



Study on the Synergistic Development of Yunnan Ports and Hinterland in the Context of Digital Economy

Lei Xiao ^a, Hang Liu ^{*}, Yanyan Wu ^b

School of Economics and Management, Kunming University, Kunming, China

Email: ^a391644664@qq.com, ^bxiaoyan316316@163.com

^{*}Corresponding author's e-mail: L13315609296@163.com

Abstract. In order to assess the ability of the ports to achieve regional synergism of the shore and hinterland coupling, and to realise the development of the shore and hinterland coupling. This paper is based on analysing the mechanism of Yunnan shore and belly synergy, constructing the index system of port synergistic development potential and the level of economic development of the hinterland, using the entropy weight method-TOPSIS comprehensive evaluation method, carrying out spatio-temporal analysis of the coupling relationship between Kunming and nine core ports, and arriving at the targeted suggestions to improve the ability of shore and belly synergy. The results show that: in the coupling synergy model, the policy advantage in the degree of openness to the outside world has the highest influence on the shore-belly synergy; and the overall port digitalisation ability is weak, and the level of digital economy development is weak in pulling the development of the industry; and the port-Kunming coupling development model exhibits the basic coordination - port lagging development situation. The construction of the port synergy potential index system can better quantitatively analyse the radiation ability of the hinterland Kunming economy on the development of the port area, and provide theoretical support for the realization of regional synergy.

Keywords: land crossings, coupling coordination degree, shore and belly synergy

1 Introduction

In recent years, under the promotion of the national ‘Belt and Road’ initiative, the construction of China's open channel has achieved remarkable results, effectively promoting the circulation of commodities, and promoting the realisation of the inland hinterland to open up, Yunnan, as one of the major cities in the southwest region, has a complete policy support and ‘Belt and Road’, ‘introducing and going out’ and other friendly international environment. As one of the major cities in the southwest region, Yunnan has complete policy support and ‘Belt and Road’, ‘introducing and going out’ and other friendly international environment, the level of digital economic development has been

© The Author(s) 2024

K. Zhang et al. (eds.), *Proceedings of the 4th International Conference on Internet Finance and Digital Economy (ICIFDE 2024)*, Advances in Economics, Business and Management Research 301,

https://doi.org/10.2991/978-94-6463-534-8_6

rapidly improved, in which the port economy has become an important part of the economic development of the land extension area, the state constantly put forward the construction of a new type of port development model and improve the national image of the open window of the new pattern, in order to continuously improve the port In order to continuously improve the security and facilitation of ports, to achieve the goal of steady improvement of the development capacity of the port governance capacity, and to improve the opening-up capacity of the southwest region, it is crucial to increase the research on the development potential of the ports ^[1]. As a key factor in the development of foreign linkage, the port cities such as Mohan and Ruili have a significant effect on the development of the hinterland economy. Further research on the linkage mechanism of ports and hinterland will help Yunnan to achieve the promotion of cross-regional flow of resources, realise the complementary advantages within the region, realise the linkage development of hinterland and ports, and realise the substantial enhancement of the economy of the carrier cities.

This paper selects 9 representative ports from 14 land ports in Yunnan Province, and establishes a synergistic development potential evaluation system of ports: based on the shore and hinterland economic development system supported by the mode of port and hinterland linkage "port - shore industrial cluster - hinterland industrial cluster", and constructs a synergistic path of development potential - the level of economic development in Kunming. The main indicator layer, combined with the indicators to measure the level of digital economic development, using the coupling coordination model and entropy weight-TOPSIS analysis method, to analyse the level of synergistic development of the shore and hinterland, to provide development experience for the economic development of other ports.

2 Theoretical Analysis

2.1 Shore-belly Integration Study

Research based on the integration of port hinterland. The main focus is on the research of integrated development of the port and hinterland under the "port logistics hinterland" model under the momentum of digital economy development, measuring the economic coupling and coordination between the port and the hinterland of the city it is located in, and exploring the division of labor of coastal resources based on the evolution law of the port economic hinterland, in order to achieve balanced and coordinated development^[2]; Continuously exploring the role of port logistics in regional economic development^[3]. The 'Trinity' model can realise the complementary advantages, resource sharing and linked development of the two, and the mechanism and realisation path of the synergy between the two systems are explored from the perspectives of the regional economy and port logistics^[4]. A study focusing on the mechanisms by which the twin ports drive economic coordination in the hinterland, analysing the extent to which each factor influences it^[5].

