic relationship between ports and cities; how the role of shared values is under pressure[J]. Case Studies on Transport Policy, 2022, 10(4): 2358-2368.
[3] Russo F, Musolino G. Port-city interactions: models and case studies[J]. Transportation Research Procedia, 2023, 69: 695-702.
[4] Hargono S, Sutomo S, Alisyahbana J. The Influence of the Port to the Economical Growth of the Batam Island[J]. Procedia Environmental Sciences, 2013, 17: 795-804.
[5] Chang Y T, Shin S H, Lee P T W. Economic impact of port sectors on South African economy: An input–output analysis[J]. Transport Policy, 2014, 35: 333-340.
[6] Cong L ze, Zhang D, Wang M li, et al. The role of ports in the economic development of port cities: Panel evidence from China[J]. Transport Policy, 2020, 90: 13-21.
[7] Wu Z, Woo S H, Lai P L, et al. The economic impact of inland ports on regional development: Evidence from the Yangtze River region[J]. Transport Policy, 2022, 127: 80-91.
[8] Zhao Q, Xu H, Wall R S, et al. Building a bridge between port and city: Improving the urban competitiveness of port cities[J]. Journal of Transport Geography, 2017, 59: 120-133.