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Ports Factors Impacting the Regional Economy-Case
Study of Hainan Ports Cluster

by

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Abstract

There are several port clusters in China, but there is little information available about the port clusters in Hainan. However, ports on Hainan Island have subsequently received a great deal of attention as part of the Hainan FTP building. Based on the expansion of port factors (port infrastructure and port integration) in Hainan during the past ten years and using seaborne trade as a mediating factor, this thesis investigates the relationship between port factors and the regional economy of Hainan.

In this paper, the relation between port factors and regional economy of Hainan case has been Researched. The research question was: What is the impact of the investments in the port infrastructure and Hainan ports integration on the port-side economy and further impact the regional economy?

The author conducts a quantitative analysis of selected data from the last decade in Hainan and find that, in light of the province's current situation, an increase in port infrastructure investment and a further strengthening of the integration of the Hainan ports cluster still bode well for the seaborne trade and regional economy. And the author also concluded, the success of seaborne trade and the regional economy is a direct result of port integration and port infrastructure, as well as the policies support of FTP construction.

The structure of the paper is: A review of the literature on port clusters and their added value, as well as the impact of ports on the region and trade. Following with the analyzing hypothesis model is developed using Stata software, and using port integration and port infrastructure as independent variables, seaborne trade as mediating variables, and regional economy as dependent variables set to be the framework. Then draws the conclusions from the empirical research. Then, a SWOT analysis is performed using the findings of the aforementioned study. Finally, discuss the findings and related literature, the added value and obtain points, next with relevant suggestions are made.

The key findings are: using GDP per capita as the dependent variable to judge the impact of infrastructure investments on the regional economy is biased. Meanwhile, seaborne trade is an important mediating effect factor. It achieved a significance of 1% in all data analysis and is a direct reflection of the independent variable.

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List of Abbreviations

FTP -- Free Trade Port

General Plan – General Plan for the Construction of Hainan Free Trade Port

Hainan FTP Law -- Hainan Free Trade Port Law of the People's Republic of China

1.Introduction

1.1 Introduction

Ports are crucial to the world economy and typically handle 90% of the volume of all global trade in goods (Mlambo, 2021). Ports performance influence the trade, which has further effect on the regional economic, both local and regional economies are supported by ports. Regional economies can be significantly impacted by changing trends in regional and international trade, which can also have a big effect on how goods are distributed (US EPA,2016).

Many researches support that there is a positive relationship in port and regional economic. According to Jean and Theo (2022), Ports are economic development catalysts because they facilitate trade and assist supplier networks. Economic advantages might be direct, indirect, or induced through port investments. in addition, DP World, the one of the largest port groups in the Middle East, also endorse ports have clear positive national/regional economic benefits as they help and boost national competitiveness. Taken together, port activities and shipping tend to have a multiplier effect on an economy that is much greater than the port itself. (DP World official website, 2022). Lastly, the OECD's 2014 research The Competitiveness of Global Port-Cities found that one tonne of port throughput is related with an average of \$100 in added economic value, while one million tonnes is associated with an increase of 300 jobs. The survey also found that enterprises in a port's hinterland benefit, with less than five percent of economic ties to suppliers occurring within the port region. In the six years since the publication of this research, consumer behaviors have changed so drastically that the trend can only be described as upward. Consequently, these benefits will continue to be obtained. (OECD,2014). These are all the positive reference mentioned the relationship between ports and economy.

Hainan Island is the second largest island in China with a total length of the coastline of 1944.35 kilometers with large and small ports are dotted throughout. Among them are both the masts of the traditional fishing port of the fishing boats to and from, but also the lofty giant ships docked in the modern industrial port, and quite popular cruise yacht port. These ports are the important support for the economic and social development of Hainan, and also becoming an essential platform for external exchanges. Currently, Hainan is exploring the construction of a Free Trade Port (FTP). As the funnels, the level of port construction will directly affect the development of the free trade port.

1.2 Research Questions

Dubai, Singapore and Hong Kong are internationally recognized as successful Free Trade

Ports. Historically, the economic blooming of these three places has been achieved through the construction of free trade ports. These three regions are unavoidable and act as reference to Hainan. These can be told from the interaction between Hainan Provincial Government and the ports local authorities (Sohu.com,2022; Sina.com,2022).

Hainan ports and its economy, historically, due to the small volume, do not gain much attentions and literature researches in China. Hence this research studying Hainan case to enrich the literature research in China ports. Secondly, Hainan as a special case which surrounded by the sea with limited direct hinterland but conducting the FTP exploration (the first case in the world), research on its economy and ports development can be the additional supports of how ports acting as a crucial connection between sea and land. The larger ports always go beyond its physical limits and extend well into the hinterland, no matter the hinterland direct or indirect.

The vision as above, thus this research is trying to connect ports factors data to the regional economy and analyses the impact of these two variables via the intermediate variable, the seaborne trade. This is accomplished by reflecting on the theory and analyzing at the collected facts from that viewpoint.

In order to answer their interrelations, the present study investigates the following research questions (Main question and sub-questions).

Main question:

What is the impact of the investments in the port infrastructure and Hainan ports integration on the port-side economy and further impact the regional economy?

Sub questions:

- (1) How can the influence of investments in port infrastructure on the port and regional economy be measured?
- (2) What is the competitive position of the Hainan ports cluster compared to the Greater Bay Area? As the Greater Bay Area within the Pearl River Delta, which is the closest competitor to Hainan ports clusters and Greater Bay Area also one of the national development strategies.
- (3) What is the relationship between the Hainan ports cluster and the Greater Bay Area?
- (4) How can port development in Hainan influence the cooperation with the Southeast Asia region? As Hainan and Southeast Asia are geographic proximity, Southeast Asia is the first regional doorway for Hainan to open its doors to the outside world. Hainan and Southeast Asia are close in humanities, there are many original Hainanese in Southeast Asia. Southeast Asia and Hainan have mutual complementarity, can cooperate in logistics development, financial services etc. In addition, in the light of the situation in the South China Sea, strengthening

exchanges and cooperation between Hainan and Southeast Asian countries is of great practical significance.

To answer the above research questions, this thesis will apply with Stata software to analyze the variables and its indicators spanned from Year 2011- Year 2020. Detail regarding the methodology will illustrate at Chapter 3.

1.3 Overview of the Thesis

Chapter 2 presents a comprehensive literature review of port economic impact. In chapter 3, the conceptual framework and hypothesis following with data and methodological issues are discussed. In chapter 4, a practical point of view applies SWOT analysis to better understand Hainan Ports clusters and its regional economy. Chapter 5 will be presented the findings of the empirical analysis. Chapter 6 discusses the implication and concludes with future research directions.

2.Literature Review

As the thesis title unveiled, the author is studying the ports clusters, its added values and the impact of ports on regional development and trade. Hence the following literature review are based on the above keywords.

2.1 Port clusters and its added value

Ports clusters consist of geographically concentrated and mutually related business units centered around transport, logistics, trade, and industrial production (Jean and Theo,2022). Ports clusters' added value are generated via the surrounding with the related port business. The currently researches on port clusters mainly include the following aspects: theoretical research on port clusters, including the spatial structure of port clusters and the evolutionary history of port clusters; the role of ports on economic development. It also involves port competitiveness, port resource integration, integrated ports and port performance evaluation, which we can see the researches in port integration and port infrastructure are related with the development of port clusters.

2.1.1 Port Integration

Many studies have justified port integration beneficial for the global supply chain and maritime logistics and international trade. Port integration has steadily caught the attention of policymakers, port authorities and the researchers. According to Notteboom, Pallis and Rodrigue (2022), port integration can be divided into vertical integration and horizontal integration. Vertical integration refers to acquire the upstream and downstream industries/ stage the port involved; while for the horizontal integration which refer to acquiring stakes at port terminals in a variety of markets.

Employing both horizontal and vertical integration simultaneously, it is not only expanding regionally but also from sea to inland services. Across every case, the result is a more integrated and efficient transport chain, including maritime shipping, port terminal operations, inland access, and even freight distribution facilities. If inland facilities such as inland (dry) ports and corridors are constructed, port regionalization is imperative (Jean and Theo,2022). Furthermore, Ma et al., (2021) based on China, given out the relationship between port integration and regional economic development. They study the impact of port integration (PI) policies on the regional economic growth of port- cities and demonstrates that PI can stimulate the economic growth of cities, and its effects grow with time. In addition, they show that the impacts of PI are larger on small and medium-sized cities, find that the success of port integration varies per geographical region and the size of the city.

Published by Statista Research Department (See Fig.1), although China occupied seven of top ten ports in container throughput, the international logistics performance not stand out at all. The overall LPI ranking 26 and the logistics quality and competence ranking 27 (Word bank, LPI dataset,2018).

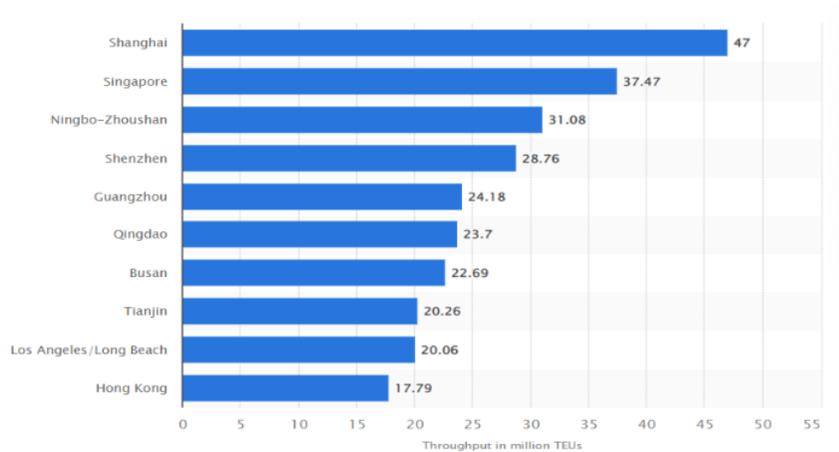


Figure 1 The largest container ports worldwide in 2021, based on throughput
 Source: <https://www.statista.com/statistics/264171/turnover-volume-of-the-largest-container-ports-worldwide/>

Ports in China coastal provinces roam independently, and there is a lot of homogenous competition among them. Which has resulted in low resource utilization, low production efficiency, and excessive function duplication (Wang et al. (2012)). In terms of handling the related problems, China on-going the ports clusters integrations. According to the Ministry of Communications of China introduction (2006), China totally divided into five major ports clusters which are Bohai Rim, Yangtze River Delta, Southeast Coast, Pearl River Delta, and Southwest Coast. Hainan ports clusters are belonging to the latter one, Southwest Coast. (See Fig.2). And the ports cities are also affiliated to the small and medium-sized cities, comply with the Ma et al., (2021) research and worthy for further improvement. Following will further introduce the five ports clusters integrations in chapter 4.