2.2 Study on the Interaction of "Shore-Hinterland" Industries

Numerous ports in Yunnan are undergoing rapid digital transformation of the shore and belly industry in the context of the digital economy and regional economic integration. On the one hand, port cities are nodes of connectivity in bordering countries, and achieving industrial synergy with hinterland cities to promote the transformation and upgrading of digital industries is a key factor in realising cross-border cooperation^[6]. On the other hand, port collaboration on regional economic development exists in industrial agglomeration, industrial collaboration effect, through the study of port carrying capacity to explore the port to the hinterland of the industrial collaboration mechanism^[7].

2.3 Comprehensive Review

Based on existing research, the study of the linkage between the level of economic development of port cities and hinterland cities is in line with the requirements of the times, and is a theoretical need to deal with the development and opening-up policy of the border region. From the research perspective of scholars at home and abroad, some research ideas are provided on how to realise the interaction of port hinterland economy. The innovations throughout the text are : through the construction of the port synergistic development potential index system and the hinterland economic development level system, to achieve the coupling and coordination analysis of the two systems, based on the digital economy background to promote the development of the shore and hinterland industries^[8].Analysing the specific development directions and realisation paths for achieving shore-belly synergies at ports with different levels of development.

3 Data Sources and Research Methodology

3.1 Data Sources and Scope of the Study

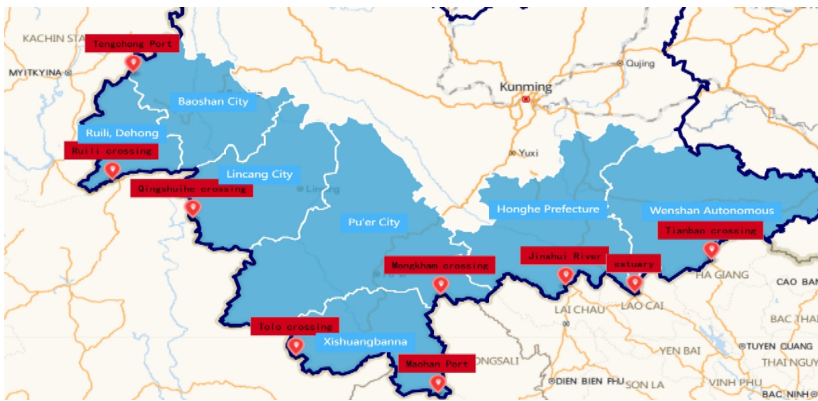


Fig. 1. Distribution of Land Ports and Carrier Counties along the Border in Yunnan Province

The main reference data comes from China Ports Yearbook 2022, Economic Development Bulletin of Border Ports, County Development Statistical Yearbook, with reference to Peking University's Digital Financial Inclusion Index Data^[9]. According to the principles of scientificity, rigour, and data availability, among the 14 land ports in Yunnan, the ports with better development and data advantages were selected for the study to be more representative, and the other ports with poorer linkage and interrupted opening time were excluded to reduce the possibility of the results of the study being affected by other factors. Nine land ports were selected as the research object. The distribution of the ports is shown in Figure 1.

3.2 Analysis of the External Environment of the Linkage Pathway

According to the synergistic theory research shows that regional development comes from the interactive synergistic relationship between the systems, to achieve the overall development of the composite system, Yunnan port development system and hinterland development system, logistics conditions as a carrier, industry, capital, technology, policy and other elements to link, to achieve the port - hinterland linkage of the composite system. In this paper, the main path of the linkage of the coast and hinterland selection of the core factors affecting the level of regional digital economic development, industry as the core of the linkage of the hinterland radiation driven role to the policy advantage as the core of the development conditions of the port^[10]. the two are based on the medium of infrastructure construction to achieve the construction of the coast and the hinterland synergy model, as shown in Figure 2.

