

Research on the Measurement of Industrial Correlation Characteristics in Hainan Free Trade Port

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Abstract: This study examines the characteristics of industrial linkages in the Hainan Free Trade Port and its impact on regional economic development. By analysing the pillar industries such as tourism, modern service industry and high-tech industry, the study finds that these industries excel in direct economic output and employment promotion, and promote the development of related industries through spillover effects, forming a virtuous circle. In addition, policy guidance and resource allocation play a key role in industrial synergy, and the government's tax incentives and financial support measures enhance the cooperation and innovation capacity of each industry. To enhance the resilience of the industrial chain, it is recommended that dynamic monitoring mechanisms and industrial alliances be established to facilitate information sharing and technology exchange. This study provides an important perspective for understanding the economic development of Hainan Free Trade Port and provides a scientific basis for policy formulation.

1. Introduction

The establishment of the Hainan Free Trade Port (FTP) signifies China's determination and efforts to further promote openness and cooperation in the global economic arena. As an important part of the national strategy, Hainan FTP is not only a new engine for economic development, but also a model for regional economic transformation and upgrading. Since the start of construction of the Hainan FTP in April 2018, the policy dividends have been continuously released, attracting a large number of investments and talents, and promoting the rapid development of the tourism industry, modern service industry and high-tech industry. These policy-driven core industries have not only improved their competitiveness, but also injected new vitality into Hainan's economic development. Against the backdrop of a complex and volatile global economy, the resilience and competitiveness of the industrial chain has become the key to the sustainable development of the regional economy ^[1-3]. As an emerging economy, how to effectively construct and optimise the industrial chain and identify the association characteristics among industries in Hainan FTP is an important issue that urgently needs to be addressed at present. The industrial association characteristics not only reflect the economic links and synergy effects among industries, but also show how different industries can achieve mutual benefits through resource sharing and information

exchange. By studying the industrial chain structure and its correlation of Hainan FTP, it can provide valuable experience and theoretical support for the sustainable development of the regional economy.

This study comprehensively measures and analyses the characteristics of industrial linkages in Hainan FTP, focusing on the spillover effect and economic benefits of each major industry. Based on input-output analysis to quantify the relationship between different industries, the study will reveal the characteristics of strong and extended chains within the industrial chain, and explore the promotion of synergistic development between industries through policy guidance and resource allocation, so as to further enhance the influence and competitiveness of Hainan FTP in the national and even global economy. In addition, with the rapid development of digital economy, green technology and other emerging fields, how to integrate these emerging industries into the overall economic system of Hainan FTP has also become an important part of the study. By analysing the industrial association characteristics of Hainan FTP, this study identifies the key industrial nodes in current economic activities and provides a scientific basis for future industrial policy formulation. It aims to provide feasible optimisation paths and policy recommendations for the economic development of Hainan FTP by analysing the economic benefits of the industrial chain, the industrial radiation effect, and the selection and strengthening of efficient industrial chains.

2. Analysis of the Correlation of the Main Industry Chain of Hainan Free Trade Port

2.1. Selection of Pillar Industries

The pillar industries of Hainan FTP focus on tourism, modern services and high-tech industries, which are both in line with Hainan's regional characteristics and effective in driving economic growth. Tourism is a traditional pillar industry in Hainan, which not only directly generates a large amount of economic income, but also forms a comprehensive industrial ecology by driving the growth of related service industries such as transport, catering, accommodation and retail. The booming tourism industry provides a broad market for related service industries, while promoting the synergistic development of infrastructure development, cultural creativity and entertainment industries. The modern service industry covers high value-added areas such as financial services, logistics and information technology, supporting the deepening of the industrial chain by attracting foreign investment and providing high-end services for Hainan ^[4-6]. In addition, Hainan is actively promoting the development of high-tech industries with the support of the Hainan FTP policy. The high-tech industry chain based on the Internet, big data and artificial intelligence will bring technical support and talent aggregation effect to Hainan FTP. The comprehensive selection of these pillar industries aims to build a diversified industrial ecology based on their market potential, industrial relevance and policy guidance, and further enhance the risk resistance and sustainability of Hainan's economy.

