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Configuration Analysis of Factors Influencing Port Competitiveness of Hinterland Cities under TOE Framework: Evidence from China

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Abstract: Attention is increasingly being paid to the influence of hinterland cities on port competitiveness, but in-depth research is lacking on the formation conditions and mechanism of hinterland cities' influence on port competitiveness. Based on the technology–organization–environment (TOE) framework and the characteristics of Chinese government organizational behavior, in this study, we used fuzzy-set qualitative comparative analysis (fsQCA) to conduct a condition configuration analysis of 21 coastal ports and their hinterland cities in China. The findings showed the following: (1) The technology, organization, and environment conditions of hinterland cities cannot provide the necessary conditions for high or low port competitiveness alone: different combinations of these conditions have produced three high and four low port competitiveness configurations. (2) The three configurations of high port competitiveness are the organization–environment, economy–balance, and finance–balance types. Adequate government financial supply, high tertiary industry proportion, good economic development, and market openness are the core conditions required for achieving high port competitiveness. (3) The four configurations of low port competitiveness are finance–facilities–environment, capability–finance–environment, technology–finance–economy, and capability–industry–economy restrictions. Here, low-level innovation capability, inadequate government financial supply, and low tertiary industry proportion are the core conditions leading to low port competitiveness. We revealed the concurrent synergistic effect of the three conditions of technology, organization, and environment in hinterland cities and demonstrated the causal complexity and asymmetry of the impact of hinterland cities on port competitiveness. Our conclusions provide empirical evidence that will aid hinterland cities in formulating differentiated port competitiveness promotion policies according to their own conditions and endowments.

Keywords: port competitiveness; hinterland cities; TOE framework; fuzzy-set qualitative comparative analysis

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1. Introduction

Ports are connection nodes between inland and overseas economies, playing an important role in the process of economic and social development. In the stage of economic globalization, ports have evolved into organizations with comprehensive functions in the global logistics network and value chain, and their strategic position in the national economy has been constantly strengthening [1]. With the positive influence of China's rapid economic development, continuous increases in openness to the outside world, and other favorable factors, China's ports have extensively developed, especially in terms of the rapid growth of port logistics in coastal areas. In China, researchers have analyzed the positive effect of port cargo throughput on the economic growth of port cities [2], the promoting effect of port prosperity on the upgrading and evolution of port cities' economic structure [3], and the relationship between changes in port operation strategy and the changes in port hinterland economic development characteristics [4]. However, relatively few studies have been conducted on the mechanism of hinterland cities' influence on ports.

Appropriate hinterland economic performance will provide a suitable foundation and premise for the development of port logistics as well as a dynamic basis for the rapid growth of port logistics. Therefore, studies of the impact of China's hinterland cities on ports are valuable for the improvement in port competitiveness.

At present, some hinterland cities in China still lack support for ports, and many ports cannot fully use the features and advantages of hinterland economic development, which reduces the competitiveness of ports to some extent. However, the existing studies in this field have two deficiencies: First, studies of the synergistic interaction of multiple elements are lacking. Researchers have mainly analyzed the relationship between hinterland cities and port development from the perspective of one or two variables (such as economic development or industrial structure) [5–8]. However, the impact of hinterland conditions on port competitiveness is a complex process of the synergistic interaction of multiple factors, and the lack of analysis of core conditions and configurations is preventing the systematic understanding of the complex operation mechanism of multifactor interactions. Second, researchers have failed to analyze the differences between hinterland cities and have ignored asymmetric causality. Hinterland cities do not have a general and standard impact on port competitiveness. For example, the industrial structure of a hinterland area may help improve port competitiveness, but this does not mean that removing the influence of industrial structure will reduce port competitiveness. The industrial structure and economy of the hinterland area may lead to an improvement in port competitiveness, but the synergistic effect of industrial structure and specific population structure may lead to a decline in competitiveness.

The configuration perspective is widely used to understand the causal complexity affecting a certain result [9]. This perspective shows that multiple influencing factors are interdependent and can achieve the common purpose of influencing the results through different permutations and combinations. Based on this, in this study, we empirically analyzed the influencing factors and promotion paths of hinterland port competitiveness. Specifically, we aimed to answer the following research questions in this study: What is the configuration of hinterland cities' conditions that affects port competitiveness? Which conditions play a more important role in this? What is the relationship between these conditions? The main contributions of this study are as follows: First, based on the TOE framework, we constructed an integrated analysis framework to understand port competitiveness, and we took 21 ports and their hinterland cities in China as cases to reveal the configuration of the condition and the mechanism of action leading to the differences in port competitiveness through fuzzy-set qualitative comparative analysis. Second, by discussing the synergistic effect of multiple conditions in the TOE framework, we explained the complex interactive nature of multiple factors influencing hinterland city port competitiveness, thereby compensating for the deficiencies of previous studies in explaining such problems.

The remainder of this paper is organized as follows: In Section 2, we review the literature related to the TOE framework and port competitiveness and establish the model of influencing factor configurations affecting hinterland port competitiveness. In Section 3, we describe our study methods and sample data. Section 4 provides the results of the fsQCA approach and presents an analysis of different configurations. Section 5 describes our conclusions and some policy suggestions.

