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Original Paper

The Interactive Relationship between Shaanxi Port Economy and Urban Economic Development—Take Xi'an Xianyang International Airport as an Example

Donghui Shan[1]

[1] Xi'an FanYi University, Shaanxi, Xi' an, China

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Abstract

As an important channel linking domestic and foreign markets, port development can directly stimulate the growth of the regional economy.The northwest inland ports serve as pivotal hubs within the framework of the "Belt and Road" initiative, a strategic development policy aimed at enhancing regional connectivity and economic growth. By fostering the development of port economies, these regions can significantly augment their interconnectivity and foster robust economic and trade partnerships with nations situated along the Belt and Road corridors. This academic study takes Xi'an Xianyang International Airport as its subject of in-depth inquiry. By constructing panel data, it computes the dynamic relative concentration index (DCI). Subsequently, it examines the impact of the airport's development on the growth of the host city from a comprehensive and in-depth perspective.The main conclusions include: (1) there is a positive correlation between the urban GDP and the total import and export of ports, the total amount of import and export freight at the port, and the total amount of urban fixed assets investment on urban development.(2) There exists a positive correlation between the number of entries and exits at the port and urban GDP. However, this correlation is not as significant as that between the total amount of imports and exports at the port and the total amount of import and export cargo at the port.(3) The DCI value experienced a gradual increase from 2004 to 2006, during which the coastal city relationships were predominantly port-driven. Subsequently, from 2006 to 2008, the DCI value saw a gradual decline, yet it remained above 1,

indicating that the coastal city relationships continued to be port-driven. Between 2008 and 2016, the DCI value persisted above 1, maintaining the port-driven nature of coastal city relationships. However, from 2017 to 2022, the DCI value dropped below 1, signaling a shift towards urban-driven coastal city relationships.

Keywords

Inland port,City development, Panel data model, Dynamic Concentration Index

1. Introduction

The inland port economy is an economic form that depends on the joint development of ports and open platforms to attract the aggregation, integration, transformation, and diffusion of resource elements such as logistics, business flow, capital flow, information flow, and technology flow, and to achieve interconnection and interaction with the global economy (Li, Z. Y., Li, Z., Yang et al., 2023). The prosperity of the inland port economy serves as a crucial driving force for promoting regional openness and economic expansion. In the National 14th Five-Year Port Development Plan, special emphasis is placed on strengthening the role of inland ports as global hubs and encouraging inland regions to cultivate the port economy, thereby facilitating the transformation of the economic structure from a single "channel economy" to a diversified "industrial economy".The development of the inland port economy is conducive to strengthening regional internal and external cooperation and development, promoting resource sharing and complementary advantages, and promoting the balanced development of the regional economy. Moreover, the development of the inland port economy helps to drive the regional economy in a more open direction, attract foreign investment, introduce advanced technology and management experience, and enhance the international competitiveness of the regional economy.

Research into the impact of ports on urban development has predominantly concentrated on border ports, with comparatively fewer studies examining the influence of inland ports on city growth. Ma and Ge (2017) selected four border ports in Dehong Prefecture, Yunnan Province, as their research subjects. They constructed a panel data model and calculated the relative concentration index (RCI) at the county level to examine the impact of these border ports on the development of their respective carrier cities (Ma, Ge, Huang et al., 2017). Xiao (2023) developed an evaluation index system to assess the level of coordinated development between the port economy and the urban economy. Through the calculation of the coupling coordination degree between the dynamic land port and urban economy, the study explores the coordinated development level of Xinjiang's land port and city (DCI) (Xiao & Jin, 2023). Li and Zhang (2021) developed an index system for port and urban economies, and investigated the interactive relationship between the development of Manzhouli port and the urban economy using relevant analysis and correlation economic analysis methods (Li, Zhang, & Yu, 2021) Chen and Zhang (2018) selected eight ports in Xinjiang and Central Asian countries as their research subjects, including JiMu, Buck, La Shankou, Huoerguosi, Altun, Spiti, Yingshan, and Eight Ports. Utilizing construction panel data, they calculated the relatively concentrated index (RCI) to discuss the impact of these ports