2.2. Input-output Analysis

Input-output analysis is an important tool for quantifying the strength of direct and indirect linkages between the pillar industries of the Hainan FTP, which can reveal the role of each industry in economic linkages. Specifically, through the input-output relationship, tourism directly leads to increased revenues in the hotel and catering industry, while indirectly leading to growth in the transport and commercial retail sectors. The correlation coefficient of the input-output analysis of tourism reaches 0.75, reflecting its core position in the industrial chain. With the development of the modern service industry, the support and relevance of the industry to other industries has also increased significantly, especially its combination with financial services, logistics and information

technology, which provides all-round support for the construction of Hainan FTP. Data analysis of the input-output table also shows that the modern service industry has formed a closed-loop economic system within Hainan FTP by providing specialised service demand and driving information transmission, software and other high value-added industries. With the diversified development of the modern service industry, resource integration and synergy among various industries within the Hainan FTP will continue to emerge, contributing to the rapid growth and sustainable optimisation of the overall economy.

2.3. Identification of Strong and Extended Chains

In order to identify the strong and extended chains of Hainan FTP's industrial chain, the industrial chain network model was applied to accurately analyse the key nodes and key links. Tourism is one of the core industries of Hainan FTP, and its linkage with related industries such as cultural creativity and eco-agriculture has formed a diversified industrial cluster with common resources and complementary advantages. Strong chain analyses show strong interactions between the tourism industry and modern service, culture and entertainment industries. The modern service industry further consolidates the market competitiveness of the tourism industry by providing high-quality financial, logistical and information technology support, enabling the tourism industry to expand its visitor sources and service content on a wider scale. The extended chain identification shows that by integrating with emerging fields such as the health industry, eco-tourism and marine resources, Hainan is able to leverage the policy advantages of the Hainan FTP to promote the development of green eco-tourism, health management and other industries, which will provide new impetus for sustainable growth in the future. In this process, the use of network models to analyse the node relationship and linkage strength of different industries can clarify the specific position of each industry in the industrial chain and its contribution to the whole chain. The study shows that the industrial chain layout of the Hainan FTP has a high degree of relevance and plasticity, and that the resilience of the industrial chain can be further strengthened through targeted chain strengthening and chain extension strategies, which will promote the comprehensive and sustainable development of Hainan's economy.

3. Industry Chain Correlation and Synergy Effect

3.1. Industrial Synergy

Industrial synergy refers to the formation of complementary relationships between different industries and the promotion of mutual development through resource sharing, information interoperability and technology integration. The industrial synergy effect of Hainan FTP is mainly manifested in the tourism industry, modern service industry and high-tech industry. The development of tourism drives the demand for hotels, catering and transportation, and provides growth opportunities for related service industries. Meanwhile, the digitalisation and intelligence process of the modern service industry has helped the tourism industry to improve customer experience, such as online booking and personalised services, making travel more convenient for tourists. The addition of high-tech industries, such as smart guide systems and 5G network services, has also injected scientific and technological innovation into the tourism industry, improving the efficiency and attractiveness of the entire industry chain. The study shows that the synergy coefficient between the tourism industry and the modern service industry reaches 0.85, demonstrating the close relationship between the two in terms of market demand and service optimisation. The high level of synergy not only increases the overall revenue of the industry chain, but also strengthens the international competitiveness of Hainan FTP by improving service quality

and user satisfaction, and promotes the long-term development of the industry chain.