2. Literature Review and Model

2.1. Port Competitiveness

At present, a universally recognized unified paradigm has not been designed for measuring and evaluating port competitiveness. In the literature, studies on port competitiveness evaluation have mostly focused on the hardware facilities of ports, such as the geographical location, telecommunication system, inland transportation, port handling capacity, operation capacity, and natural environment [10–12]. Some researchers found that most hardware indicators are variable in the short term and do not have long-term coupling with the macro economy of hinterland cities [13]. Some results have suggested that in addition to hardware facilities, port competitiveness is affected by economic soft power factors such as policy, efficiency, interdepartmental patency, and supply and demand scale and structure [14]. Therefore, many researchers have attempted to analyze port competitiveness through correlation regression [15], evidence theory [16], the entropy-weight cloud model [17], and the TOPSIS evaluation method [18]. In practice, such as in national or regional statistical yearbooks, the main indicators of port competitiveness are throughput, 10,000 tons of berths, and other hardware facilities.

2.2. Hinterland Cities and Port Competitiveness

From the perspective of hinterland economic development, port prosperity can improve the economic activity of hinterland cities [19] and drive the growth [20] and promote the agglomeration [21] of the related industries in the region where the port is located. Therefore, many cities with ports also have the characteristics of a port economy. In the initial period of port construction, port development can drive the development of the hinterland city, and over time, the development of the hinterland city can in turn promote the development of the port. In 1934, Kautz proposed the theory of seaport location, which states that seaport locations are determined by the development status of the city and that the economic scale and development vitality of hinterland cities effectively support port development [22]. In China, Cheung took Chinese ports as the study object and analyzed the impact of economic development and population factors on port throughput based on the data of seven major port cities and ports in China from 1995 to 2007 [23]. Liu et al. analyzed the driving effect of tertiary industry development in hinterland cities on port prosperity by taking Zhanjiang as the study object [2]. Li et al., taking Tangshan Port as an example, reported that the structure of the secondary industry and tertiary industry affected the increase in port throughput [24].

In China, some valuable studies have been conducted on the impact of hinterland port competitiveness, but researchers have mainly discussed the single value of many potential factors based on statistical regression to test the marginal net effect of a single element. They have ignored the mechanism driving the influence of these variables on port competitiveness and the organization's process; an integrated analysis of the institutional environment has not been completed, and a system to investigate the synergistic effect between multiple conditions is lacking. Therefore, the conditions and mechanisms through which the influencing factors of hinterland port competitiveness play a role in China's practice scenarios still need to be further clarified, and more thorough explanations need to be provided.

2.3. TOE Frame and Configuration Model

The technology–organization–environment (TOE) framework proposed by Tornatizky and Fleischer (1990) emphasizes the impact of multilevel technology application scenarios, such as the degree of an organization's demand for technology and the applicability of technology to organizational rules [25]. The TOE framework is used to divide the conditions that affect technology application into three categories: technology [26], organization [27], and environment [28]. The specific variables in each of the technology, organization, and environment categories are not specified in the TOE framework, which allows researchers to adjust and modify the TOE framework according to different research fields or objects, thereby improving the effectiveness and applicability of the framework [29]. Therefore, the TOE framework has been used to refine condition variables and construct configuration models in multiple fields using the QCA method [30–33].

Based on published research results, in this study, we constructed a configuration model containing six antecedent conditions from the technical, organizational, and environmental categories based on the TOE framework, which we applied to China's institutional situation and the actual scenario of hinterland port competitiveness construction (Figure 1).