Figure 2 China Coastal Port Layout Plan

Nonetheless, according to the research of Wang et al. (2015), despite the fact that port integration in China continues to demonstrate significant growth, operational challenges exist and have been highlighted in the present research. Following will illustrating the data and methodology in chapter 3.

2.1.2 Port Infrastructure

Port infrastructure is a sector of transport infrastructure, including piers, channel harbors, docks, and other structures. Generally speaking, a port's terminal to terminal surroundings range (Law Insider.com,2022).

According to the experience and data of Dubai, the Dubai government has been promoting transport-related infrastructure since the 1970s, with port development and airport construction being the most important infrastructure projects. The Dubai government attaches great importance to improving the port infrastructure, especially the acquisition of cargo handling machinery and equipment for container terminals (Hainan Institute of Public Diplomacy,2021). According to Dubai Global Ports Group data, Dubai's flagship port - Jebel Ali Port has four

container terminals, more than 1 million m² of container yards, 43,000 m³ of large refrigerated warehouses, 28 major berths, 83 quay cranes, 19 automatic quay cranes, 50 automated container rail cranes. In 2019, the Port of Jebel Ali's annual container handling capacity was increased to 19.3 million TEUs, while Hainan is 2.68 million TEUs (Hainan Institute of Public Diplomacy,2021).

More specifically, it's easy to understand why so many people assume that containers equal to the ports and forget the rest. After all, the container business has been the fastest-growing market for ports over the past few decades, and it's likely to keep growing quickly in the years to come. Most of the money that goes into building new port infrastructure is for the container market. In terms of value, the container market is responsible for more than 90% of all seaborne trade (Peter W. de Langen,2020). Obviously how importance of improving the port infrastructure and how the ports boost both economic and social infrastructure and create outside economies.

The results of the study by Ziaul and Hans (2018), which took into account 91 countries with seaports and used SEM to provide empirical evidence, show that it is crucial for developing countries to continuously improve the quality of port infrastructure because it contributes to better logistics performance, which in turn leads to increased seaborne trade and higher economic growth. However, as the poor nations get wealthy, this link gets weaker. According to a ranking from the World Economic Forum (WEF) from 2002-2018, that showing that some developing countries have made big improvements in their quality of port infrastructure (Peter W. de Langen,2020).

Fratila et. al. (2021) also using eight panel data regression models from 2007 to 2018 evaluated the impact of maritime transport, related investment, and air pollution on economic growth within 20 countries of the European Union. Although their research result is partly about the air pollutants, they also justified that investment in maritime port infrastructure are indeed positively correlated with economic growth.

Song and Geenhuizen (2014) based on China region ports, estimate the output elasticity of port infrastructure through production function, applying panel data analysis for the period of 1999–2010, and calculate the model at the level of four port regions as well as the port province level. The results indicate even though the strength varied from region to region, it is clear positive effects of port infrastructure investment in all regions.

2.2 Ports impact on regional development and trade

According to the publication of 2022 Shipping's half year report, Clarkson Research Services predicted that global seaborne trade volumes are back to pre-Covid levels and are on track to grow 1.64% this year ("As material macro-economic headwinds and inflation pressures build, seaborne trade growth has slowed below trend and needs monitoring carefully. we are now projecting 12.2bn tonnes of seaborne trade in 2022, down from a 12.4bn forecast at start year". source:<<https://www.clarksons.com/home/news-and-insights/2022/2022-shippings-half-year-report/>>) (See Fig.3).

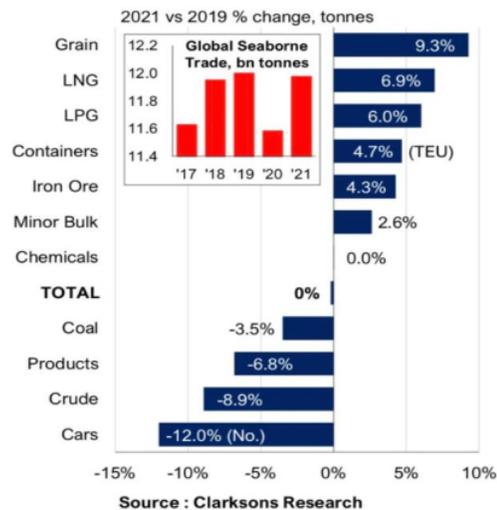


Figure 3 Global Seaborne Trade, bn tonnes
Source: <https://splash247.com/global-seaborne-trade-volumes-forecast-to-grow-3-4-this-year/>

Seaborne trade, broadly maritime transport, it is well known as one of the main activities (80~90% world trade) of boosting economy. Stopford (2013) indicated the relationship of ship/ports, seaborne trade and economic development: due to cost advantages, ocean shipping also enhances trade (although lower tariffs also have impact), seaborne trade enables the global distribution of economic activities, which creates value around the World. In another word, shipping, through the facilitation of trade, contributes to economic development. As a result, transport and logistics grew faster than trade, which grew faster than GDP.

In addition, using a Vector Error Correction Model (VECM) and annual data on the amount of crude oil, petroleum products, and dry goods moved, Michail (2020) assessed the relationship between the global macroeconomic environment and the demand for seaborne transport. Overall, the results of the thesis show that a change in the world's GDP has a positive effect

on all types of goods that are shipped, though the size of this effect varies from type to type. The majority of the above-mentioned reactions are attributed to high and middle-income countries, while low-income countries appear to have a negative impact. However, in the view of demand inelasticity, the price of oil has negative effect. The major points from this paper are that the amount of goods transported via sea routes can be heavily influenced by global GDP growth. We can reiterate how's the close relationship between seaborne trade and economy.

Furthermore, according to the United Nations Conference on Trade and Development (UNCTAD) Review of Maritime Transport that developing countries increasingly driving growth in the world economy and seaborne trade, and becoming important players in global value chains. The UNCTAD e-handbook of statistics 2021 also indicated that developing economies still accounted for the largest share of global seaborne trade, both in terms of exports and imports in 2020. But they loaded 59.5 % and discharged 69.5 % of the world total, the structure of their trade has changed over the years with their share of world seaborne imports increasingly surpassing their share of exports since 2013(UNCTAD, 2021). That means the populations in developing countries currently the consumption power rising respectively. This feature in some extends illustrated the seaborne trade positive impacting on the developing countries.

2.3 Literature review conclusions

The results of the literature review show that these variables have been studied in the past and positive relationships have been obtained. Based on the findings of previous studies, this thesis considers that it is feasible to apply this variable to the study of Hainan port cluster. Hence the following research hypothesis in chapter 3 is proposed.

3. Conceptual framework, Data and Methodology

Form above literature review, this thesis selects the port integration and port infrastructure as the independent variables and named as ports factors. Ports factors, namely, its infrastructure upgrade or the organization chart reconstruction might further impact the regional economy. This thesis is a case study of Hainan ports cluster based on the following progress and data:

In 2017, Hainan Provincial government decided to implement a proposal of 5 ports integration and resource inter-matching, aiming are: **Haikou Port** is one of the 25 main coastal hub ports planned by the Ministry of Transport (As the first port of Hainan Island, although affected by the pandemic, in 2020, the cargo throughput of Haikou port still reached 11.781 million tons and 1.97 million TEUs of container throughput.), **Yangpu Port** is a regional international shipping hub and logistics center, **Basuo Port** is an important industrial port in Hainan Province, **Sanya Port** is mainly for international passenger transportation and supplemented by freight transportation, **Qinglan Port** is an important feeder supplemental port in the eastern part of Hainan Province and a major maritime hub for the national space launch base. (See Fig.4)

In 2018, the central government decided to build Hainan into an island free trade port (FTP).

In 2019, Hainan's Road and Waterway fixed asset investment about 16.3 billion RMB; road and waterway operational freight volume of 237.95 million tons (increase of 13.5% compared last year); freight transshipment of 168.2-billion-ton kilometers (increase of 95.9% compared last year); port cargo throughput of 198 million tons, an increase of 8.5%, especially the foreign trade throughput was 35.81 million tons, an increase of 11.7% compare last year.

Starting from 2020, Hainan plans to promote the container terminal of Yangpu port renovation project, plans to start Xinhai Port (belongs to Haikou port) anchorage project, and Macun port area (belongs to Haikou port) channel reconstruction and expansion project, plans to start Qiongzhou Strait ro-ro transport channel reconstruction and expansion project, and lastly building the new seaport into a passenger hub etc. Ports in Hainan responsible for beyond 90% of freight volume and 60% above of passenger flows. From above illustration that we can also indicate how the ports infrastructure investment rapidly.

Form the briefly introduction of Hainan case above and the literature researches, Hainan ports clusters are belonging to a developing country which we could consider improve the quality of port infrastructure still beneficial for the economic growth. And the above-mentioned developing context employ as well.

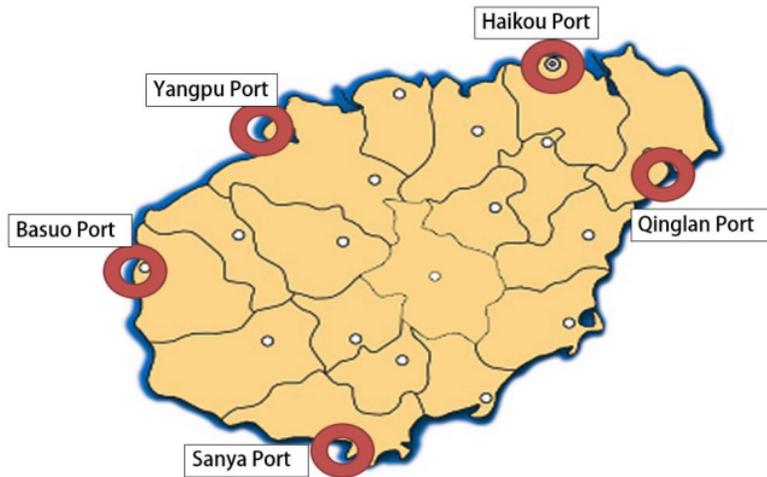


Figure 4 "Five ports in four directions" of Hainan Ports Clusters

3.1 Theoretical Analysis and Hypothesis Development

As the introduction part already illustrated that the Hainan ports cluster integration plan get started, then the investment in related port infrastructure been increase accordingly. For the author's understanding, which make sense due to port integration objectives is to reduce homogenous competition and boost cargo consolidation distribution system (Notteboom and Haralambides, 2020). Each port's relative advantages are differed, and one of the major follow-up measures of horizontal port integration is to increase relative advantage investment based on the geographic location and relative advantages of their own, and cooperate with other ports to increase competitiveness. Specifically, following port integration, the port will increase its hardware and software investment based on their own situation. The Hainan ports cluster integration program has clearly defined the direction in which each port should develop. Each port infrastructure shall as per the planned role develop its equipment and facilities. Via this, the port infrastructure will boost. In addition, eliminating the information asymmetry via linking of port community systems for a better port integration also need investment in port infrastructure in software aspect.