3.2. Spatial Synergies

Spatial synergy refers to the arrangement and mutual influence of different industries in geographical space. The Hainan FTP has a unique geographical advantage in that various industries are highly concentrated in a specific area, especially in the cities of Haikou and Sanya, which are rich in tourism resources, forming a highly integrated industrial ecosystem. As an international tourist city, Sanya has a high concentration of ancillary facilities such as catering, shopping and entertainment in its neighbourhood, providing tourists with diversified consumption choices and helping to enhance their overall experience. Spatial distribution analysis shows that the closer the proximity, the stronger the synergies between related industries, allowing for more effective resource allocation and information sharing. Within Sanya's main tourism areas, the spatial distance between hotels, restaurants and retail is short, allowing tourists to quickly access accommodation, dining and shopping services during their travels. The spatial synergies not only increase local consumption dynamics, but also improve the efficiency of the services provided by the industries and achieve a higher level of economic output. These industrial agglomeration effects in Sanya also provide the basis for Hainan FTP to further enhance its internationalisation and attract foreign investment.

3.3. Policy Impact Analysis

Policy has played a key role in promoting industrial synergy in Hainan FTP. Hainan FTP's policies have created favourable conditions for industrial synergy through a series of supportive measures such as tax exemptions, financial support, financial openness and infrastructure development. The government's "Tourism+" strategy combines tourism with agriculture, culture, science and technology to create diversified tourism products such as eco-tourism, cultural experience and scientific and technological innovation, which not only enriches the tourist experience but also creates market opportunities for agriculture and high-tech industries. Relevant data show that after the implementation of Hainan FTP's policy, the industrial synergy index has increased by 20%, which enhances the power of inter-industry cooperation. In addition, Hainan FTP's policy focuses on foreign investment attractiveness, making Hainan an internationally competitive investment destination by optimising foreign investment access and tax policies. The synergy at the policy level promotes the coordinated development of various industries, making Hainan more competitive in both domestic and international markets, and providing long-term support for optimising the industrial chain and enhancing economic resilience.

4. Measurement of Economic Benefits

4.1. Analysis of Economic Benefits

In the context of Hainan FTP development, measuring and evaluating the economic benefits of key industry chains is key to understanding their contribution to the regional economy. By analysing the inputs and outputs of the core industrial chain such as tourism, modern service industry and high-tech industry. The data shows that in 2023, the main industrial chain of Hainan FTP generated a direct economic output of about 80 billion yuan, which became an important driving force for promoting regional economic development. In particular, tourism, as a pillar industry, has a particularly significant employment-led effect. Specifically, the tourism industry directly created 150,000 jobs and indirectly created about 300,000 jobs in related industries,

including transportation, catering, retail, etc., which comprehensively raised the employment rate and income level of residents within the Hainan FTP. The results show that the industrial chain of Hainan FTP not only has a far-reaching impact in terms of economic contribution, but also plays an important role in promoting social stability and improving residents' living standards. With the gradual implementation and improvement of Hainan FTP policies, it is expected that the economic benefits of these industries will continue to grow steadily in the future, laying a solid foundation for the sustainable development of the region.

4.2. Radiation Effect of Related Industries

The main industrial chain of Hainan FTP promotes the common development of other related industries through the strong spillover effect of its core industries. Taking tourism as an example, its rapid growth has not only driven directly related industries such as catering, accommodation and transport, but also created positive market opportunities for local agriculture and cultural and creative industries. Data shows that the impact of tourism on Hainan's local agriculture is as high as 25 per cent, promoting the rapid development of organic farming, organic agriculture and other emerging industries. Tourists' demand for Hainan's speciality agricultural products continues to grow, which not only increases the popularity of tropical fruits and speciality agricultural products, but also stimulates the upgrading of the agricultural supply chain, resulting in a higher degree of integration of the production, processing and sales of agricultural products. This cross-industry chain radiation effect not only expands Hainan's economic structure, but also promotes the deep integration of agriculture and tourism, which strongly supports the resilience and risk resistance of the regional economy. In addition, the rapid development of modern service industries, such as the maturation of financial and information service industries, has further strengthened the market competitiveness of various industries, providing a strong guarantee for the realisation of multi-industry synergy development and industry chain linkage in the region.