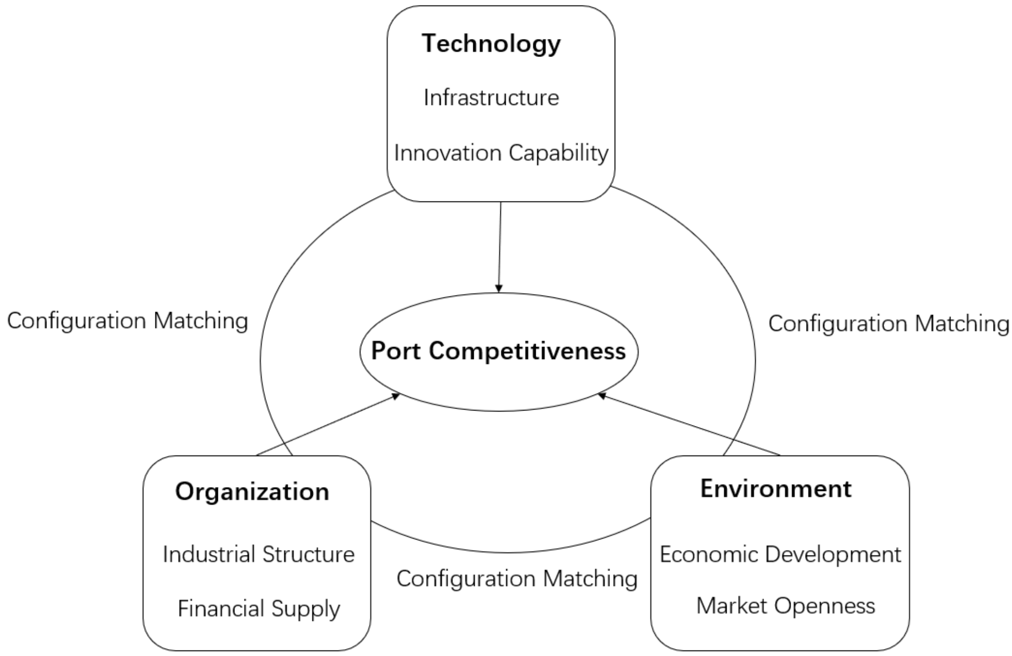

Figure 1. Configuration model based on TOE framework.

The six conditions were as follows:

(1) Hinterland technology conditions, which include two secondary conditions: infrastructure and innovation capability. Infrastructure (such as digital, transportation, and research infrastructure) not only provides an important foundation and basic guarantee for economic development [34], but also promotes the competitiveness of ports [35]. Technology can influence organizations, but it can also be adversely affected by organizations [36]. The stronger the innovation ability of the organization, the more capable the organization of applying technology, and the greater the application of innovative technology [37]. In other words, regions with high innovation capacity are more likely to increase support for ports by promoting the integrated development of different types of infrastructure.

(2) Hinterland organization conditions, which include the financial supply and industrial structure as two secondary conditions. In reality, support from the Chinese government is an important factor affecting technology application, and financial supply is an important indicator reflecting government support [38,39]. The increase in the competitiveness of hinterland ports requires corresponding financial allocation support, which can be used for technical facility construction, infrastructure development, and port linkage. Industrial structure directly reflects hinterland industrial development quality and economic benefits, and industrial structure optimization can promote port transformation and development and increasing competitiveness [40].

(3) Hinterland environment conditions, which include economic development and market openness as two secondary conditions. Hinterland macroenvironmental conditions directly impact port competitiveness, which is impacted by economic development and market openness. Economic development directly affects commodity market transactions in hinterland ports and thus plays an important role in promoting the development of port logistics [41]. A modern port is often an international logistics center, which is closely related to the openness of hinterland cities [42]. Therefore, the higher the degree of market openness, the more port competitiveness is promoted.

From the perspective of configuration, the effects of the technology, organization, and environment conditions on the port competitiveness of hinterland areas are not independent of each other but play a synergistic role through linkage and matching. Specifically, the nonsynergistic effects of multiple conditions may include either mutual reinforcement through adaptation or mutual cancellation through substitution. Therefore, from the perspective of configuration, we empirically analyzed how technology, organization, and environment conditions affect port competitiveness through mutual linkage and matching.

3. Materials and Methods

3.1. fsQCA Method

QCA was proposed by Ragin (1987) in the 1980s. With QCA, researchers can determine the logical relationship between matched patterns of different conditions and obtain results through cross-case comparison. That is, researchers can identify which configuration of variables can lead to the emergence of a result and which configurations cause the reduction in an outcome, to further identify the synergistic effects of multiple variables while acknowledging the causal complexity [9].

Compared with quantitative research based on regression analysis, QCA has the following advantages [9]: First, through cross-case comparison of large, medium, and small samples, researchers can identify the mechanism of action of variables reflecting conditions and ensure the external generalization of empirical results to a certain extent. Second, researchers can identify the equivalence of conditions with results, which can help with understanding the different mechanisms driving the results in different case scenarios so that they may further discuss the adaptation relationship between conditions. Third, researchers can further compare the results when the condition configuration disappears, thereby broadening the theoretical explanations of problems in specific research dimensions. Under the causal asymmetry premise, the variables representing the conditions and the "not set" conditions may not be the same.

Qualitative comparative analysis (QCA) includes three basic categories of analyses [9]: clear-set qualitative comparative analysis (csQCA), fuzzy-set qualitative comparative analysis (fsQCA), and multivalued-set qualitative comparative analysis (mvQCA). Among them, csQCA can only deal with binary variables; that is, the values of the antecedent conditions and the results of analysis must be calibrated to 0 or 1. mvQCA is similar to csQCA, but mvQCA can handle multicategory problems. For example, according to the category, the values of conditions and results can be 1, 2, 3, etc. fsQCA enables the QCA method to handle not only multicategory problems, but also degree of change problems and partial membership problems; that is, the case receives a membership score between 0 (nonmembership) and 1 (full membership). Therefore, fsQCA has been widely used in relevant empirical studies in recent years. In this study, we attempted to analyze the factors influencing hinterland port competitiveness based on the perspective of the configuration of conditions. Considering the characteristics of the data used in this study, we adopted fsQCA for our empirical tests.

3.2. Samples Selection and Data Source

We selected 21 coastal ports and their hinterland cities in China as the study samples. Since 2009, the China Statistical Yearbook has included coastal ports with an annual throughput of 10 million tons or more. As the influence of hinterland conditions on port competitiveness has a certain time lag effect, we determined the lag period of the variables reflecting their conditions as two years [43]. A description of the outcome and condition variables is shown in Table 1.