on the economic development of their respective carrier cities (Chen & Zhang, 2018). Guo, in his 2017 study, chose the Bohai Rim region as the focus of his research. He established a port-city evaluation index system and applied a coupling coordination model to analyze the evolution of the 17 port cities in the area. Furthermore, he discussed the constraints and driving mechanisms behind the coordinated development of ports and cities (Guo, Gu, Zhao et al., 2017). At present, most studies have been carried out in regions such as Xinjiang, Yunnan, Heilongjiang, the Bohai Rim, and Manzhouli. However, the influence of inland ports, especially those in the northwest, on the development of their carrier cities has seldom been studied. This paper comprehensively considers the availability of data and the representativeness of the research area, selecting Xi'an Xianyang International Airport as the research subject to explore its influence on the development of the carrier city. By constructing the relevant economic index system and measuring the dynamic relative concentration index (DCI), this paper discusses the influence of Xi'an Xianyang International Airport on the urban development of Xi'an.

2. Study Area Overview

The research subjects are Xi'an, Shaanxi Province, and "Xi'an Xianyang International Airport". Xi'an is located in the northwest of China, in the central Guanzhong Plain, facing the Weihe River in the north and the Qinling Mountains in the south. It is one of the nine central cities in China. In 2023, the regional GDP of Xi'an reached 1,201,076 billion yuan, and the total import and export value was 359,759 billion yuan. Among them, the total export value was 2,333.4 billion yuan, and the total import value was 126.36 billion yuan. The import and export of general trade amounted to 140.579 billion yuan. The import and export of Belt and Road countries reached 112.116 billion yuan, and 5,351 freight trains operated on Chang'an, carrying 4.648 million tons of goods.

In 2013, in response to the "Belt and Road" initiative, the China-Europe freight train service known as "Chang'an" was launched. In 2016, the national port development plan, which was significantly more comprehensive and urgent, was released. It explicitly focused on the inland regions, emphasizing the need to align with the trend of opening up to the outside world and the requirements for industrial transfer. The plan aims to accelerate the opening-up process of inland areas and advocates for the strategic layout of inland ports to meet the burgeoning demand for openness. Shaanxi Province has been granted approval by the State Council to open an airport, namely Xi'an Airport. Xi'an Xianyang International Airport currently boasts 360 routes connecting over 230 cities both domestically and internationally, encompassing numerous countries and regions in Southeast Asia, Japan, South Korea, Central Asia, Europe, and beyond. The cumulative passenger throughput of Xi'an Xianyang International Airport is projected to surpass 40 million in 2023. During the first half of 2024, the customs service at Xi'an Xianyang Airport ensured that the inbound passenger count at Xi'an Airport reached 263,000, marking a 3.3-fold increase compared to the same period last year. Of this increase, the number of foreign passengers reached 73,000, a 5.7-fold rise from the previous year's corresponding period. The third phase of the Xi'an Xianyang International Airport project is anticipated

to be completed by the end of 2023 and to commence operations in 2025. This project is a pivotal piece of infrastructure for Shaanxi Province to further integrate into the "Belt and Road" framework and to expedite the development of the "Silk Road" across land, sea, and air.

3. Selection of Indicators, Research Methods, and Data Sources

3.1 Selection of Indicators

This study focuses on the mutual interactive relationship between the port economy and the urban economy. The principles for the construction of the port index and the city index are as follows: the construction of the index system should be able to reflect the development level of the city and the port from different aspects. Firstly, it should be representative. The port and urban economy are relatively complex development systems, so the selected indicators should be the most representative of the same indicators. Secondly, it should be comprehensive. The selection of indicators should fully reflect the characteristics of the city and the port system. Thirdly, it should be operable. Each indicator should have a clear and precise meaning, and the data should be accurate and easy to obtain. Based on existing research, the urban development level is taken as the dependent variable, the port variable as the independent variable, and the total amount of import and export of the port, the urbanization level of the carrier city, and the investment level of the carrier city are taken as the control variables to construct the index system as shown in Table 2-1.