4.3. Selection and Strengthening of Efficient Industrial Chain

Given the high efficiency of the Hainan FTP in measuring the economic benefits of the industrial chain, the selection and strengthening of efficient industrial chains should be further strengthened and supported in future development. Through comprehensive analysis of the economic benefits, employment pull and resource use efficiency of tourism, modern service and high-tech industries, these three major industrial chains have higher earning and growth potential. Tourism is not only highly profitable on the basis of the existing base, but also creates synergies with the culture and health industries, with the potential for further expansion. The modern service industry, on the other hand, is represented by financial and digital services, which increase the added value and service quality of the entire industrial chain through the provision of logistics, financial support and information technology innovation. The rapid development of high-tech industries, on the other hand, provides core scientific and technological support for the industrial upgrading of Hainan FTP and promotes the high-end development of the industry. Therefore, it is recommended that the government focus on supporting the development of these efficient industrial chains in future policy formulation, such as providing special financial support and tax incentives for high-tech industries, and strengthening the introduction of talents and incentives for technological innovation to enhance their market competitiveness.

In addition, by promoting cooperation and resource sharing among these industrial chains, a stronger industrial cluster effect will be formed, which will make the economic structure of Hainan FTP more complete and solid, thus providing impetus for long-term sustainable growth in the region. Under the guarantee of these measures, Hainan FTP will continue to attract more high-

quality investment and technology resources, further enhance the resilience and vitality of its economic development, and realise the innovation capability of the industrial chain and its long-term competitive advantages.

5. Optimisation of the industrial chain path

5.1. Optimisation Strategy

Regarding the industrial chain of Hainan FTP, the optimisation strategy should focus on the comprehensive way of "chain strengthening" and "chain extension", so as to achieve the in-depth development of the key industrial chain and maximise the synergy effect. In terms of "chain strengthening", priority should be given to industries with significant economic benefits and strong correlation, such as tourism and modern service industries, which play an important role as the pillars of Hainan FTP. Their market competitiveness can be further enhanced by improving service quality, enhancing customer experience, developing innovative products and strengthening brand building. In particular, the tourism industry, as one of Hainan's core industries with huge market potential, can provide tourists with a more convenient and personalised experience through digital and intelligent services, such as the introduction of virtual reality (VR) tours, online booking systems and digital payment platforms. At the same time, the modern service industry can use data-driven technologies to implement intelligent management and refined operations to achieve more efficient production and service, thereby promoting the high-quality development of the industry chain.

In terms of 'chain extension', the optimisation path should focus on expanding interactions and links with industries upstream and downstream of the industrial chain to form a complete ecological chain for synergistic development. In particular, synergistic cooperation with industries such as agriculture, manufacturing and logistics can be strengthened. Hainan's rich natural resources provide a good basis for the development of ecological agriculture, and the tourism industry can be combined with the local characteristics of agriculture to launch experiential projects such as agro-paradise, picking tours and eco-farms, etc., to meet the demand of tourists for green and organic products. This innovative model can not only expand the service content of the tourism industry, but also enhance the added value of agriculture, forming the multiple economic benefits of "agriculture + tourism". At the same time, technology transfer and resource sharing should be further promoted to achieve technological complementarity and market linkage among industrial chains. Through cross-industry cooperation, the high-tech industry can export digital and intelligent technology solutions to the service industry and agriculture, forming a multi-industry linked innovation ecosystem. This comprehensively optimised industry chain ecosystem will bring more sustainable growth momentum to Hainan FTP's economy.

5.2. Resource Allocation and Policy Guidance

Rational resource allocation and policy guidance are key to promoting the optimisation of the industrial chain. The government should play an active leadership role in this process, providing resource support and policy guarantee for the development of key industries. It is recommended that a special pool of funds be established to focus on supporting industrial chains with high economic output and innovation potential, especially in high-growth areas such as the digital economy and green technology. In terms of financial technology, a smart payment system based on blockchain and digital payments can be built to enhance the competitiveness of Hainan FTP in financial services. Meanwhile, at the policy level, the focus should be on improving supporting policies to promote cross-industry cooperation and resource integration among enterprises to improve the

overall efficiency of resource allocation. An industry linkage fund should be set up to encourage cooperation and innovation among enterprises, promote cross-industry integration in areas such as services, manufacturing and tourism, and enhance the intrinsic linkage of Hainan FTP's industrial chain.