Table 1. Outcome and condition variables.

Measure	Name	Abbreviation
Outcome	Port Competitiveness	PC
Conditions	Infrastructure	IN
	Innovation Capability	IC
	Industrial Structure	IS
	Financial Supply	FS
	Economic Development	ED
	Market Openness	MO

3.2.1. Results of Variables

We focused on port competitiveness as the outcome. The evaluation of port competitiveness mainly considers three factors: (1) the characteristics of the port or the hinterland city; (2) whether objective factors should be considered or subjective evaluation should be performed; (3) where a single indicator or multiple indicators should be chosen. First, we studied the factors influencing port competitiveness, so it was not appropriate to repeatedly include these factors in the result variables. Therefore, we only considered the characteristics of the port when evaluating port competitiveness. Second, to avoid the influence of subjective evaluation, we only selected indicators of objective factors. Finally, although many researchers have tried to establish complex index systems to evaluate port competitiveness, our purpose in this study was not to conduct a refined ranking of port competitiveness, so we selected the port cargo throughput, which is widely used in practice, as the index for measuring the outcome variable. We obtained the port cargo throughput data from the China Statistical Yearbook 2020, which covers coastal ports with a throughput of more than 10 million tons in 2019.

3.2.2. Condition Variables

We used the fixed asset investment per 10,000 people of each city in 2017 as an indicator to directly measure the level of infrastructure construction in hinterland cities [44]. We obtained the fixed asset investment and population data from the statistical bulletin of each city in 2017.

We used the following variables to represent the conditions:

Innovation ability: We adopted the number of patent applications per 10,000 people in each city in 2017 as an indicator to directly measure the innovation capacity of the hinterland cities [45]. We obtained the number of patent applications from the statistical bulletin of each city in 2017.

Financial supply: We adopted the per capita general public budget expenditure of each city in 2017 as the index for directly measuring the financial supply level of the hinterland cities. We obtained the general public budget expenditure from the statistical bulletin of each city in 2017.

Industrial structure: We adopted the proportion of the added value of the tertiary industry in the GDP of each city in 2017 as the index for directly measuring the industrial structure of the hinterland cities [3,24]. We obtained added value of the tertiary industry from the statistical bulletin and statistical yearbook of each city in 2017.

Economic development: We selected the 2017 per capita gross regional product (GRP) of each city as the index for directly measuring the economic development of the hinterland cities. We obtained the data from the statistical bulletin of each city in 2017.

Market openness: We used the ratio of total import and export volume to gross regional product of each city in 2017 as the index for directly measuring the degree of openness of hinterland cities [46]. We obtained the data on total imports and exports from cities' statistical bulletins in 2017.

3.3. Calibration

In fsQCA, calibration refers to the process of assigning a set membership to a case [9]. After calibration, the membership degree of the set is between 0 and 1, and the results of the calibration include complete membership, intersection, and no membership. In this study, we adopted the direct method to calibrate the initial data, as shown in Table 2. Due to the lack of clear rationale and external standards for the calibration of port competitiveness and influencing factors, we conducted calibration based on the descriptive statistics of cases [47].

Referring to existing studies [48], we set the three points of complete membership, intersection, and complete nonmembership in this study to the 95%, 50%, and 5% quantiles of the sample data, respectively. The measurement index description for each variable and the calibration points are shown in Table 3. We used fsQCA3.0 for analysis in this study. Because the value of the sample intersection point is exactly 0.5 after calibration, we adjusted 0.5 to 0.501 according to the partial membership of the value of the intersection point [48]. Table 4 provides the fuzzy-set data of each variable after calibration.

Table 2. Initial data used for calibration.

Cities	PC	IN	IC	FS	IS	MO	ED
Ningbo-Zhoushan	112,009	7.042298049	71.68102039	1.819688215	0.457197336	1.321401784	228,828
Shenzhen	25,785	4.108554233	141.359961	3.667456878	0.586183768	1.248372098	183,127
Guangzhou	60,616	4.083091927	81.61728191	1.507745682	0.709401646	0.451764509	150,678
Shanghai	66,351	2.996530664	54.47809025	3.121004991	0.68970487	2.628650959	124,600
Weihai	3730	10.411594	29.46630804	1.272508494	0.478184535	0.40369817	123,163
Tianjin	49,220	7.241895598	55.88135169	2.108178589	0.580076342	0.41122311	119,441
Qingdao	57,736	8.371024164	58.48016791	1.510144772	0.553587478	0.45604533	119,357
Xiamen	21,344	5.938802993	61.34413965	2.024663342	0.577321554	1.336658102	109,740
Dalian	36,641	2.365535995	19.72806641	1.316444826	0.520688765	0.561142873	105,378
Yantai	38,632	7.890992186	16.90693148	0.998772816	0.43394491	0.419351542	103,706
Fuzhou	21,255	7.602336815	33.39425587	1.228224543	0.509795862	0.328832126	93,290
Fangcheng	10,141	7.15560519	10.7636673	1.281323123	0.311642081	1.036298913	79,351
Taizhou	4901	4.116149068	45.88264139	0.920398823	0.497146907	0.359574041	72,912
Rizhao	46,377	5.798731356	9.477112978	0.796434082	0.443881857	0.454183207	68,848
Haikou	12,447	6.229919458	14.05307865	0.873641125	0.772783499	0.151185202	61,583
Wenzhou	7541	4.534454693	49.91861096	0.826478568	0.579457933	0.243361696	59,306
Lianyungang	23,456	5.762283109	20.2151204	0.864376771	0.434430048	0.195317974	58,577
Yingkou	23,818	1.886382281	4.799015587	0.852337982	0.480090041	0.289839323	52,821
Qinhuangdao	21,880	2.807605761	15.53619648	0.381091681	1.013067933	0.436272866	48,539
Shantou	3155	3.577618487	25.78902322	0.591883314	0.451509299	0.236281033	42,025
Zhanjiang	21,570	2.247132101	9.392197125	0.616413415	0.426351703	0.122392468	38,744