Thus, it can be hypothesized that:

H1 (a): The port integration has a positive effect on port infrastructure.

The essence of port integration is to rationalize the allocation of resources among competing

regional ports through policy intervention and market mechanisms. Obviously, better utilization of port resources necessarily means higher port efficiency and productivity (Guo et al., 2018). Which is to say, efficient port logistics can reduce delays and overstocks caused by random ship arrivals, thereby reducing the need for storage and warehouse space. The terminal's increased capacity could compensate for deficiencies elsewhere in the supply chain, or even expand the port's hinterland and market potential (Zhou et al., 2017). What the higher port efficiency and productivity can advance the development of shipping, logistics, trade, and port-side industries.

Thus, it can be hypothesized that:

H1 (b): The port integration has a positive effect on seaborne trade.

In the same vein, PI can promote the growth of shipping, logistics, trade, and port-side industries, also known as a "port cluster." This promotes urban economic prosperity (Wu and Yang, 2018). In addition to bringing port-cities closer to their respective territories and facilitating the movement of production factors towards the port-city, port integration restricts the extent of governmental management of different regions. The resulting specialization of labor increases labor productivity, thereby increasing employment and development opportunities in the port city and fostering urban economic growth (Song and Geenhuizen, 2014). PI also benefits on manufacturing prices, it appears that transportation and energy expenses, along with the costs of constructing infrastructure fall as well.

In conclusion, and this should go without saying, increased port efficiency, the better exploitation of port resources, and expanded communication between collaborating ports all improve the position of ports within global supply chains and the openness of the port-city to the rest of the world. All the closed circle and reactions will boost the regional economy in the end.

Thus, it can be hypothesized that:

H1 (c): The port integration has a positive effect on regional economy mediated through seaborne trade.

While measure the regional economy and impact of port infrastructure quality and amounts is based on the perspective of transport infrastructures proposed by Lakshmanan (2011). According to his point of view, investments in port infrastructure are a form of exogenous capital, which helps enhance port infrastructure (quality and quantity). An improvement in port infrastructure will benefit the region's overall logistics performance. Better logistics performance refers to higher levels of reliability, reduced risk of damage, the capacity to check

and stay updated on shipments, timely delivery etc. the improved port infrastructure and logistics performance would increase the accessibility and expanding the markets globally.

The realization of these prospects can be measured by a country/region's overall seaborne trade. Seaborne trade benefits are defined by increased labor supply, expanded production, innovation diffusion, competitive pressures, economic restructuring, etc., resulting in increased total factor productivity and GDP growth (Lakshmanan, 2011). Furthermore, Yeo et al. (2008) also found that quality of port service, logistics costs, regional connectivity, hinterland condition and port accessibility, contributes significantly to a port's competitiveness. Gordon et al. (2005) stated that a combination of port facilities, including sufficient investment, supportive government policies, quality in operation, and information technology, can assist a port achieve sustainable competitiveness, resulting in more seaborne trade.

Thus, it can be hypothesized that:

H2 (a): The port infrastructure has a positive effect on seaborne trade.

In the same vein, Sánchez et al. (2003) concluded that freight costs are lower in efficient ports after controlling for distance, liner service availability, type of product and insurance costs. And Panayides et al. (2015) also found that efficient ports have better quality infrastructure and logistics performance than inefficient ones. An efficient port system with enhanced logistic abilities is a key determinant of foreign direct investment into a country. Vice versa, Clark et al. (2004) indicated that inefficient ports reduce national and international trade and affect economic growth adversely. Other researchers like Ellis (2011) trusted that the role of ports in the internationalization process of business firms was highlighted.

Thus, it can be hypothesized that:

H2 (b): The port infrastructure has a positive effect on regional economy mediated through seaborne trade.

Lastly, ports are the hub and node of watery transport networks that connect countries to the world. In current global environment, items are frequently produced far from consumer markets, and raw materials are often obtained from multiple countries. Vertical specialization, in which distinct aspects of a product's production are done in separate nations, has risen considerably in the last two decades (Hummels et al., 2001). All the achievements are due to the effective maritime transit.

Regarding how to measure the value of maritime transport that Helling (1997) from the perspective of explaining how a dollar's worth of water transportation is split over 10

interrelated economic groups. Sleeper (2012) also found that GDP is proportional to the number of internationally recognized ports. Bottasso et al. (2014) analyzed 120 port districts in 13 European nations and found that ports improve local GDP and favorably affect neighboring GDP.

Back to the updated news of Singapore, that Singapore's Deputy Prime Minister Wong Swee Keat announced the launch of Blueprint 2025 for the transformation of the maritime industry in his speech at the opening of Singapore Maritime Week in April 2022. A key objective of the blueprint is to increase the value added of Singapore's maritime industry by S\$2 billion, or an average of 2-3% per annum, between 2020 and 2025. If seaborne trade not that important to Singapore, they will not be planning to increase the ratio. The maritime industry is at the heart of Singapore's maritime cluster and is a key driver of industries and economic activities such as manufacturing, wholesale trade and logistics in Singapore. Globally, the maritime industry is the backbone of trade and is tasked with moving more than 80% of the world's goods around the world (Xinhua Finance,2022).

Thus, it can be hypothesized that:

H3: Seaborne trade has a positive effect on regional economy.

To sum up, Fig. 5 presents the conceptual framework of this study.

3.2 Conceptual framework

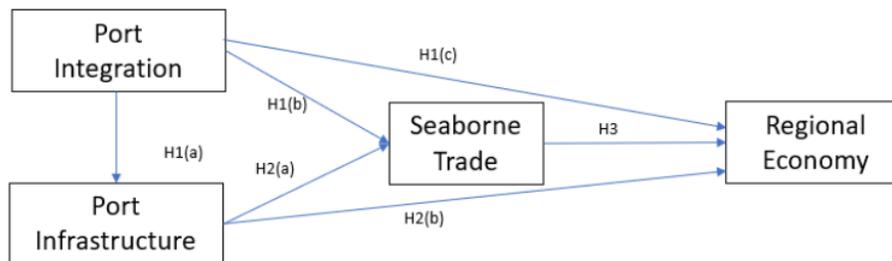


Figure 5 Conceptual Framework

According to the above conceptual framework, first, we examine the effects of Port Integration on Port Infrastructure, Seaborne Trade and Regional Economy. Then look at the effects of Port Infrastructure on Seaborne Trade and Regional Economy. And then the effect of Seaborne Trade on Regional Economy is examined. Finally, the indirect (or mediated) effects of Port Integration on Regional Economy via Seaborne Trade, Port Infrastructure on Regional Economy via Seaborne Trade are investigated.

3.3 Methodology and Data

3.3.1 Data Sourcing

This empirical analysis collects annual data from the following database for all observable variables of latent constructs.

- China Port annual report (mot.gov.cn).
- National Bureau of Statistics of PRC (stats.gov.cn).
- State Administration for Industry and Commerce of PRC (saic.gov.cn).
- General Administration of Customs of PRC (customs.gov.cn).
- Ministry of Commerce of PRC (mofcom.gov.cn).
- Hainan Statistical Yearbook (data.cnki.net).

Since the latent constructs are multi-facet, hence consider a multiple observed indicators become relevant and necessary. The indicators chosen are based on the related literature review of ports integration and port infrastructure researches. What it is worthy mentioned is that, according to the research of Wang et al. (2015), despite the fact that port integration in China continues to demonstrate significant growth, operational challenges exist and have been highlighted in the present research. Firstly, the majority of case data included in the present review represent a statistical summary of the ports' throughput and terminal facility; consequently, it is not possible to quantify the full integration of port functionality and integration effects, i.e., available data denote a physical summation as opposed to the chemical reaction. That is what this thesis encountered similar problems when looking for Hainan port cluster variables and their indicators. Following will illustrating the data and methodology.

The hypotheses are verified whether there is positive impact on the second variables before and under Hainan FTP constructions. Hence, the author will from the database mentioned above to pool the data from Year 2011 to Year 2020. And then select Stata as the method of analysis.

3.3.2 Indicators and Selection Statement

Table 1 lists all the latent constructs with observed indicators.

Indicators

Latent Construct	Observed Indicators
Port Integration	Total logistics Amounts in Hainan (billion yuan) (a1)
	Total revenue of logistics industry (billion yuan) (a2)
	Water transport cargo turnover Volume (billion ton kilometers) (a3)

Port Infrastructure	Total Terminal Length (M) (b1) Operation Berth (number) (b2) Number of Operation berths above 10,000 tons (number) (b3)
Seaborne Trade	Port cargo throughput (million tons) (m1) Foreign trade cargo throughput (million tons) (m2) Container Port Traffic (10000 TEUs) (m3)
Regional Economy	GDP Per capita (Yuan) (y1) GDP (billion yuan) (y2)

Table 1 List of observed and latent variables

Illustration regarding the indicator selection as below.

(1) Port Integration

A literature review shows that there are metrics on how to evaluate port performance, but there are few literatures on directly given metrics for port integration. As mentioned above, the study by Wang et al. (2015) concluded, it is not possible to quantify the full integration of port functionality and integration effects, i.e., available data denote a physical summation as opposed to the chemical reaction. According to this limitation combined with the realistic consideration of Hainan port group, the indicators for measuring port integration are selected.

Total logistics Amounts in Hainan and Total revenue of logistics industry: As previously stated, port integration is intended to avoid disorderly competition and to complement the strengths and weaknesses of each port. The integrated ports benefit from efficient supply chain transportation. Suppliers, manufacturers, logistics service providers, freight forwarders, cargo shipping lines, and others are all impacted by port efficiency. Greater understanding of how ports operate can benefit everyone. As a result, the total logistics amount and total revenue of the logistics industry will rise.

Furthermore, one of the five categories of rectification measures in the "Hainan Provincial Port Resources Integration Program" is the integration of the port logistics segment. Even the port integration program is logistics-related, using the total amount of logistics and the logistics revenue makes sense. And the goal of Hainan port integration is to create a win-win situation. First, it establishes unified pricing between ports in order to avoid vicious competition for low price quotations in the competition for customers attraction; second, it establishes high-quality, efficient, convenient, and low-cost "end-to-end" full logistics services for customers, who can choose the most suitable and nearest port to transport their goods. Uniform pricing increases port revenue, and customers choose the best way to cut costs, resulting in a win-win situation.

This win-win situation in the end result in total promotes social logistics revenue and the total amount.