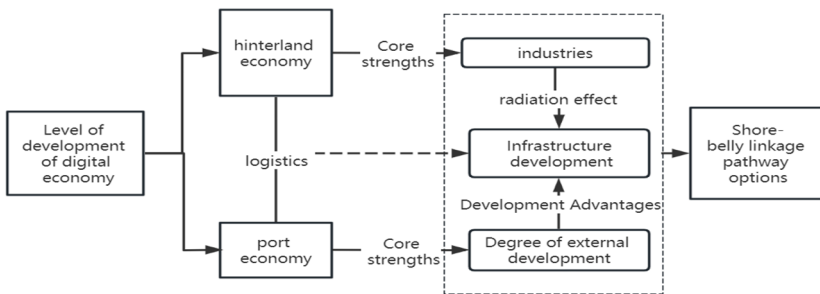


Fig. 2. Mechanism of coupled coordination of economic support systems in the shore-belly

3.3 Construction of an Indicator System for the Shoreline Belly

1. Indicator system for the level of economic development of ports

In order to measure the level of economic development of land ports along the border, four first-level indicators and 18 second-level indicators with significant impacts were constructed to build a system of indicators for the level of economic development of ports, as shown in Table 1.

Table 1. Indicator system for the level of economic development of ports

Tier 1 indicators (W)	Secondary indicators (W)	Significance of the indicators
degree of openness to the outside world (38.24 %)	Border market (4.05 %)	Size of border trade (number)
	Actual foreign investment (11.85%)	capacity to attract foreign investment (\$ billion)
	Cross-border/border cooperation zones(15.3 %)	Policy support
	Number of persons entering and leaving the port(7.04 %)	international exchange activity (10,000 visits)
Degree of industrial development (26.41 %)	Growth rate of imports and exports of (2.83 %)	the international competitiveness of industries (%)
	total import and export freight volume(8.05 %)	the international competitiveness of industries (tonnes)
	Dependence on urban industrial structure (5.43 %)	industry development trends and characteristics %
	Urbanisation rate (3.86 %)	the degree of variation in the consumption of the population in %
	Basic public finance general budget expenditure(6.26 %)	government support for industrial development (\$ million)
Infrastructure development (16.07 %)	road mileage(4.92 %)	completeness of land-based facilities (km)
	Motor mail(2.61 %)	completeness of land-based facilities (km)
	postal business outlets (4.54 %)	e-commerce development capacity in port-dependent cities (number)
	inspection and quarantine facilities(4 %)	the capacity of cross-border trade ports (square metres)
	Internet users per 100 population (3.41 %)	the digital literacy of the population and digitalisation
Level of digitisation (19.28 %)	employees in computer services and software (4.64 %)	regional digital talent
	total telecommunication services per capita (3.68 %)	the digital literacy of the population and digitalisation
	mobile telephone subscriptions per 100 population(4.06 %)	the digital literacy of the population and digitalisation
	Digital Financial Inclusion Index (3.49 %)	Capacity for Building Digital Finance

2. System of indicators of the level of economic development of the hinterland

To comprehensively assess the extent of regional economic development in Kunming, taking into account the existing system for evaluating the level of regional economic development. This study selects the per capita GDP and per capita local public budget income of Kunming region in 2018-2022 to measure the scale of economic development, and at the same time, uses the growth rate of per capita investment in fixed assets and per capita total retail sales of consumer goods to assess the quality of economic development, and takes into account comprehensively the value added of the second, third and third industries to measure the changes in the structure of economic development. The value added of the second and third industries is used to measure the

changes in the structure of economic development. The indicators are shown in Table 2 below.

Table 2. System of indicators of the level of economic development of the hinterland

Category I indicators	Category II indicators	Weighting %
economic level	GDP per capita (million yuan)	6.829
	Per capita local public budget income (yuan)	6.269
	Fixed investment growth rate %	8.229
	Total retail sales of consumer goods per capita (\$ million)	8.123
	Proportion of secondary sector	6.644
	Tertiary sector ratio	8.265
	Internet users per 100 population	12.76
Degree of digitisation	Percentage of employees in computer services and software	14.031
	Total telecommunication services per capita	14.489
	Mobile phone subscribers per 100 population	14.361

3.4 Coupled Coherence Models

The evaluation system of economic development of the hinterland selects entropy value method to determine the weights of each index by the objective raw data, and the results are as shown in Table 1 and Table 2. The TOPSIS method is used to measure the economic synergy potential of the ports and the comprehensive index of the economic development of the hinterland^[11], which provides basic data for the coupling and coordination analysis. X_{ij} is the j^{th} value of the i^{th} evaluation unit after standardisation of the data, also known as the weighted standardisation matrix, using the formula (1) to derive the index of the various secondary indicators, the sum of the sum of the various first-level indicators of the index index Q_{ij} , the results are shown in Table 3. By calculating the distance between each programme and positive ideal solution and negative ideal solution to determine the advantages and disadvantages, thus determining the Euclidean distance T^+ , T^- , using the formula (2) to find the relative proximity M ^[12].