Table 3. Calibration.

Outcome and Conditions	Calibration Points		
	Complete Membership	Intersection	Complete Nonmembership
PC	66,351	23,456	3730
IN	8.37	5.76	2.25
IC	81.62	29.47	9.39
IS	3.12	1.23	0.59
FS	0.77	0.51	0.43
ED	183,127	93,290	42,025
MO	1.34	0.42	0.15

Table 4. Fuzzy-set data.

Cities	PC	IN	IC	FS	IS	MO	ED
Ningbo-Zhoushan	1	0.81	0.92	0.72	0.13	0.95	0.99
Shenzhen	0.54	0.2	1	0.98	0.71	0.94	0.95
Guangzhou	0.93	0.19	0.95	0.61	0.91	0.53	0.87
Shanghai	0.95	0.09	0.81	0.95	0.89	1	0.74
Weihai	0.05	1	0.501	0.52	0.24	0.46	0.73
Tianjin	0.86	0.85	0.82	0.8	0.69	0.48	0.71
Qingdao	0.92	0.95	0.84	0.61	0.62	0.53	0.7
Xiamen	0.42	0.55	0.86	0.78	0.68	0.95	0.63
Dalian	0.72	0.05	0.19	0.53	0.53	0.61	0.6
Yantai	0.74	0.92	0.13	0.25	0.06	0.501	0.59
Fuzhou	0.42	0.89	0.56	0.501	0.501	0.27	0.501
Fangcheng	0.12	0.83	0.06	0.52	0	0.88	0.31
Taizhou	0.06	0.2	0.72	0.19	0.39	0.34	0.23
Rizhao	0.83	0.51	0.05	0.12	0.09	0.53	0.19
Haikou	0.16	0.63	0.09	0.16	0.95	0.05	0.14

Table 4. *Cont.*

Cities	PC	IN	IC	FS	IS	MO	ED
Wenzhou	0.08	0.26	0.76	0.13	0.69	0.12	0.12
Lianyungang	0.501	0.501	0.2	0.15	0.06	0.08	0.12
Yingkou	0.51	0.04	0.02	0.15	0.26	0.19	0.09
Qinhuangdao	0.44	0.07	0.11	0.02	1	0.51	0.07
Shantou	0.04	0.13	0.37	0.05	0.11	0.11	0.05
Zhanjiang	0.43	0.05	0.05	0.05	0.05	0.03	0.04

4. Results

4.1. Necessary Conditions and Configuration of Conditions

Before analyzing the configuration of conditions, we first conducted separate tests of the necessity of each condition. Then, we conducted sufficient condition analysis for each condition that could not be taken as a necessary condition alone, and we identified the configuration of conditions with the strongest explanatory power of the target case through Boolean algebra minimization. The results are shown in Table 5.

Table 5. Results of necessary condition analysis.

Conditions	High Port Competitiveness		Low Port Competitiveness	
	Consistency	Coverage	Consistency	Coverage
IN	0.594	0.655	0.565	0.598
~IN	0.635	0.604	0.674	0.614
IC	0.637	0.682	0.505	0.519
~IC	0.550	0.537	0.690	0.646
FS	0.639	0.779	0.435	0.509
~FS	0.597	0.524	0.811	0.683
IS	0.606	0.680	0.536	0.576
~IS	0.622	0.583	0.702	0.631
ED	0.707	0.809	0.437	0.480
~ED	0.545	0.502	0.826	0.730
MO	0.695	0.741	0.499	0.510
~MO	0.540	0.529	0.746	0.701

Note: ~ represents the not-in-set operation, which resulted from counterfactual analysis in fsQCA.

According to the analysis results of the necessary conditions for high port competitiveness in Table 4, we found that the consistency of each condition was lower than the critical value of 0.9, which indicated that each condition could not constitute a necessary condition to explain the variation in the result. In the analysis of the conditions necessary for low port competitiveness, we found that the consistency of each condition was lower than the critical value of 0.9, which indicated that each condition did not constitute a necessary condition to explain its respective result variables. This analysis showed the complexity of influencing factors of hinterland port competitiveness; that is, the technology, organization, and environmental conditions need to be matched with each other to jointly affect port competitiveness in hinterland cities. In other words, analyses of the level of hinterland port competitiveness should comprehensively consider the concurrent synergistic effects of the three conditions: technology, organization, and environment.