Water transport cargo turnover Volume: Water transport cargo turnover reflects the overall social logistics and its revenue increase. Cargo turnover volume by definition refers to the total volume of goods transported in a certain period of time, calculated by the actual volume and distance compounded by various modes of transportation. According to the formula is: cargo turnover = the actual number of tons of goods transported × the average distance of goods transported (Hainan Provincial Yearbook, 2021). The tonnage of goods transported by water transport is increased, the increase in total social logistics.

The indicator of cargo turnover amount not only covers the number of transport objects, but also includes the factor of transport distance, thus being able to reflect the results of transport production in a comprehensive manner. And water transport cargo turnover volume is specifically calculated for waterborne transport modes. Again, port integration can reflect the transport production. Therefore, this indicator is selected.

(2) Port Infrastructure

The indicators of *Total terminal length*, *the amount of operational berth* and *Number of Operation berths above 10,000 tons* are all belongs to the hardware input for port infrastructure and reflection of checking the construction of port infrastructure. These three indicators are relatively straightforward and the authors believe they do not need to be over-explained.

(3) Seaborne Trade

Trade is equated to cargo in the context of seaborne trade. *Cargo throughput* is an important quantitative indicator that reflects the outcomes of port operations, as well as a quantitative reference base for measuring the development of countries, regions, and cities. While cargo to/from flow provides the most obvious manifestation of a port's position and the influence in the international and inter-regional water transportation chain, *foreign trade cargo throughput* is used to assess the level of interaction between the Hainan port group and the international. When it comes to *containers*, as previously stated, the container industry has been the fastest growing market for ports in recent decades and is expected to continue to grow significantly in the coming years. The container market handles more than 90% of all seaborne trade in terms of value and is used for a wide range of commodities. That is the selected considerations.

(4) Regional Economy

Generally, measure a country's economy, typically uses *total GDP* or *GDP per capita*. GDP is the primary indicator of national economic accounting and a key indicator of a country's or

region's economic status and level of development. It reflects a country's economic strength and market size (or region). The GDP per capita index, on the other hand, reflects the country's level of development as well as the stability of the society. The higher the GDP per capita, the higher the country's industrial development index and the people's standard of living. On the contrary, the country's development lags and the people's living well-being index falls. It is an important indicator of the people's living standards in the country, even though it is not directly equivalent to indicating living standards and income per capita, it can be used as one of the macroeconomic development indicators to understand the state of economic development.

3.3.3 Stata Methodology Strategies

Panel data can also be referred to as longitudinal data or cross-sectional time series data. These longitudinal data contain "observations on the same units over multiple time periods" (Kennedy, 2008: 281). the format of the data what the author selected is the typical panel data and belongs to the mixed type. As in other data analysis processes, is to describe the data of interest carefully before analysis, double check if an entity has more than one observation in a particular time period and excluded the missing value, selected the qualified indicators just as above mentioned. And then imported into Stata, preparing the panel data set, data pre-processing and rename.

According to the analysis strategies in Stata, this thesis mainly represented the following information: descriptive analysis, correlate analysis, regression and robust analysis. The reason of choosing these test analyses will detail illustrated with results in chapter 5- the empirical analysis. See Appendix B- regarding the input codes and commands.

4.The Hainan Case Analysis

4.1 Ports integration introduction in China

Hainan ports clusters integration is not the first case in China. As this thesis made the ports integration (PI) objectives above, are to reduce homogeneous and disorderly competition, to a certain extent eliminates the fierce competition among ports in the province, improve the efficiency of port resources utilization, reduce the blindness of port investment and construction, and contribute to the long-term development of the port industry.

Ports clusters integration in China can be divided into 3 stages. The first stage started in the 1990s which set up the Shanghai Combined Port Management Committee in January 1996. This was the official prelude to PI in China. The second stage started in 2005 which the former Ningbo and Zhoushan ports were merge and management in general. What's more, they utilized the funds of Ningbo Port to effectively developed the domain of Zhoushan Port, and strived to realize the intended complementarities between the two ports. Subsequently, Guangxi and Hebei joined the efforts on port integration in 2007 and 2009 respectively, setting up the Beibu Gulf Port Group and the Hebei Port Group, with the same mission: To integrate port resources in the region (Ma et al.,2021).

The third stage started in 2015 and it is a significant year. Before 2015, only individual regions in China had carried out large-scale port consolidation, while when Zhejiang Province took the lead in starting intra-provincial port consolidation in 2015, after which Jiangsu Province, Liaoning Province, Shandong Province, Fujian Province, Guangdong Province and other places started or proposed intra-provincial port consolidation one after another. China's PI scale and scope continues to expand (Industrial Securities,2020). (See Fig. 6).

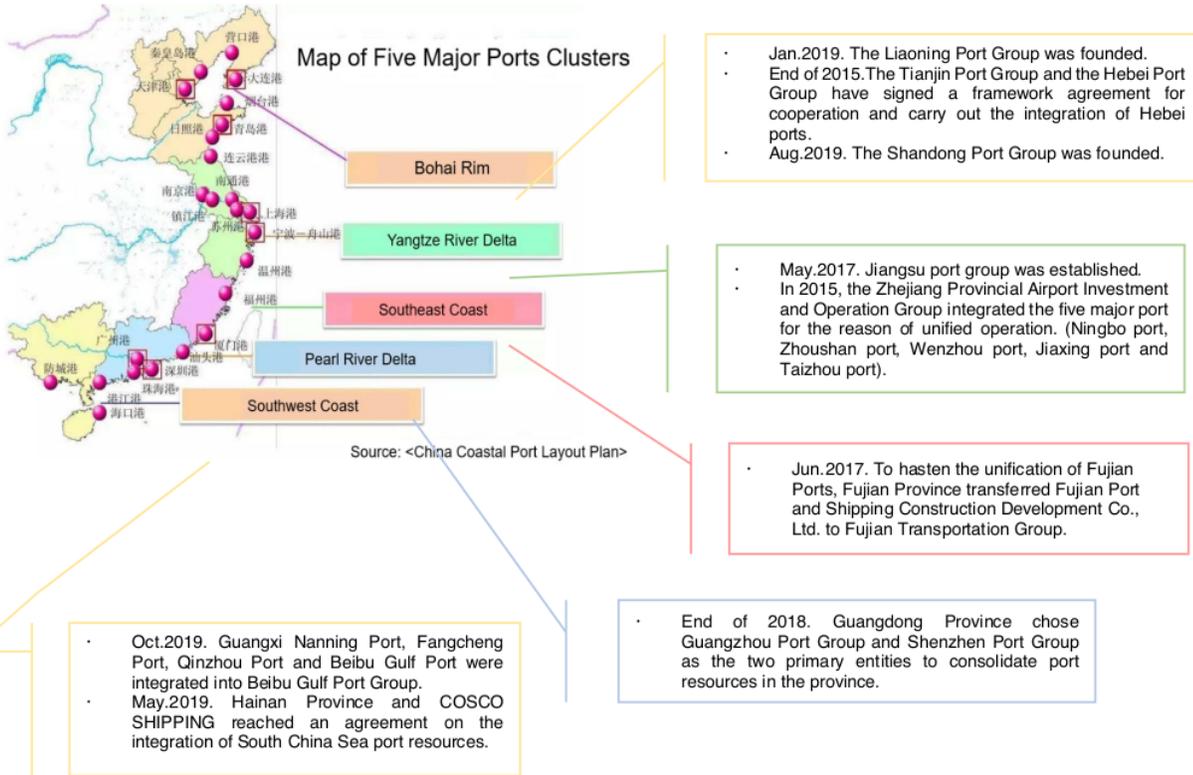


Figure 6 The third stage ports cluster integration in China
 Source: Ma et al.2021. Port Integration and Regional Economic Development: Lessons from China

4.2 SWOT Listing

The integration progress mentioned in section 3.1 clearly side-noted the fierce competition that Hainan ports clusters encounters. Each port clusters are thriving for improving their own strength and achieved a higher throughput in the end. Especially Hainan ports clusters' same rim Cluster- Beibu Gulf Port Group.

Beibu Gulf port group is also the transit point for the trade of products from Southeast Asian countries, these ports are located close to each other and have the same function, which greatly increases the competitive pressure of Hainan ports. For example, due to Guangxi province is backed by the great southwest, Guizhou province as well as Hunan province, most of the goods will choose Guangxi ports in and out, hence substantial increase in annual throughput. Beibu Gulf port cluster is so promotional in terms of development prospects. This

is a challenge for the development of the port economy of Hainan region (Wang,2020).

Therefore, the SWOT matrix analysis, will be closely related to the core of Hainan port cluster of various major internal strengths, weaknesses, opportunities and threats, etc., through the investigation listed, and then use the idea of system analysis, the various factors match each other to analyze, from which a series of corresponding conclusions. Finally, it is crucial to formulate corresponding development strategies, plans and countermeasures based on the research results. Likewise, this section serves as a precursor analysis for the discussion and conclusion in section 6.

4.2.1 Strength Points

The strength of Hainan's regional economy and port cluster can be summarized as follows.

(1) Excellent location with wide radiation range

Surrounded by sea on all sides, Hainan Island is rich in port resources, with 78 large and small harbors, many of which can be built with deep-water berths. It is a large island in the south, and is the combination of land and sea land in South China and Southwest China. It can be used as the frontier of the great southwest to the sea and the development and utilization of the South China Sea resources base.

Overall, Hainan near Hong Kong, looking far away from Taiwan, close to the Pearl River Delta, neighboring Southeast Asia. Not only has the support of the economic hinterland, but also by the radiation and drive of the economically developed areas, to facilitate internal attraction and outreach, economic development.

Externally, Hainan is close to East Asia and Southeast Asia between the international deep-water shipping lanes; the South China Sea is China's access to Southeast Asia, the Indian Ocean until Africa, Europe, the sea channel. Sea transport is relatively convenient, convenient for the development of outward-oriented economy. Hainan Facing South-Eastern Asia and located on "One Road One Belt", optimal of external opening about incorporated with ASEAN countries regarding the economic and trade, and comply with China's Ocean Development and free trade port strategy (Government documents, 2020).

In short, the geographical location of Hainan Free Trade Port involves "exchange and cooperation with Southeast Asian countries", "linkage development with Guangdong, Hong Kong and Macao Bay Area", "backed by a large domestic market and hinterland economy "The three aspects of the relationship. (Xie & Gao, 2020).

(2) A broad prospect of development under FTP planning and transportation system

The concept of a Free Trade Zone (FTZ) in China is not novel. Since 2013, China's central government decided to implement comprehensively deepening reform and established the first FTZ, Shanghai FTZ. Later on, 11 more FTZs were added during 2015 and 2017. Hainan is the most recent and the largest (35,400km²) inclusion in 2018. (See Fig.7).