Table 2-1 Index System of Urban Economy and Port Economy

type of variable	Specific indicators	Index selection
dependent variable (y)	Urban development level	Urban GDP (GDP)
Port variable (x)	Port development level and scale (x1)	Total import and export volume of the port
	Population circulation capacity of the port (x2)	Number of entry and exits at the port
	Circulation capacity of goods at the port (x3)	Total import and export freight volume at the port
controlled variable (c)	Urbanization level of carrier city (c1)	The urbanization rate of the carrier cities
	Investment level of the carrier city (c2)	Total investment in fixed assets of the carrier city

Note. Data for the last two dozen years, 2003-2022. Data sources: Shaanxi Statistical Yearbook, China City Statistical Yearbook, China County Statistical Yearbook, Shaanxi Provincial Department of Commerce, Shaanxi Provincial Bureau of Statistics, Shaanxi Provincial People's Government, Shaanxi E-port and other websites.

3.2 Research Methods

3.2.1 Correlation Analysis

In this study, the Pearson correlation coefficient was used to study the interrelationship between the port economy and the urban economy. The Pearson's correlation coefficient (Pearson correlation coefficient) is used to measure the linear correlation between two variables X and Y, ranging from -1 to 1, and its mathematical expression is:

$$r = \frac{\sum_{i=1}^{n}(x_i - \overline{x})(y_i - \overline{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \overline{x})^2 (y_i - \overline{y})^2}}$$

where x_i and y_i represent the variables under study; i = 1, 2,..., n ;x and y are respectively the means of the n study variables; r is positive or negative for the correlation between the variables. The closer the magnitude of the correlation coefficient r is to 0, the weaker the linear correlation between the variables, and the closer it is to 1, the stronger the linear correlation between the variables.

3.2.2 The DCI Dynamic Concentration Index

This paper refers to the dynamic concentration index (DCI) model proposed by Guo Jianke et al. The DCI model is defined as the importance of the growth of port transportation relative to the economic growth of the city when the research period and research area are determined. It is mainly reflected through the elasticity coefficient of port and city development and the relative concentration index of port city development. The specific calculation formula is as follows: $D_e CID_e$ 1) The elasticity coefficient of port and urban development, i.e., abbreviated as, refers to the ratio of the average growth rate of port transportation to the average growth rate of the economic development of the city within a certain research period. The calculation formula is:

$$D_e = \left(\sqrt[n-1]{\frac{T_n}{T_1}} - 1 \right) / \left(\sqrt[n-1]{\frac{C_n}{C_1}} - 1 \right)$$

Where, T_n represents the port throughput in the n year in the study period and C_n represents the urban GDP in the n year in the study period.

2) The relative concentration index of port city development refers to the ratio of the proportion of average transportation growth of a certain port in a certain region to the proportion of average development growth level of the city in which it is located. The calculation formula is as follows:

$$D_i = \left(\frac{T_n - T_1}{(n-1) * \sum_{i=1}^{n} T_i} \right) / \left(\frac{C_n - C_1}{(n-1) * \sum_{i=1}^{n} C_i} \right)$$

Where, D_i represents the relative concentration index of the port-city increment.

$$DCI = \alpha D_e + \beta D_i$$

Where, take 0.6 for α and 0.4 for β according to Guo Jianke et al.

The division of DCI values reveals three modes of the relationship between the port and the urban development. If the DCI value exceeds 1, it indicates that the development speed of the port exceeds that of the city, and the port becomes the engine to promote the urban development, forming a port-driven relationship; if the DCI value approaches 1, it reflects that the development pace of the port and the city is mutually promoting, forming a dynamic balance of the shore city interaction; if the DCI value is lower than 1, it means that the city development speed is faster, the city leads the port, and the city becomes the leading development force, showing a city-driven relationship.

4. Results and the Analysis

4.1 The Mutual Relationship between the Port Economy and the Urban Economy

A correlation analysis was conducted on the selected port economic indicators and urban economic indicators, and the results are shown in Table 3-1.