Condition configuration analysis is the process of exploring whether the configuration of multiple conditions is a subset of the result set. First, in parameter setting, we set the consistency threshold to 0.8 to determine whether the block grouping state passed the consistency requirement in fuzzy-set theory [48]. Second, considering that the frequency threshold should include at least 75% of the observed cases and the total number of cases in this study was 21, we set the case frequency threshold to 1 [9]. We set the PRI consistency to 0.65 [49]. Finally, when we used fsQCA3.0 for the standard analysis of high and low port competitiveness, according to the necessity analysis results, we found that single conditions were not necessary for explaining the respective result variables. Therefore, we selected the present or absent option in the counterfactual analysis module. Then, we obtained complex, simplified, and intermediate solutions(see Table A1 in Appendix A).

To present the results more clearly, we adopted the form of QCA result presentation proposed by Ragin and Fiss (2008) [47], which clearly indicates the relative importance of each condition in the configuration, as shown in Table 6.

Table 6. Configurations of port competitiveness. • indicates the presence of the core condition, • indicates the presence of the edge condition, ⊗ indicates the absence of the core condition, ⊗ indicates the absence of the edge condition, and a blank indicates that the presence or absence of the condition was insignificant for the outcome.

Condition	Configurations of High Port Competitiveness			Configurations of Low Port Competitiveness			
	C1	C2	C3	NC1	NC2	NC3	NC4
IN	⊗	•	•	⊗	•	⊗	•
IC		•	•	•	⊗	⊗	⊗
FS	•	•	•	⊗	⊗	⊗	•
IS	•	•			•	•	⊗
ED	•	•	•	⊗	⊗	⊗	⊗
MO	•		•	⊗	⊗	•	•
Consistency	0.909	0.853	0.834	0.975	0.952	0.943	0.936
Raw coverage	0.353	0.314	0.338	0.298	0.069	0.226	0.243
Unique coverage	0.179	0.046	0.069	0.126	0.253	0.062	0.067
Solution consistency		0.562			0.557		
Solution coverage		0.861			0.942		

4.2. Analysis of Configurations of Conditions of High Port Competitiveness

Table 6 presents three configuration paths that explain high port competitiveness. Each column represents a possible condition configuration. The solution consistency was 0.562, which means that 56.2% of ports had a higher level of competitiveness in all cases that met the three condition configurations. The solution coverage was 0.861; that is, the three configurations of conditions explained 86.1% of the cases of high port competitiveness. Based on the configuration of conditions, we further identified the different adaptation relationships between technology, organization, and environment in influencing the improvement in hinterland port competitiveness.

(1) Configuration C1: organization–environment type. When hinterland areas had sufficient financial supply, an optimized industrial structure, strong economic development, and market openness, their ports had a high level of competitiveness. We found that financial supply, industrial structure, economic development, and market openness were the core conditions; infrastructure and innovation ability were irrelevant for high-level port competitiveness. Because this path was composed of organizational and environmental conditions, and all condition variables were core conditions, we named this configuration path the organization–environment type. This means that hinterland organization and environmental factors were important conditions driving the formation of high-level port competitiveness. This path explained approximately 35.3% of the cases of high port competitiveness; approximately 17.9% of the cases of high port competitiveness could only be explained by this path. Typical cases within this path were Shanghai, Guangzhou, Dalian, and Shenzhen.

(2) Configuration C2: economy–balanced type. When hinterland areas had perfect infrastructure and innovation ability, sufficient financial supply, optimized industrial structure, and strong economic development, their ports had a high level of competitiveness. Here, infrastructure and innovation capacity were marginal conditions; financial supply, industrial structure, and economic development were core conditions; and market openness was irrelevant for high-level port competitiveness. Because technology, organization, and environmental conditions can create influence only through linkage and matching among each other, and the technology condition variable was an edge condition, the organization

variable was the core condition, and the economic development within the environment condition was the core condition, we named this configuration path the economy–balanced type. This path explained approximately 31.4% of the high port competitiveness cases, and approximately 4.6% of high port competitiveness cases could only be explained by this path. Typical cases within this path are Qingdao, Tianjin, Xiamen, and Fuzhou.

(3) Configuration C3: finance–balanced type. When hinterland areas had perfect infrastructure and innovation ability, sufficient financial supply, strong economic development, and market openness, their ports had a high level of competitiveness. Infrastructure and innovation capacity were marginal conditions; financial supply, economic development, and market openness were core conditions. Industrial structure is of no importance to high-level port competitiveness. Because technology, organization, and environment conditions created influence only through linkage and matching among each other, and the variables in the technology condition were in the edge condition, the financial supply in the organization condition was the core condition, and the condition variables in the environment condition were the core condition, we named this configuration path the finance–balanced type. This path explained approximately 33.8% of the cases of high port competitiveness, and approximately 6.9% of the cases of high port competitiveness could only be explained by this path. Typical cases under this path were Ningbo, Qingdao, and Xiamen.