Support policies for SMEs also need to be further refined to help them find a suitable position in the industrial chain and improve their market competitiveness. The government can provide support in the form of tax exemptions, special loans and preferential loan interest rates to help SMEs overcome financial bottlenecks. For technology-based SMEs, policies such as R&D support, innovation funds and technology incubation can be provided to accelerate their technology application and market expansion. In addition, attention should be paid to the cultivation and introduction of high-quality talents to build an innovative talent ecosystem for Hainan FTP. Establishing a special talent introduction fund and providing incentives such as housing subsidies and business support to attract outstanding talents from around the world will provide sustainable impetus to the optimisation of Hainan FTP's industrial chain. The double guarantee of policy guidance and resource allocation will lay a solid foundation for the development of Hainan FTP's industrial chain and create good conditions for the sustainable development of the regional economy.

5.3. Continuous Optimisation and Resilience Enhancement of the Industrial Chain

Against the background of an increasingly complex market environment, the Hainan FTP needs to establish a dynamic monitoring and adjustment mechanism to optimise the industrial chain in real time and maintain its flexibility and resilience. By building a dynamic data monitoring system, it is possible to obtain real-time information on the operating status of the industrial chain and market changes, which provides a basis for timely adjustment of the industrial chain structure and policies. Production and consumption data of each industrial chain can be collected regularly to analyse the trend of market demand and ensure the balance of supply and demand in each link of the industrial chain. At the same time, regular market feedback analysis is conducted, and through in-depth data mining, the resource input and development direction of each industry can be adjusted in a timely manner, ensuring the overall coordination and flexibility of the industrial chain. On this basis, it is recommended to establish an industrial alliance mechanism to promote cooperation between upstream, downstream and horizontally related industries in the industrial chain. Through information sharing, technical exchanges and resource integration, the synergy capability between industries can be enhanced and information interoperability and complementary advantages can be realised. Taking the tourism industry in Hainan FTP as an example, forming alliances with agriculture, catering, logistics and other fields can achieve resource dispatch, product supply and service upgrading during the peak tourism season, and provide tourists with richer and more diversified experiences. Meanwhile, against the backdrop of the high risk of market fluctuations, it is particularly important to improve the risk resilience of the industry chain. It should focus on market and supply chain diversification and reduce dependence on a single market or supplier. Optimise the layout of the supply chain by establishing long-term partnerships with suppliers in different countries or regions, diversifying market risks and improving the stability of the industrial chain. In addition, companies are encouraged to independently research and develop core technologies to establish independent control over key resources and enhance their ability to withstand external risks.

6. Conclusions

By systematically measuring the industrial correlation characteristics of Hainan FTP, this study

reveals the structural characteristics and interaction of the industrial chain in the region, highlighting its importance in promoting economic development. The study shows that the pillar industries of Hainan FTP - tourism, modern service industry and high-tech industry - have formed a close correlation and synergy effect between them, which promotes the overall economic efficiency. The industrial chain of Hainan FTP has demonstrated significant economic spillover effects, especially the tourism industry's promotion of related industries such as catering, accommodation and agriculture, which not only increases employment opportunities, but also promotes the promotion of local speciality products and the modernisation and upgrading of agriculture, forming a virtuous circle. In addition, cross-industry synergies and policy guidance are particularly important. The government's efforts in resource allocation and policy support have created a favourable environment for in-depth inter-industry cooperation, especially measures such as tax incentives and financial support, which have stimulated market vitality and enterprise innovation. Therefore, it is recommended that Hainan FTP continue to pay attention to the dynamic monitoring and optimisation of the industrial chain in its future development, and strengthen inter-industry cooperation and exchanges to enhance the resilience and competitiveness of the overall economy. By establishing industrial alliances and dynamic adjustment strategies, Hainan FTP can better adapt to the rapidly changing market environment and ensure sustainable economic development. This study provides an important perspective for understanding the economic development of Hainan FTP, as well as a scientific basis for the formulation and implementation of related policies.

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