$$Q_{ij} = x'_{ij} * w_{ij} \quad (1)$$

$$M = \frac{T_i^-}{T^+ + T^-} \quad (2)$$

Coupling coordination degree model: In this study, the degree of coupling can indicate the potential for economic synergy in the ports and the strength of the coupling effect between the economic development systems in the hinterland, but it is still necessary to construct a coupling coordination model to show the coupling co-ordination¹¹. The coupling coordination degree, D the larger indicates that the development level of the two systems is more coordinated. C is the degree of coupling, the larger indicates

that the coupling development degree is higher, and vice versa tends to disordered development. T is the combined coordination index of the M_1 port system and the M_2 hinterland system. The two systems are balanced with a fixed AB dominance coefficient of 0.5 and the formula is as follows:

$$D = \sqrt{C * T} \quad (3)$$

$$C = 2 * \sqrt{(M_1 * M_2) / (M_1 + M_2)^2} \quad (4)$$

$$T = A * M_1 + B * M_2 \quad (5)$$

To further reflect the gap between the two, the relative development degree E in the relative development degree model is used to measure whether the economic synergy potential of the ports and the economic development system of the hinterland are ahead of or lagging behind development. The formula is as follows.

$$E = M_1 / M_2 \quad (6)$$

Combined with the existing research results to divide the degree of coordination, the summary of the port economic synergy potential and the hinterland economic development coupling coordination division type, the coupling coordination degree D , in the (0,1] interval is divided into five coupling coordination types, (0,0.2] on behalf of a serious dysfunction; (0.2, 0.4] on behalf of a moderate dysfunction; (0.4,0.6] on behalf of the basic coordination; (0.6,0.8] represents medium coordination ;(0.8,1] on behalf of a high degree of coordination. The relative development degree E , which is divided into (0,2], (2,4], and (4,∞) in each interval of D , represents the lag characteristics under that coupled coordination type, which are port lag, basic coordination, and hinterland lag, respectively.

4 Research Analyses and Findings

4.1 Analysis of the Composite Index of Economic Development in the Coastal Hinterland

From the data Kunming economic development level composite index, the lowest composite index in 2020 is 0.38; Maximum 0.63 for composite index M_2 in 2022, the data in the last five years show that the impact of the epidemic has hindered the improvement of the level of economic development, relatively degraded to before 2018, thus choosing the data in 2022 to integrate the degree of superiority and inferiority, in order to complete the calculation of the degree of synergy, and to reduce the impact of the epidemic factors. Excluding the impact of changes in non-regional development factors in 2019,2020, the comprehensive evaluation score of Kunming's overall economic development level is mainly affected by the degree of digitalisation.

According to the Comprehensive evaluation index of the first category of indicators for ports in Table 3, it can be seen that the coordinated development potential of ports can be divided into five categories: $0 < M_1 \leq 0.2$ for low synergistic ability, $0.2 < M_1 \leq 0.4$ for low synergistic ability, $0.4 < M_1 \leq 0.6$ for general synergistic ability, $0.6 < M_1 \leq 0.8$ for higher synergistic ability, and $0.8 < M_1 \leq 1$ for high synergistic ability. The data show that Tianbao port, Mengding Qingshuihe port, Daluo port, Mengkang port are ports with low synergy ability, and other ports are ports with general synergy ability, and the overall ports have weak ability to achieve the linkage between the shore and the belly. The strongest synergy potential of the ports in 2022 is the Hekou Highway Port, where the degree of openness to the outside world is the key to influence the synergy potential, but the digitalisation level is weak, and it is the weakest digitalisation ability in the main nine ports of Yunnan. The port with the weakest capacity, so the index of the indicator tends to be close to 0. However, its weak digitalisation capacity is still the first place in the comprehensive score, which indicates that the transformation and upgrading of the port industry is the entry point to significantly improve the level of economic development. The weakest synergistic potential of the port is Daluo Port, its openness to the outside world and the index of industrial development level are low, the index of infrastructure construction index is less than 1, which proves from another angle that the port relies on the infrastructure, policy support and its own level of industrial development to achieve the synergistic possibilities are very small, the openness to the outside world is mainly affected by the index of the number of people entering and exiting the port, and the index of the five secondary indicators under the level of industrial development is balanced. The index of infrastructure development is mainly dependent on the construction of postal routes.