4.3. Configuration Analysis of Low Port Competitiveness Conditions

Table 6 presents four configuration paths explaining low port competitiveness. Each column represents a possible condition configuration. The solution consistency was 0.557, which means that 55.7% of ports had a relatively low level of competitiveness in all cases that met the four condition configurations. The solution coverage was 0.942; that is, the four types of condition configurations explained 94.2% of low port competitiveness cases.

(1) Configuration NC1: finance–facilities–environment restraints type. When the infrastructure construction level of hinterland areas was low, the financial supply and environmental conditions were seriously constrained; a strong innovation ability could not promote improvements in port competitiveness. The lack of infrastructure was the marginal condition, innovation ability was the core condition, the lack of financial supply was the core condition, the lacks of economic development and market openness were the marginal conditions, and industrial structure was not important for high-level port competitiveness. Because the lack of financial supply was the core condition, and the lack of infrastructure and environmental conditions were the edge conditions, we named this configuration path the finance–facilities–environment restraints type. This path explained approximately 29.8% of the low port competitiveness cases, and approximately 12.6% of the low port competitiveness cases could only be explained by this path. Typical cases within this path were Wenzhou and Taizhou.

(2) Configuration NC2: capacity–finance–environment restraints type. When hinterland areas lacked innovation ability, financial supply and environmental conditions were considerably constrained. Even appropriate infrastructure construction and an optimized industrial structure could not promote improvements in port competitiveness. Here, infrastructure was the marginal condition, the lack of innovation ability was the core condition, the lack of financial supply and the industrial structure were the core conditions, and the lacks of economic development and market openness were the marginal conditions. Because the lacks of innovation ability and financial supply were the core conditions and the lack of environmental conditions was the edge condition, we named this configuration path the capacity–finance–environment restraints type. This path explained approximately 6.9% of the low port competitiveness cases, and approximately 25.3% of the low port competitiveness cases could only be explained by this path. A typical case within this path was Haikou.

(3) Configuration NC3: technology–finance–economy restraints type. When hinterland areas lack technical conditions, financial supply, and economic development, even with a relatively optimized industrial structure and market openness level, their port

competitiveness will be relatively low. The lack of infrastructure was the marginal condition; the lacking innovation ability, financial supply, and industrial structure were the core conditions; and the lacks of economic development and market openness were the marginal conditions. In the absence of appropriate technical conditions, as the lack of financial supply was the core condition and the lack of economic development was the edge condition, we named this configuration path the technology–finance–economic restraints type. This path explained 22.6% of the low port competitiveness cases, and 6.2% of the low port competitiveness cases could only be explained by this path. The typical case within this path was Qinhuangdao.

(4) Configuration NC4: capacity–industry–economy restraints type. When hinterland areas lacked innovation ability, their industrial structure was unreasonable, their economic development was low, and their port competitiveness level was relatively low even if they had suitable infrastructure, sufficient financial supply, and market openness. The infrastructure was the marginal condition; the lacks of innovation ability, financial supply, and industrial structure were the core conditions; and the lacks of economic development and market openness were the marginal conditions. As the lacks of innovation ability and industrial structure were the core conditions and the lack of economic development was the edge condition, we named this configuration path the capacity–industry–economy restraints type. This path explained 24.3% of the cases of low port competitiveness, and approximately 6.7% of the cases of low port competitiveness could only be explained by this path. A typical case within this path was Fangcheng.

5. Conclusions

In this study, we selected 21 coastal ports and their hinterland cities in China as cases. Based on the TOE framework, we used fsQCA to analyze port competitiveness configurations. Our main conclusions were as follows:

(1) Technology, organization, and environment conditions could not independently constitute the necessary conditions for high and low port competitiveness, indicating that the single conditions had weak explanatory power for port competitiveness.

(2) We identified three paths driving high hinterland port competitiveness: organization--environment, economy–balanced, and finance–balanced. Here, the financial supply and economic development of hinterland ports were the core conditions in the three paths, which means that compared with other conditions, the government support and economic development of hinterland areas played a crucial role in port competitiveness.

Our findings provide the main two empirical contributions:

(1) Based on the results of prior studies on the relationship between hinterland areas and port competitiveness, we designed an integrated framework for the analysis of hinterland cities' impact on port competitiveness based on the TOE framework, which integrates the technology, organization, and environment conditions of hinterland cities. By considering the Chinese context and emphasizing the importance of government support, we expanded and refined the TOE framework, deriving six secondary conditions that affected the port competitiveness of hinterland cities, which provided the premise and basis for qualitative comparative analysis of the relationship between these configurations. These findings help with better understanding the macro situation and influencing factors of China's port competitiveness, thereby enhancing the effectiveness of the empirical results.