Table 3-1 Pearson Correlation Coefficient

Specific indicators	y	x_1	x_2	x_3	x_4	x_5
y	1	0.965**	0.406	0.565**	-0.031	0.955**
x_1	0.965**	1	0.337	0.636	-0.117	0.907**
x_2	0.406	0.337	1	0.381	-0.058	0.342
x_3	0.565**	0.636	0.381	1	0.222	0.603**
x_4	-0.031	-0.117	-0.058	0.222	1	0.009
x_5	0.955**	0.907**	0.342	0.603**	0.009	1

Through the correlation analysis, it is evident that the urban GDP exhibits a highly positive correlation with the total volume of import and export at ports, the total amount of the import and export volume of ports, and the total investment in urban fixed assets. This outcome demonstrates that the aggregate amount of import and export and the total volume of import and export at ports play a direct role in promoting the development of the urban economy. Xi'an Xianyang International Airport, with the growth of its total import and export volume and cargo volume, directly propels the economic development of Xi'an and its surrounding areas. Amid the rapid development of airport air transport, particularly in the context of the COVID-19 pandemic in 2020, the air transport of Xi'an Xianyang International Airport has achieved remarkable accomplishments in China, ranking 11th globally,

emerging as the "dark horse" in the global aviation industry. The impact of the total import and export freight volume on the urban economy is less significant than that of the total import and export volume, yet it still displays a robust positive correlation. This signifies that the cargo handling capacity of airports plays a crucial role in facilitating the local economic development. With the advancement of the airport expansion project, it is anticipated that the airport's cargo throughput will reach 1 million tons by 2030. The number of entries and exits at ports is positively correlated with the urban GDP, albeit not as prominently as the total amount of import and export at ports and the total amount of import and export freight at ports. Nevertheless, it still showcases the positive role of airports in promoting international exchanges and the development of the tourism industry. With the implementation of the 144-hour transit visa-free policy, Xi'an Xianyang International Airport is expected to attract more international passengers, enhance the city's international image, and drive the development of related industries.

4.2 City-shore Relationship Measurement

The dynamic concentration index (DCI) for Shaanxi Province from 2003 to 2022 is displayed in Table 3-2, as calculated by the DCI value.

Table 3-2 Dynamic Concentration Index for Shore City, 2003-2022

a particular year	De	Di	DCI
2003	2.1409	1.0326	1.6976
2004	-1.0098	-2.2082	-1.4892
2005	1.4836	3.2532	2.1915
2006	3.9515	7.6365	5.4255
2007	2.6066	3.4908	2.9603
2008	1.8352	1.8720	1.8499
2009	2.5819	3.0621	2.7740
2010	2.2046	1.9685	2.1102
2011	2.0686	1.5872	1.8760
2012	1.9494	1.2725	1.6786
2013	1.8627	1.0801	1.5497
2014	1.6741	0.7933	1.3218
2015	1.4591	0.5491	1.0951
2016	1.7659	0.8842	1.4132
2017	1.1623	0.2948	0.8153
2018	1.2356	0.3449	0.8793
2019	1.0925	0.2514	0.7561
2020	1.0915	0.2502	0.7550