Figure 7 China Special Economic Zones
Sources: icontainers cited World Economic Forum/RT Economy Watch China Checkup /UNCTAD

Regarding the FTP plan, the construction is carried out in steps in conjunction with the needs of the times. From 2020, the construction of the FTP has made significant progress to 2025, the initial establishment of the FTP system, and then to 2035, the free trade port system and mode of operation tends to maturity (Ma et al., 2021). (See Fig.8).

Regarding the transportation system, also visionary plans have been made in the early stage. For example, the "Hainan Modern Comprehensive Transportation System Planning", "Hainan Province National Economic and Social Development 14th Five-Year Plan and 2035 Visionary Goals Outline" and "Hainan Province "14th Five-Year" Modern Logistics Industry Development Plan" and other integrated planning plans were issued. The transportation network constructions are all based those plans (Hainan Modern Comprehensive Transportation System Planning,2020). (See Fig.9).

Objectives



Figure 8 The Objectives of Hainan FTP construction
 source: Hainan International Economic and Development Bureau (IEDB)
http://www.investhainan.cn/hwh/Resources/202007/t20200720_3284983.html



Figure 9 Hainan modern integrated transport system planning diagram
 Source: <Hainan Modern Comprehensive Transportation System Planning>

Since the year 2021, Hainan province has achieved 19.3 billion yuan of investment in highway and waterway fixed assets, and the transportation network has been gradually built and perfected (Hainan Statistical Yearbook, 2021).

In the waterway aspect, Hainan Province actively integrated port resources, has formed the

north of Haikou port, south of Sanya port, west of Yangpu port, Basuo port, east of Qinglan port "the five ports in four directions" pattern, port function positioning clearly. In the past two years, Hainan port clusters are developing rapidly, the port key construction process is accelerating, the integration of port resources is steadily advancing, the current overall layout of the port structure adjustment has achieved significant progress, and the length of the quay continues to increase, the port berths and 10,000-ton berths are increasing as well. Xiuying port (part of Haikou port) can serve maximum 30,000 tons of container ships, the third phase of Macun port bulk terminal (part of Haikou port) can serve for 35,000 tons of bulk. By 2025, the number of 10,000-ton berths and above in Hainan coastal ports will reach 80, "five ports in four directions" development pattern will be more complete (Hainan Statistical Yearbook,2021).

In land and air transport aspect, Hainan strengthens the port and railroad, air and other intermodal transportation connection. Investing in the aviation flight circle, Hainan actively build a regional aviation hub for the Pacific Ocean and the Indian Ocean. Hence, the domestic and international routes and the entering number of airline companies have increased significantly.

The province has opened over 400 domestic routes, 8 cargo routes, 103 overseas routes, covering 20 countries such as South Korea, Japan, Russia, Ukraine, Kazakhstan and 62 districts. This year, it will promote the third phase expansion of Meilan Airport and the planning and construction of Sanya New Airport, Dongfang Cargo Airport and Danzhou Airport. By 2025, Hainan will strive to reach 5 civil transport airports and build a comprehensive airport system with Haikou, Sanya and Boao airports as the core, supplemented by other airports and general aviation airports, to become an aviation hub with access to the whole country and facing the Pacific and Indian Oceans. It is expected that by 2025, the air passenger throughput of the province's airports will exceed 70 million passengers (Hainan Statistical Yearbook,2021).

(3) Liberty in polices making of central government supports

The liberty of policy making support from the central government is the biggest strength. China's reform and opening up has now entered the deep water, and the construction of Hainan FTP carries the function of a test to solve the challenges China is currently encountering. The central government has instructed to give various preferential policies and issued many relatively liberal policies. Quite supportive in terms of policies.

After approximately 2 years of FTP construction from 2018 to 2020 and for the reason of running more smoothly, the Central Committee and the State Council of China issued the General Plan for the Construction of Hainan Free Trade Port ("General Plan") in June 2020, and then in June 2021, Hainan Free Trade Port Law of the People's Republic of China ("Hainan

FTP Law") came into effect. Under the planning and legal protection framework of the General Plan and the Hainan FTP Law, Hainan is now striding. Many policies are based on the above two Acts and give policy preferences to relevant industries. The policies like international trade, import/export of goods, port development and so on are favorable to port operators. (See Table 2).

No.	Name of the Policy
1	Exempt from import duties, import value-added tax and consumption tax on imported operational vehicles and yachts.
2	Products originating from Hainan, including output products whose added value exceeds 30 percent after the domestic processing of imported intermediary products, are exempt from taxes when entering the rest of China.
3	Export tax rebates on domestically built ships that are registered at Yangpu Port of China and engaged in international transport.
4	Allow ships (those engaged in domestic and foreign trade) that transit at Yangpu Port of China to refuel with bonded oil.
5	Build Yangpu Port of China into an international port of registry.
6	Adopt a trial policy of tax rebates at the port of departure on goods that use Yangpu Port of China as a transit port for the final departure from China.
7	Adopt an import & export management system featuring "free flow through the first line and efficient control at the second line" in Yangpu Bonded Port Area and other qualified zones.
8	Replace pre-audit with post-audit for the banking sector on authenticity review of cross-border and new international trade.
9	Conduct the negative list of cross-border trade in services for Hainan Free Trade Port.
10	Support the construction of trading venues for international energy, shipping, property rights and equity stakes.
11	Enable non-residents to participate in trading and fund settlement at trading venues.
12	Build a new international land and sea transport hub to connect Western China with the world.
13	Build a pilot zone for cruise tourism.
14	Build a pilot zone for reform, development and innovation of the yacht industry.

Table 2 The selected policies related with the port industries
source: Hainan International Economic and Development Bureau (IEDB)
http://www.investhainan.cn/hwh/Resources/202007/t20200720_3284983.html

Under those policies and take Yangpu Port as an example. With a coastline of more than 30 kilometers and a water depth of 10 to 24 meters, Yangpu is less exposed to typhoons and other natural disasters, and the port can operate for over 330 days throughout the year. Currently, Yangpu Port operates 36 domestic and international shipping routes, connecting

most of the major ports in Southeast Asia, and is the only designated site in Hainan Province for the supervision of imported meat and imported grain. The imported goods from Yangpu Port will transfer to Haikou and Sanya by barge or by road. Yangpu has a clear leading position in Hainan's maritime logistics. In addition, Yangpu Port currently has a total of 47 berths of different types of terminals and accounts for 76% of the province's foreign trade cargo throughput in 2021; Yangpu Exploitation Zone also has a maturing industrial base and accounts for 33% of the province's total industrial output in 2020. Yangpu, as one of the hubs of Hainan's industry and foreign trade and a pilot area for "free flow through the first line (boundary line) and efficient control at the second line (spatial dividing line of the Hainan Yangpu FTP Zone", has huge development potential (C.H. Poon,2022).

Therefore, it is reasonable that Hainan will build an international shipping service pioneer area in Yangpu, establish a more open and convenient international ship registration system, to promote the return of Chinese "flag of convenience" ships, to create "Hainan ship registration", and promote the abolition of ship import tariffs, VAT and vehicle tax, reduce the personal income tax of seafarers and explore the implementation of the ship tonnage tax system (C.H. Poon,2022).

Hainan's economic centers are scattered along the island's coastline. While Haikou, the provincial capital, is the industrial and commercial center of Hainan, the coastal cities of Sanya, Qionghai, Wenchang and Dongfang have their own distinctive economic development. It would be a cost-effective logistics solution for Hainan to have a port that concentrates the export commodities of Hainan cities and provides sufficient international shipping routes to overseas markets (C.H. Poon,2022).

The importance of Yangpu to Hainan's development is not only serve the local economy, but also connect Hainan to the international market. As China is now pushing forward with the development and opening up of the western part of the country, Yangpu will be able to connect Hainan to the world supply chain by serving as a maritime gateway to the western part of China. Yangpu is positioned as a regional international container hub port, linking with Beibu Gulf in Guangxi as the sea port for western China (e.g., Chongqing, Sichuan, Guangxi and Guizhou provinces, cities and autonomous regions), connecting to the Silk Road Economic Belt and the 21st Century Maritime Silk Road ("One Belt, One Road") (<The Master Plan for the New Western Land and Sea Corridor>, National Development and Reform Commission).

This means that exports from Hainan and western China, as well as imports from the Belt and Road countries to China by sea, can use Yangpu Port as a hub port. Hainan can also use the regional advantage of Yangpu Port to develop industries such as processing and

manufacturing, petrochemicals, and shipping services alongside the port, making the FTP more diversified. This makes Yangpu important for the development of Hainan FTP.

4.2.2 Weakness Points

(1) FTP Area is large resulting in the difficulty of unified construction

Hainan FTP is located in the southernmost end of China and it is a wide area, the island area of 33,900 square kilometers, the sea area of about 2 million square kilometers (Hainan Statistical Yearbook, 2021). Consider this and then compared to Shanghai, Guangdong and the rest of the 11 areas are about 120 square kilometers of the free trade zone, Hainan FTP either in the theoretical planning or in the actual construction process, the factors that need to be considered or the interests that need to be reconciled or the difficulties that need to be encountered are relatively greater. Also, in terms of its large area, it is necessary to give special policies treatment to some areas so that they can prioritize to become the "window" and the trial site for the construction of the FTP. Meanwhile, ensure the coordinate and balance path among others areas also essential. It is relatively difficult to harmonize.

(2) Small port economic hinterland

The economic hinterland of the port can be divided into direct hinterland and indirect hinterland. Direct hinterland in terms of the definition is the area that can be reached by various means of transportation; indirect hinterland in terms of the area that can be reached by goods and passengers in transit through the port (Liu, 2010). Hainan Province is an island province, for Hainan's port cluster, the direct hinterland is only Hainan Island, although Hainan is building FTP, it must be admitted that Hainan's economic volume is low, still is a less developed area, low level of industrialization and urbanization, low level of income of resident. lack of talented etc., these problems from a vary degree limit the speed and quality of development, which in turn affects the Hainan port economy.

Lastly, Hainan's indirect economic hinterland, currently radiating mainly in the southwest coastal areas, but these areas have been built large ports, and Qiongzhou Strait climate is variable, typhoons, heavy rains, foggy weather frequently, decreasing the interaction frequency of Hainan and the mainland China, increasing the risks and costs, which is not favorable to foreign investment, and likewise weakening the impact of the economic hinterland.