(2) In this study, we empirically analyzed the linkage effects of technology, organization, and environment conditions of hinterland cities on promoting port competitiveness. We proved that hinterland cities could achieve the same results (high or low port competitiveness) through different combinations of multiple conditions. Additionally, we proved that analyzing the relationship between hinterland cities and port development from only one or two specific variables is ineffective. Prior researchers have empirically shown that the adjustment of industrial structure positively impacts port development, and the increase in the proportion of the tertiary industry plays a strong positive role in promoting the development of port logistics [3,24]. In this study, configurations C1 and C2 showed that

an increased proportion of tertiary industry could enhance port competitiveness, which is consistent with the existing research results. However, configuration C3 showed that the proportion of the tertiary industry had no effect on the results. Configurations NC2 and NC3 showed that even though hinterland cities had a high proportion of tertiary industry, it did not lead to high port competitiveness in the absence of suitable infrastructure, innovation ability, government support, and economic development.

We provide the following suggestions for the improvement in port competitiveness:

(1) The existence of concurrent synergistic effects of technology, organization, and environment in hinterland cities revealed the complexity of port competitiveness improvement. Hinterland cities can, based on their existing characteristics, focus on the adaptation of multiple conditions from an overall perspective, formulate policies in accordance with local conditions, and design different methods to improve port competitiveness. Among them, to enhance port competitiveness, hinterland cities require government support and must promote the level of economic development.

(2) The impact of infrastructure and innovation capacity should be seriously considered by government departments in hinterland cities. In addition to the industrial structure and economic openness often considered in previous studies, we explored the impact of the infrastructure and innovation capacity of hinterland cities on port competitiveness. Infrastructure and innovation capability appeared twice as marginal conditions in the configuration of high port competitiveness, and the configuration analysis of low port competitiveness further confirmed the important role of infrastructure and innovation capability in port competitiveness. Therefore, the governments of hinterland cities should accelerate the construction of infrastructure and focus on improving the innovation ability of the region to provide technical support for the improvement in port competitiveness.

Finally, this study had limitations, and the following three aspects can be considered for improvement in subsequent research:

(1) Although the TOE framework used in this study covered the technology, organization, and environment influencing factors in the relationship between hinterland area and port competitiveness, we omitted some factors due to the limitations of fsQCA on the quantity of condition variables. Future improvements can be achieved by incorporating more condition variables into the model through factor analysis or principal component analysis.

(2) Our findings reflect the notable differences between QCA and mainstream statistical analysis methods. However, this does not mean that the two are mutually exclusive. Researchers are increasingly trying to integrate QCA methods with mainstream statistical analysis methods. In subsequent research, researchers can try to use mainstream statistical analysis methods (such as OLS and HLM) to quantify the port competitiveness configuration, so as to increase the predictive and explanatory power of the results.

(3) We did not conduct cross-year case data analysis, which limits the interpretation and applicability of our conclusions in the temporal dimension. In the future, the temporal dimension can be considered to analyze the dynamic evolution of the port competitiveness of hinterland cities, which may help to avoid the path leading to low port competitiveness.

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Appendix A

Table A1. Results of fsQCA of port competitiveness.

Configurations		Raw Coverage	Unique Coverage	Consistency
Configuration Solution for High Port Competitiveness				
Complex Solution	~IN*FS*IS*MO*ED	0.353	0.179	0.909
	IN*IC*FS*IS*ED	0.314	0.046	0.853
	IN*IC*FS*MO*ED	0.338	0.069	0.834
solution coverage: 0.562				
solution consistency: 0.861				
Parsimonious Solution	FS*MO*ED	0.536	0.089	0.805
	FS*IS	0.528	0.080	0.864
solution coverage: 0.617				
solution consistency: 0.812				
Intermediate Solution	~IN*FS*IS*MO*ED	0.353	0.179	0.909
	IN*IC*FS*IS*ED	0.314	0.046	0.853
	IN*IC*FS*MO*ED	0.338	0.069	0.834
solution coverage: 0.562				
solution consistency: 0.861				
Configuration Solution for Low Port Competitiveness				
Complex Solution	~IN*IC*~FS*~MO*~ED	0.298	0.126	0.974
	IN*~IC*~FS*IS*~MO*~ED	0.253	0.069	0.952
	~IN*~IC*~FS*IS*MO*~ED	0.226	0.062	0.943
	IN*~IC*FS*~IS*MO*~ED	0.243	0.067	0.936
solution coverage: 0.557				
solution consistency: 0.942				
Parsimonious Solution	IC*~FS	0.419	0.069	0.816
	~FS*IS	0.458	0.127	0.767
	~IC*FS*~IS	0.325	0.061	0.881
solution coverage: 0.633				
solution consistency: 0.799				
Intermediate Solution	~IN*IC*~FS*~MO*~ED	0.298	0.126	0.974
	IN*~IC*~FS*IS*~MO*~ED	0.253	0.069	0.952
	~IN*~IC*~FS*IS*MO*~ED	0.226	0.062	0.943
	IN*~IC*FS*~IS*MO*~ED	0.243	0.067	0.936
solution coverage: 0.557				
solution consistency: 0.942				

Note: "*" Indicates the interaction between variables. "~" represents the not-in-set operation, which resulted from counterfactual analysis in fsQCA.

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