Table 3. Comprehensive evaluation index of the first category of indicators for ports in 2022

crossing	degree of openness to the outside world	Level of industrial development	Infrastructure development	Level of digitisation	Integrated synergies	M_1	D	E
Estuary Road	25.25	14.41	12.70	0.00	0.54	0.51	0.57	0.81
Ruili	16.90	16.17	3.82	10.04	0.51	0.48	0.55	0.76
Miller's Nest	17.73	13.72	3.61	12.23	0.47	0.48	0.55	0.76
guardian angel	2.81	5.68	8.94	11.17	0.31	0.34	0.47	0.54
Tengchong Mon-key Bridge	3.85	13.28	11.12	10.75	0.42	0.42	0.52	0.67
Mengding Qingshui River	5.75	2.22	5.56	18.85	0.36	0.39	0.50	0.61
Chengdu's main airport	3.19	6.43	0.80	12.23	0.29	0.29	0.43	0.46
Jinshui River	13.11	3.64	12.26	0.00	0.40	0.38	0.49	0.59
Mongkham	4.23	4.86	11.99	13.71	0.38	0.41	0.51	0.64

4.2 Analysis of the Degree of Coordination of Shore-Abdominal Coupling

According to the coupled coordination model and the relative development degree calculation method, the data of the nine major ports, and the hinterland Kunming in 2022 are brought into the calculation, and the coordinated development of the synergistic potential of the ports and the economic development of the hinterland are derived, as shown in Table 3. In conjunction with the coupling co-ordination classification criteria, the port - Kunming as a whole presents a basic coordinated development situation, the overall port and the main provincial capital of Kunming synergy capacity gap is small, tends to be balanced.

From the point of view of relative development degree, the main characteristics of each port coupling co-ordination development is shown as the basic co-ordination - port lagging situation, co-ordination of the development of insufficient capacity, are lower than 1, co-ordination of the development of a higher degree of Hekou Port, Ruili Port, Mohan Port, Tengchong Monkey Bridge Port. But Ruili Port and Mohan Port relative development degree convergence and tend to rank first, combined with the overall indicator system analysis to see the key to the synergistic ability of the coast and abdomen in the port indicator system, the advantages of the political environment, relying on the transformation of the city's industrial structure and the overall digital level of support. Coordination of digital development level and port industry transformation is the key factor to achieve the synergy between the coast and the hinterland.

4.3 Conclusion

This paper constructs the port economic synergy potential and hinterland economic development index system and coupling coordination degree model, measured the spatial difference between the economic hinterland of Kunming and the economic coupling coordination degree of Yunnan land border ports, the research results show that:

1. the development of digital economy industry in the hinterland is a key factor to improve regional coordinated development. The degree of digitisation of the Kunming hinterland in recent years plays a major role in the speed of economic development. Regions with higher synergistic capacity of ports mainly rely on the indicators of policy support and industrial development capacity, Based on the status quo of progressive digitisation, to promote the digital transformation of the industry and the implementation of more proactive externally oriented policies are the core elements of the development of the port economy. For the synergistic ability of the weaker ports such as Ta Luo to improve the infrastructure is the core of its economic development.

2. The study as a whole to see the coupling synergistic ability in general, the degree of shore and belly coupling by the industry and digital level indicators have a greater impact. Data analysis of Ruili Port and Mohan Port coupling degree of coordination convergence is based on the port industry development indicators and digitisation level indicators have obvious differences in the case of the indicators complement each other on the whole can improve the coupling capacity of the shore and the abdomen. For ports like Daluo Port, which have a weak level of their own industrial development but

have intensive foreign traffic, improving their acceptance of the hinterland industries is a key factor to improve the coupling coordination between the coast and the hinterland.

5 Policy Recommendations

5.1 Improving the Efficiency of the Use of the Open-Door Policy

The degree of openness to the outside world is an indicator that has great weight in influencing the development of shore and hinterland coupling, of which preferential policies account for the main part. The ways that can be taken include: enhancing policy transparency, ensuring the transparency of the policy formulation process, enabling enterprises and the public to deeply understand and make use of the policies, and optimizing the policy dissemination and interpretation mechanism. Inferior ports to learn from the experience of other ports system innovation, such as Kunming City hosting the limitations of the implementation process of the Millan Port, combined with the limited capacity of the port industry to undertake, Kunming industry less outward-oriented and other situations, reasonable coordination can improve management effectiveness, and to promote the development of regional linkage.