(3) Late start and lack of experience of FTP construction

The third and most important point is that the construction of the FTP started late, and is currently in the exploration period, lacking corresponding experience and lessons. Although

China has accumulated some experience in the construction of other free trade zones, but compared with the world's North American free trade zone, the European Union and other large free trade zones, the construction of China's free trade zones is still relatively young. Frankly, is still in the exploratory stage, the experience is still lacking. In particular, the newly established Hainan FTP, both in terms of geographic location, or economic environment and geopolitical, are different from China's existing several other free trade zones. This determines the future of the construction of Hainan FTP direction and path selection cannot blindly imitate China's other several free trade zones, but must be appropriate to local conditions, and under seeking all the time (Hong and Gong, 2019).

4.2.3 Opportunities Points

(1) Covid-19 Impact provides economic development opportunity for China

Due to the impact of covid-19, citation from International Monetary Fund below (see Fig.10) shows that multiple countries have a negative economic growth rate in 2020, which is a huge blow to the world economic development. China is one of the few countries with economic growth due to the rapid control of the pandemic. In addition, China is already the second largest economies in the world and Hainan, as the pioneer of China's reforms, has a large potential for economic development, thus favoring the development of the Hainan port cluster.

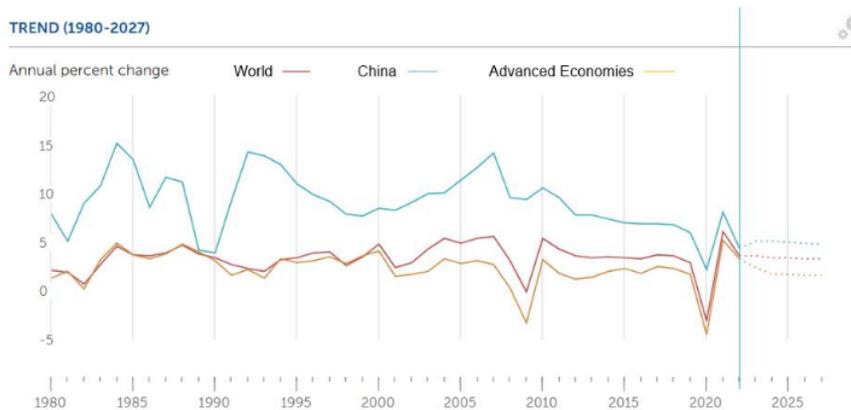


Figure 10 Real GDP growth| Annual percent change (1980-2027)
International Monetary Fund
Source: https://www.imf.org/external/datamapper/NGDP_RPCH@WEOWEOWORLD/CHN/ADVEC.

(2) Opportunities brought by the Beibu Gulf and the Greater Bay Area

The "Beibu Gulf", as mentioned above, refers to the northern coastal areas of the Leizhou Peninsula in Guangdong, the western part of Hainan, the southern coast of Guangxi and the

northern coast of Vietnam. The Beibu Gulf Economic Circle is one of the four major economic circles in China's coastal region and is geographically connected to ASEAN countries by both land and sea, making the Beibu Gulf an important hub on the international corridor facing ASEAN. Hainan port cluster is located in the eastern part of the Beibu Gulf (Wang, 2020). With the development of trade between Beibu Gulf and ASEAN, and in the above-mentioned analysis of advantages referring to Hainan FTP's geographical location involves the "Association of Southeast Asian Nations". Hainan has been actively integrated into its regional economic cooperation and has gained a very rare opportunity (C.H. Poon (2022).

It is worth mentioning that currently, ASEAN has become one of the most dynamic and potential markets in the world. 2014-2019 (before covid-19), the average annual growth rate of ASEAN GDP is about 5%, much higher than the world's 2.9% and the EU's 2.1% growth rate. It is an economy including 650 million people in 10 countries. Among them, Singapore, as a free trade port, is already a global transportation hub, trade center, and financial center; while Vietnam, the closest to Hainan, is one of the fastest growing economies in the world in recent years, with an average real GDP growth rate of 6.7% since 2015(Xie & Gao, 2020).

And, mentioned about the Guangdong-Hong Kong-Macao Greater Bay Area, due to it covers Hong Kong, Macau and all nine cities in the Pearl River Delta, with a total population of more than 70 million, making it one of the most open, economically largest and dynamic regions in China. In the future, it will be built into a world-class city cluster and international science and technology innovation center that can rank with the New York Bay Area, San Francisco Bay Area and Tokyo Bay Area of Japan. Among them, Hong Kong, Macau, Guangzhou and Shenzhen are the core engines of regional development (Xie & Gao, 2020).

(3) Hainan FTP modeling as a window to showcase its "openness to the global"

China's growth to this point has been met with increasingly severe siege by the U.S.-led Western countries. Since the outbreak of the China-U.S. trade war, and especially after the outbreak of the Russia-Ukraine war, some western countries are seeking to de-link their economies from China, and making high-profile announcements about transferring their industrial chains to countries with similar values. This tendency of anti-globalization, which emphasizes ideology and downplays economic efficiency, will harm everyone (Chi,2021).

However, China's economy is at the juncture of building a modernized economic system and promoting quality change, efficiency change in economic development and say no to wave of anti-globalization. China's competitive manpower advantage in the world trading is gradually weakening, and accelerating the formation of a new pattern of comprehensive opening is an

inevitable choice to cross this threshold. Anti-globalization is not China's future path, the Chinese central government has repeatedly stressed that countries should seek to cooperate with each other and working to build a community with a shared future for mankind rather than resist each other. The pace of China's opening up to the world will be greater, and Hainan FTP as a test field to carry China's further expansion of openness, for China to better adapt to economic globalization, both with infinite opportunities, also bears the significant mission (Chi,2021).

4.2.4 Threats Points

(1) Industries development planning may deviate from the original plan

Internally, as we know from the above analysis, the FTP construction in Hainan lacks a ready-made model to be applied, and every step it taken is full of stress and risk. Which in the process of development, it is easy to deviate from the planned guidelines and original intention. We are shall avoid the tendency of haste and blind optimism, as the construction of Hainan FTP is not built in a day (Hong and Kong,2019).

(2) South-sea issues resulted in defected trust mechanism and cooperation

Externally, due to the existence of multiple power players in the South China Sea and the complex international environment, the South China Sea has gathered almost all major powers since 2010. Currently, in exception to the United States, Japan, India, Britain, France, Germany, Russia and even Australia have various forms of military presence in the South China Sea. The reason for this one is the South China Sea's geopolitical location determines its special position in the global geopolitical landscape, second is expansive maritime power has endured in the long human history. In addition, some claimants' policy adjustments, reshaping of regional and international power structures, the conflicts between China and the United States, and the "overreaction" of the United States to China's South China Sea policy are also important factors (Wu, 2021).

Under this condition, the South China Sea has become a testing ground and ASEAN as the most important regional partner in the construction of Hainan FTP, if controversies arise due to the South China Sea dispute, it is very easy to destroy the mutual trust mechanism between the two sides, threatening the healthy operation of the FTP.

4.3 SWOT Matrix Analysis

From above individual S(Strength), W(Weakness), O(Opportunities) and T(Threats) analysis, come up with the below SWOT matrix of how Hainan ports clusters and its regional economy can leverage opportunities to increase strengths; leverage opportunities to overcome

weaknesses; leverage strengths to avoid threats; reduce weaknesses and avoid threats. (See table 3).

S-O Strategy/Analysis	W-O Strategy/Analysis
1. Maximum using central government policy support. 2. Internally strengthen cooperation with the Beibu Gulf and the Greater Bay Area. meanwhile, externally, enhance and deeply exploit the competitive strength, achieving technology transfer and patents trading to ASEAN countries.	1. Increase global cooperation and expand indirect economic hinterland. 2. Finalize industry development and create more job opportunities, further attractive the global workforce and be open-minded to learn from the experience abroad that suits.
S-T Strategy/Analysis	W-T Strategy/Analysis
1. Cultivate vital supportive industries and some leading and competitive companies, influencing ASEAN countries via economic collaborations; 2. Keep communicating to find the balance point of south sea issues.	1. Seek common ground while reserving differences, and deal gently with the complicated political relations in the South China Sea. 2. On the basis of mutual respect to try the possibilities within the planned boundary.

Table 3 SWOT Matrix Analysis of Hainan Cluster ports and its regional economy

4.4 Chapter Conclusion

The SWOT matrix analysis on Hainan ports cluster and its regional economic development is broadly as above. While in chapter 5, this thesis will carry out the empirical analysis based on hypothesis validation and data analysis. Chapter 6 will carry out further discussion and conclusion based on the whole thesis above.

In sub-conclusion here, the greatest strength of Hainan FTP is its strategic position and irreplaceable role in the construction of "One Belt, One Road" and the Maritime Silk Road. And ports cluster development closely connective with the FTP construction. In the new opening starting point, the "One Belt and One Road" shall as an opportunity to promote the implementation of ASEAN-focused cooperation strategy; meanwhile set up pilot areas as a guide to drive the whole region and regarding the South China Sea, speed up the talks with Southeast Asian countries and some international forces. Lastly, Hainan should highly examine its own advantages and disadvantages. Hainan province only 34 years old. As an old Chinese

saying goes, "A man shall independent at the age of thirty." Age 30 to 40 is the golden age of a man, and it may also be the golden age of Hainan.

5. Empirical Analysis based on Data and Findings

5.1 Data Statement

For the stability of the panel data and sample amounts shall be sufficient, the data were selected from 2011 to 2020 at the Hainan provincial level and the municipal level where the ports are located. The data of port integration is sourced of annual China Transport Yearbook, the data of port infrastructure, seaborne trade and the regional economy are sourced of annual Hainan Yearbook. The specific data are listed as follows tables (label marked with “-” refer to missing data). Below (table 4) is an example of Hainan Provincial panel data (2011-2020), see Appendix A for the panel data format.

- Hainan provincial level data:

Latent Construct	Indicator	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Port Integration	a1	5692.62	5749.55	5864.54	6040.48	6282.1	6790.94	6958	7454	7885.32	8365.58
	a2	464.06	466.38	471.04	478.11	487.67	498.39	511.05	587.2	619	646.29
	a3	1263	1429	1257	1494	1091	973	770	774	1590.46	3625
Port Infrastructure	b1	15013	15569	16533	19104	21011	24935	25922	26213	26907	26950
	b2	91	75	76	84	100	104	122	148	148	149
	b3	34	35	40	46	50	65	73	74	78	78
Seaborne Trade	m1	10905	11792	10130	14164	15356	16390	18473	18282	19839	19895
	m2	2008	2207	2374	2597	2966	3078	3249	3207	3395	3821
	m3	112	137	142	162	154	165	193.6	268	271.26	300
Regional Economy	y1	28014	30993	34053	37166	39704	43009	46631	50263	53929	55131
	y2	2463.84	2789.38	3551.85	3449.01	3734.19	4090.2	4497.54	4910.69	5330.84	5532.39

Table 4 Hainan Provincial indicators data

However, just as the explanation at the literature review chapter stated, the author encounters some difficulties in acquiring all the indicators above and inevitably with missing data. According to Hun Myoung Park (2011), Many missing values are likely lower the quality of panel data. So called listwise deletion (an entire record is excluded from analysis if any single value of a variable is missing) tends to reduce the number of observations used in a model and thus weaken statistical power of a test (Hun Myoung Park, 2011). In addition, the amounts of indicators shall comply with the relative equivalence, which it means if one indicator only have 5 columns of data, even the other indicator have 60 columns of data, put them as a pair variable there still no results generate. In case of better employ with Stata and regression model, finally selected the indicators of a3, b3, m1, m2 and y1, y2.