2021	1.1237	0.2680	0.7814
2022	1.0529	0.2234	0.7211

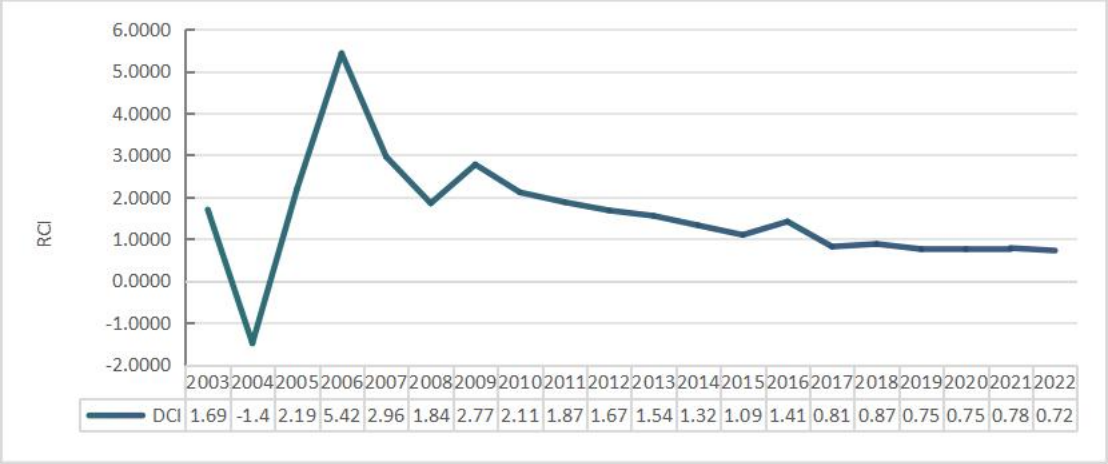

Figure 3-1 2003- -2022 DCI Values

As can be observed from Figure 3 - 1, the DCI value progressively increased from 2004 to 2006, and the DCI values in 2005 and 2006 were greater than 1, with 5.42 in 2006, indicating that the development of ports in this stage had a substantial impact on the urban economy. Port development drove urban development, and the interactive relationship between cities was port - driven. During this period, the country attached great importance to the development of the western region and introduced a series of policies and measures to promote the economic development of the western region, fully leveraging the open advantages of the western region. Xi'an Xianyang International Airport, as an important aviation hub, saw its port function strengthened, providing strong support for regional economic openness and communication. From 2007 to 2016, the DCI value remained greater than 1, and the interactive relationship was still port - driven. In the past decade, port infrastructure has been continuously enhanced, and port customs clearance capacity has provided an important guarantee for the facilitation of international trade. A series of measures have been implemented to promote international trade, strengthen economic and trade cooperation and exchanges with other countries and regions, and promote the export - oriented development of the regional economy. From 2017 to 2022, the DCI value was less than 1, and the coastal relationship became urban - driven. During this period, Xi'an began to accelerate economic development, especially with the automobile manufacturing output value reaching 100 billion yuan, becoming the first hundred - billion - yuan industry in Xi'an. Economic growth, along with the continuous upgrading of the industrial structure, and the foreign trade and financial markets also exhibited a favorable development momentum, jointly promoting the overall development of the urban economy.

5. Conclusions and Discussion

Taking the Xianyang International Airport as an example, this paper calculates the DCI index and

discusses the influence of the airport on the carrier city. The specific conclusions are as follows: (1) There is a high positive correlation between the urban GDP and the port's import and export volume, the port's import and export freight volume, and the urban fixed assets investment. (2) There is a positive correlation between the number of entries and exits at the port and the urban GDP, but it is not as significant as the total amount of import and export at the port and the total amount of import and export cargo at the port. (3) From 2004 to 2006, the DCI value gradually increased, and the relationship between the coastal city and the port was port-driven; from 2006 to 2008, the DCI value gradually decreased, but still remained greater than 1, indicating that the relationship was still port-driven; from 2008 to 2016, the DCI value was greater than 1, and the relationship was port-driven; from 2017 to 2022, the DCI value was less than 1, and the relationship was urban-driven. Combining the DCI value with the specific situation of Xi'an Xianyang International Airport, although the interaction relationship of the port-driven coastal city has weakened, the role of Xi'an Xianyang International Airport in promoting the economic development of the city has not diminished. With the implementation of the third phase of the airport expansion project, it is expected that by 2023, the passenger throughput of the airport will reach 83 million, and the cargo throughput will reach 1 million tons, which will provide new impetus for the economic growth of Xi'an.

Over the past two decades, Shaanxi Province has made remarkable and positive progress in port construction. Notably, the total value of import and export as well as the volume of China-Europe freight trains has been on a steady rise. Looking ahead, Shaanxi Province should fully leverage its policy advantages to further expand its opening up. Firstly, efforts should be made to strengthen infrastructure construction and enhance the traffic capacity and service level at ports, particularly at aviation and railway ports. Secondly, the paperless customs clearance operation should be promoted to improve the efficiency of enterprise declaration and reduce the cost of enterprise customs declaration. Thirdly, the system of publicizing port fees should be optimized to ensure that no fees are charged outside the list and thus reduce the burden on foreign trade enterprises. Fourthly, the construction of e-ports, such as the "single window" service, should be strengthened to improve port government services, logistics services, and data services. Finally, the high-quality development of the comprehensive bonded zone should be promoted to strengthen the connection with the international market and enhance Shaanxi Province's position in global trade.

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Author Biography

Shan Donghui, hailing from Nanyang in Henan province, is a teaching assistant with a research focus on regional economics and port economy.