5.2 Transformation of the Industrial Structure in the Context of the Digital Economy

The industrial structure of border land ports is relatively homogeneous and solidified, limiting the development of the economy to diversification, high quality and all-round development. Promote digital transformation, encourage enterprises to adopt digital technology, and improve the transparency and efficiency of the supply chain; make use of the advantageous platform of 'cross-border e-commerce' and the openness advantage of 'Border Mutual Market Points', and strengthen the external synergy of the land crossings such as the Mawhan River Crossing, so as to improve the outward orientation of the regional economic development. Outward orientation of economic development in the region

5.3 Increased Digital Capacity and Improved Port Acceptance Capacity

Analysed by the comprehensive evaluation index system for coordinated development potential of ports, it is found that the element of digital level is higher than the index of infrastructure construction, indicating that the capacity of ports to undertake is a key element of industrial synergy in the shore and hinterland. The main recommendations for improvement are: the main ways to enhance the efficiency of ports are to improve port inspection facilities, strengthen the construction of digital transport, logistics and communication infrastructures; simplify the customs clearance process, introduce electronic and automated systems, and speed up, reduce fees and increase efficiency. The hinterland industries make use of the advantages of bordering land ports to connect the

land hinterland with the international region, and create an efficient logistics system with ‘hubs as the centre, corridors as the link, and networks as the coverage’.

References

1. Cong Zhiying, Yu Tianfu. An analysis of the economic development of border ports in the eastern part of Northeast China [J]. *Economic Geography*, 2010, 30(12):1937-1943. DOI:10.15957/j.cnki.jjdl.2010.12.010.
2. Chen Yanyi, Cheng Pan, Bi Shanshan et al. Research on the evolution law of port hinterland scope under the development of regional port integration[J]. *Water Transport Engineering*, 2023(07):13-19.DOI:10.16233/j.cnki.issn1002-4972.20230705.027.
3. MENG Feirong, GAO Xiuli. Research on the degree of coordination of economic coupling between ports and direct hinterland and its influencing factors--taking the port cluster around Beibu Gulf as an example [J]. *Geography and Geographic Information Science*, 2017, 33(06): 94-100+127
4. Xu Jiangang. Research on "three-in-one" model of synergistic development of port logistics and regional economy[J]. *China Shipping Weekly*, 2023(28):45-47
5. DONG Xiaofei, HAN Zenglin, RONG Hongqing. Comparative analysis of the synergistic development of Dalian port, Yingkou port and hinterland economy[J]. *Regional Research and Development*, 2014, 33(05):39-43+54.
6. Wang Peipei, Cheng Yunjie. Countermeasures Research on Digital Transformation of Xinjiang Port Economic Belt[J]. *Xinjiang Social Science Forum*, 2022 (06):85-90.
7. YANG Liuxing, TIAN Guiliang, WANG Jue. Empirical study on the impact of seaport on hinterland based on VAR model:taking Lianyungang port as an example[J]. *Management Review*, 2016, 28(09):250-259.DOI:10.14120/j.cnki.cn11-5057/f.2016.09.022.
8. Bai Xuejie, Song Pei, Li Lin et al. Can Digital Economy Promote China's Industrial Structure Transformation? --Based on the perspective of efficiency-based technological progress [J]. *Journal of Xi'an Jiaotong University (Social Science Edition)*, 2021, 41(06):1-15. DOI:10.15896/j.xjtuskxb.202106001.
9. GUO Feng, WANG Jingyi, WANG Fang, et al. Measuring the development of digital inclusive finance in China: indexing and spatial characteristics[J]. *Economics (Quarterly)*, 2020, 19(04):1401-1418.DOI:10.13821/j.cnki.ceq.2020.03.12
10. Mushajiang Nuzheji. A study on the spatial differentiation of the territorial radiation effect of the border port economy in China [J]. *Academic Forum*, 2021, 44(03):124-132. DOI:10.16524/j.45-1002.2021.03.010.
11. Mushajiang Nuzheji, Xiong Ding. Research on economic competitiveness and transformation and upgrading path of China's border land ports[J]. *Price Monthly*, 2022(11):51-60. DOI:10.14076/j.issn.1006-2025.2022.11.07.
12. SUN Xiaodong, JIAO Yue, HU Jinsong. Research on decision-making method based on grey correlation and ideal solution method [J]. *China Management Science*, 2005, (04):63-68. DOI:10.16381/j.cnki.issn1003-207x.2005.04.011

Open Access This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