5.2 Descriptive Statistics Analysis

Descriptive statistical analysis is a required component of an empirical thesis and serves as a prerequisite for regression analysis. Meanwhile, descriptive statistics serve as a review of the

data that the author used, not just to showing the statistical characteristics of the data and conveying data-level information. The descriptive statistics table provides information on the presence of extreme values, missing data conditions, etc., allowing for further cleaning and optimization of the data and eliminating the effects of data muddiness.

The mean, standard deviation, maximum, and minimum values were chosen as measures for descriptive analysis in this thesis. The logarithm was originally planned to be chosen, but due to its low significance, it was not preferred. In particular, the sample variables should be kept consistent in general, which means that the variables should be 60 (10 years, 6 groups).

While the b3 (Number of Operation Berths above 10,000 tons) missing the 8 years data of Sanya and Wenchang respectively, considering the fact that Sanya port is positioned as an international passenger-oriented and freight-supporting port; Wenchang Qinglan port is an important feeder supplemental port and a major maritime hub of the national space launch base can also be considered as zero that the indicators selected are still valid. While only one year of data is missing for the m1, it is within a negligible range and is also consistent with the selection.

And regarding the min value, the observation of zero of b3(number of operation berth above 10,000 tons) and m2(foreign trade cargo throughput) are Qinglan and Sanya port, take their strategy position into consideration, they are not the cargo handle and mainly container ports, make sense the value is zero.

The mean and standard deviation are two interconnected statistical indicators that are used to describe the overall characteristics of the data. The standard deviation reflects the trend of data dispersion, while the mean reflects the trend of data concentration. they are combined to accurately reflect the data overall. The greater the standard deviation, the less representative the mean is; conversely, the more representative the mean is.

The mean shown below reflects the average level of each indicator, and it is known from the definition of indicators that the mean indicator range is reasonable. Standard deviation is defined mathematically as the degree of dispersion of a data set. The table below (table 5) shows that the mean can adequately explain the level of each indicator, but the degree of dispersion is greater for the y1 (GDP per capita) variable.

Finally, no information on the existence of extreme values has been provided, and the missing data condition has been described accordingly. The data's reliability and validity were confirmed, allowing the next step of analysis to proceed.

Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
a3	60	475.612	675.773	0.01	3625
b3	44	25.341	21.412	0	78
m1	59	5106.865	5814.951	13	19895
m2	60	962.583	1195.702	0	3821
y1	60	41468.217	13425.41	18559	72218
y2	60	1058.559	1457.881	89.11	5532.39

Table 5 Descriptive Statistics

5.3 Correlation Coefficient Analysis

Correlation analysis is the examination of two or more variables that have a correlation in order to determine the degree of similarity between two variables. The control variables must have a certain correlation with the dependent variable in order to be used in the regression equation, acted as the initial screening of the variables and the initial judgment of the correlation.

Before conducting the regression analysis in this thesis, the Pearson correlation coefficient matrix was tested (see table 6). The findings show that the core explanatory variables a3, b3 have a significant positive correlation with y2 respectively, supporting the expected hypothesis. Furthermore, the mediating variables m1, m2 (all with less than 1% significance level) are all significantly correlated with y2. However, because the correlation coefficient matrix only measures the relationship between the bivariate variables and does not account for the interaction of control variables and potential variables, the results are only provided as a guideline, and further regression analysis is required to determine the specific relationship. Finally, we can rule out the possibility of variable co-linearity by determining whether the absolute magnitude of the correlation coefficients between the explanatory variables is greater than 0.9 (all of them are less than 0.9 in this thesis).

Correlation coefficient matrix

	a3	b3	m1	m2	y1	y2
a3	1					
b3	0.697***	1				
m1	0.787***	0.941***	1			
m2	0.706***	0.814***	0.737***	1		
y1	0.136	0.220	0.245*	-0.167	1	
y2	0.726***	0.922***	0.934***	0.695***	0.287**	1

Table 6 Correlation coefficient matrix

5.4 Regression Analysis

Regression analysis is a crucial step in determining the validity of a hypothesis. The regression analysis below was run 3 times to validate the model assumptions based on the model scenario. The first regression analysis is verifying the hypotheses of H1(c), H1(b) and H3. The authors validated the mediating effect of m2 as a variable using a stepwise regression method.

The first step is to establish a link between the independent variable a3 and the dependent variable y1, clearly as: $a3 \rightarrow y1$ (H1c). At the 5% level of significance, a3 is found to be positively correlated with y1. The dependent variable is replaced with the mediating variable in the second step to see if there is a significant correlation between the independent variable and the mediating variable, clearly as: $a3 \rightarrow m2$ (H1b). The results show that a3 is positively correlated with m2 at the 1% significance level, and the significant relationship holds. The regression is repeated in the third step by including the mediating variable in the first step, clearly as: $a3 \rightarrow m2 \rightarrow y1$ (H3) and if the mediating variable is significant, it indicates that there is a mediating effect, and the result shows that m2 is negatively correlated with y1 at the 1% level of significance.

In other words, all three hypotheses are confirmed. (See table 7)

Regression Analysis 1

VARIABLES	(1) y1	(2) m2	(3) y1
a3	2.698** (0.76)	1.248*** (0.20)	10.029*** (1.46)
m2			-5.872*** (1.10)
Constant	40,184.882*** (3,797.89)	368.836** (98.59)	42,350.799*** (4,353.39)
Observations	60	60	60
R-squared	0.018	0.498	0.156
Number of groups	6	6	6
F	12.59	40.63	24.18

Standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 7 Regression Analysis 1

The second regression analysis (see table 8) is verifying the hypotheses of H2(b), H2(a) and H3. These three hypotheses are also significant and valid. Specifically, $b3 \rightarrow y1$ (H2b) at the 5% level of significance; $b3 \rightarrow m1$ (H2a) at the 1% significance level; $b3 \rightarrow m1 \rightarrow y1$ (H3) at the 10% level of significance. It is worth mentioning that, unlike the first regression analysis, the second

regression analysis uses m1 as a mediating variable indicator. Because m1, m2 are both mediating variable indicators, the author believes that replacing the indicator validation is a better way to illustrate multiple perspectives and make the validation results more reasonable.

Regression Analysis 2

VARIABLES	(1) y1	(2) m1	(3) y1
b3	143.583** (51.52)	258.436*** (2.48)	-486.344* (193.39)
m1			2.437** (0.65)
Constant	37,865.465*** (5,429.15)	211.000 (297.91)	37,351.160*** (6,051.94)
Observations	44	44	44
R-squared	0.049	0.885	0.170
Number of groups	6	6	6
F	7.768	10853	16.40

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 8 Regression Analysis 2

Same logic as the above two regressions analysis, the third regression analysis (see table 9) mainly verifying the hypotheses of H1(a) and showing a3→b3(H1a) at the 1% level of significance. At the same time, since the author already using m1 as the mediating variable for testing b3→m1(H2a) in the second regression analysis, the third one added a3→m1(H1b) for one more testing to assess the accuracy with multiple perspectives.

Regression Analysis 3

VARIABLES	(1) m1	(2) b3	(3) m1
a3	6.747*** (1.37)	0.021*** (0.00)	1.275 (0.94)
b3			228.741*** (17.81)
Constant	1,843.600** (579.76)	11.816** (3.17)	136.333 (220.43)
Observations	59	44	44
R-squared	0.620	0.486	0.897
Number of groups	6	6	6
F	24.35	80.72	720.5

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 9 Regression Analysis 3

5.5 Robust Analysis

Examining the robustness of the explanatory power of evaluation techniques and indicators is known as robust analysis. That is, whether the evaluation methods and indicators continue to provide a substantially consistent and stable explanation of the evaluation outcomes when

certain parameters are changed. The conclusion is considered robust when we alter some conditions or assumptions and discover that the result does not change. If the result changes, however, the conclusion is deemed dubious, and we must determine and justify. The findings of the relevant hypothesis are obvious after the completion of the regression analysis in this thesis. However, there are actually two indicators for the variable of regional economy in this thesis overall. The dependent variable in the regression analysis section is set to be y1. When y2 is used as the dependent variable in the robustness analysis section, the hypothesis is tested to see if the result holds. Tables 10 and 11 illustrate the specific results, where y2 was validated using the two independent variables a3 and b3, respectively, and all of them demonstrated significance. The findings demonstrate how solid the conclusions of the paper's hypotheses are.

Robust Analysis 1

VARIABLES	(1) y2	(2) m2	(3) y2
a3	1.566*** (0.28)	1.248*** (0.20)	1.013*** (0.21)
m2			0.443*** (0.07)
Constant	313.669* (129.43)	368.836** (98.59)	150.363* (71.91)
Observations	60	60	60
R-squared	0.527	0.498	0.593
Number of groups	6	6	6
F	30.22	40.63	45.12

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 10 Robust Analysis 1

Robust Analysis 2

VARIABLES	(1) y2	(2) m1	(3) y2
b3	69.661*** (2.66)	258.436*** (2.48)	20.633*** (2.97)
m1			0.190*** (0.01)
Constant	-432.541*** (92.31)	211.000 (297.91)	-472.570*** (101.09)
Observations	44	44	44
R-squared	0.849	0.885	0.904
Number of groups	6	6	6
F	687.4	10853	437.5

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 11 Robust Analysis 2

5.6 Hypothesis Conclusion

Following as above empirical analysis draw out the hypothesis conclusion as a chapter summary. (See table 12).

Latent Construct	Hypothesis	Conclusion
Port Integration	H1 (a): The port integration has a positive effect on port infrastructure.	confirmed
	H1 (b): The port integration has a positive effect on seaborne trade.	confirmed
	H1 (c): The port integration has a positive effect on regional economy mediated through seaborne trade.	confirmed
Port Infrastructure	H2 (a): The port infrastructure has a positive effect on seaborne trade.	confirmed
	H2 (b): The port infrastructure has a positive effect on regional economy mediated through seaborne trade.	confirmed
Seaborne Trade	H3: Seaborne trade has a positive effect on regional economy.	confirmed

Table 12 Hypothesis Conclusion

Besides, some new insights also obtain: y_1 and y_2 are all belongs to the dependent variables but from the correlation coefficient matrix, y_1 (GDP per capita) is not significance to any independent variables and only significance 10% to one of the intermediate variables (port cargo throughput). However, y_2 is significance to any variables. The author believes that the suitability or inappropriateness of a metric structure is primarily determined by the economic phenomena it covers and describes. GDP per capita considers the number of people, whereas GDP, as a valid tool for a country's or region's macroeconomic performance, can directly reflect and explain the dependent and intermediate variables. The following regression analysis validates such statements.

When Regression Analysis 1 and Robustness Analysis 1 are compared, both $a_3 \rightarrow y_2$ directly and $a_3 \rightarrow m_2 \rightarrow y_2$ after m_2 as an intermediate variable show 1% significance in Robustness Analysis 1. However, $a_3 \rightarrow y_1$ is not as significant as $a_3 \rightarrow y_2$, but $a_3 \rightarrow m_2 \rightarrow y_1$ is significant again at 1% when m_2 is used as an intermediate variable.

Similarly, when comparing Regression Analysis 2 and Robustness Analysis 2, both direct $b_3 \rightarrow y_2$ and $b_3 \rightarrow m_1 \rightarrow y_2$ after m_1 as an intermediate variable show 1% significance in Robustness Analysis 2. And still, $b_3 \rightarrow y_1$ is not as significant as $b_3 \rightarrow y_2$. However, $b_3 \rightarrow m_1 \rightarrow y_1$ following m_1 as an intermediate variable does not achieve 1% significance, in contrast to

m2 as an intermediate variable. The significance level is only 10%, demonstrating that the impact of port infrastructure on per capita GDP is less significant than the impact of port integration. The following is an explanation of the possibility: China's infrastructure is largely completed ahead of schedule, with a small correlation between it and GDP per capita. In addition, part of the budget for ports infrastructure construction comes from the central government, while another part comes from local governments, which still counts little relation with local GDP per capita.

6. Discussion and Conclusion

As the final chapter of the thesis, this chapter will refine the answers to the research question based on the outcomes of hypothesis testing, and with related literature to discuss findings and give out the added values of this research. In the meantime, the sub-questions are examined and analyzed from the viewpoint of their applicability, the outcome of the sub-questions will be represented at suggestions part. Finally, the limits of this thesis are then discussed.

6.1 Research Question Conclusion

In this paper, the relation between port factors and regional economy of Hainan case has been researched. Ports factors in this thesis are refer to port integration and port infrastructure. The research question was: *What is the impact of the investments in the port infrastructure and Hainan ports integration on the port-side economy and further impact the regional economy?*

In this paper, the author conducts a quantitative analysis of selected data from the last decade in Hainan and find that, in light of the province's current situation, an increase in port infrastructure investment and a further strengthening of the integration of the Hainan ports cluster still bode well for the seaborne trade and regional economy. And the author also concluded, the success of seaborne trade and the regional economy is a direct result of port integration and port infrastructure, as well as the policies support of FTP construction.

The positive relationship between port integration and regional economic development studied by Ma et al. (2021) based on the case of China and Munim and Schramm (2018) also conclude that developing countries should constantly improve the quality of port infrastructure as it contributes to higher logistics performance, leading to higher seaborne trade and generating higher economic growth etc. These preceding studies in the field are all consistent with the author's framework hypothesis of the Hainan port cluster as a case study.

So, what is the added value of this study? What can we learn from this research?

(1) Using GDP per capita as the dependent variable to judge the impact of infrastructure investments on the regional economy is biased. Meanwhile, seaborne trade is an important mediating effect factor. It achieved a significance of 1% in all data analysis and is a direct reflection of the independent variable.

(2) Why is this research important? China is a vast country, and Hainan Island is a small frontier island with few relevant port and regional economic studies; this study adds to the Hainan literature. Furthermore, this study can be used as a reference by the local government.

Continued government infrastructure construction and port integration (which requires dealing with all parties' interests) are beneficial to the FTP's development and construction. As stated in the preceding paper, the port is the primary means of communication between Hainan Island and the rest of the world, and its construction has a significant impact on the island's economy.

(3) The government supports the reorganization of the assets of the region's port enterprises in order to form a unified port enterprise group. Then rely on the enterprise group to integrate the province's ports resources, transforming the province's ports as a whole into a modern large combination of port, which is critical for the construction and development of the FTP. Besides that, Hainan ports cluster, in order to be less behind the surrounding port clusters, should be high speed and comprehensive port integration and infrastructure investment in today's FTP policy support. After the integration, the overall competitiveness of the province's ports improved significantly, and the province's role as a bridgehead in the "Belt and Road" strategy became more prominent, and it eventually became an important international shipping center and resource allocation center of the China-ASEAN free trade zone and the Beibu Gulf region.

However, the Hainan ports cluster is confronting a variety of difficulties, according to the SWOT analysis. So how can we improve the situation? What suggestions have been made for the Hainan ports cluster? The following will provide the response in connection with the thesis's sub-questions.

6.2 Suggestions

Data released by the government in these 2.5 years (2021-2022.6) show that the Hainan FTP and Hainan ports cluster are still being built at a rapid pace.

In terms of trade, 2021 saw a 57.7% YoY increase in total goods imported and exported, a 55.5% YoY increase in total services imported and exported, and a 139% YoY increase in the number of newly founded foreign firms. The province's total import and export of goods trade, particularly in the first half of 2022, was 91.7 billion yuan, up 56% YoY, ranking second in the nation and already matching the total import and export of goods trade for the entire year of 2020. The province's utilization of foreign investment is also expanding quickly, up more than 80% YoY. Moreover, like the above-mentioned Hainan shall deepen the collaboration with southeastern countries, the data also showing almost 90% goods were imported and exported to nations along the "One Belt One Road" over the previous two years (Commercial department of Hainan,2022).

Take Yangpu Port as an example of port construction. 1)Policies support: A number of FTP

shipping policies have been put into place in Yangpu. 33 foreign ships have been registered at "China Yangpu Port," which is the second largest port in China in terms of registered gross tonnage, and more than 500 shipping-related enterprises have been lured to established business there. The entire shipping sector exhibits a positive trend of rapid growth. 2) Port infrastructure: Yangpu port's container terminal efficiency grew from 47.5 to 53 units per hour, an increase of 11.57% year over year, and the daily operation capacity climbed from 3000 to 7000 TEU. 3) Regional route layout: Hainan has opened 34 domestic trade routes, essentially covering the primary ports of the largest regions along the domestic coast; and 18 foreign trade routes, achieving complete coverage of ASEAN coastal countries. As of June 2022, the container throughput reached 823,000 TEU, an increase of 45.7% year over year. All above showing that Yangpu regional international container hub has begun to show results off (Commercial department of Hainan,2022).

However, the author still has some proposal from internal and external perspective. Internally, China has multiple major ports. Over the years, Hainan's ports cluster development has lagged in comparison to other coastal provinces. One of the most fundamental reasons of this is that Hainan is isolated on the mainland, and its limited direct hinterland economic volume cannot support a leap forward in its port sector. On the basis of the theory of comparative advantage, cooperation is top options. Hainan should expand its economic hinterland outside the island, seeking partners. In the outline of opening up to the outside world, the construction of the Hainan FTP and the Greater Bay are both belong to national strategy, the complementary development of the two places creates new opportunities for the development of Hainan's port. Details are provided below.

Firstly, the strategic alliances, particularly in terms of Southeast Asia's external cooperation, can play a greater role together. In addition, the Greater Bay Area Section focused on science and technology R&D., which is exactly what Hainan needs. Hainan is also luring Greater Bay Area firms through a high level of openness to achieve industrial synergy. Thirdly, many companies and individuals seek to achieve the most competitive development by utilizing the regulations and ecosystems of the two locations. For instance, Hong Kong and Hainan's duty-free markets can connect, which may better play to their respective advantages, and boosting Hainan's improvement in service quality and growth level (China Institute for Reform and Development,2022).

Externally, Southeast Asia is the closest foreign market to Hainan; and thus, Hainan FTP shall serve as a regional "important open gateway"; this will allow Hainan to play a unique role in promoting China and Southeast Asian countries' economic and trade collaboration and a

broader range of exchanges. The specifics are listed below.

The Hainan FTP should evolve into a tunnel between China and Southeast Asian nations. Using Hainan FTP "zero tariff" and "rules of origin" as an example, encourage Southeast Asian businesses to establish factories in Hainan. (Industries comprised processing of agricultural products, tourism commodities, new energy equipment, medical equipment, communications equipment, industrial robots processing and manufacturing, etc.) In addition, utilizing the special policy of "China Yangpu Port" and the joint development of port alliances, collaboratively compile a list of exempted goods and jointly implement the "Accreditation" policy (China Institute for Reform and Development,2022).

To meet the real demand of the post-pandemic economic recovery of Southeast Asian countries, establish an island tourism cooperation unit with a focus on cruise tourism, share and forwarded passengers to each other, and engage in joint marketing of cruise lines, cruise tourism crisis management, and mutual visa-free entry, etc.

Regional economic development and trade exchanges are complementary and cannot be separated. The perspectives presented above center on the construction of Hainan FTP. The construction of the FTP will facilitate trade cooperation and support the expansion of port clusters. The development of the region will certainly promote the further leap of the ports cluster.

6.3 Research limitations

This article has researched the development of port clusters and the regional economy in Hainan and made some suggestions, but it also has certain limitations. For one aspect, the sample size limitations and incompleteness limit the scope of the analysis; this study covers a limited number of variables and does not exclude the possibility that other hidden confounding factors affect the dependent variable. Furthermore, the construction of the Hainan FTP is still in progress, and the positive correlation between the independent and dependent variables will shift as the project continues to develop. The evolution of the future development needs to be regularly monitored.

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APPENDIX

Appendix A Panel Data Set

id	year	Pro	Port Integration			Port Infrastructure			Seaborne Trade			Regional Economy	
			a1	a2	a3	b1	b2	b3	m1	m2	m3	y1	y2
1	2011	Hainan	5692.62	464.06	1263	15013	91	34	10905	2008	112	28014	2463.84
1	2012	Hainan	5749.55	466.38	1429	15569	75	35	11792	2207	137	30993	2789.38
1	2013	Hainan	5864.54	471.04	1257	16533	76	40	10130	2374	142	34053	3551.85
1	2014	Hainan	6040.48	478.11	1494	19104	84	46	14164	2597	162	37166	3449.01
1	2015	Hainan	6282.1	487.67	1091	21011	100	50	15356	2966	154	39704	3734.19
1	2016	Hainan	6790.94	498.39	973	24935	104	65	16390	3078	165	43009	4090.2
1	2017	Hainan	6958	511.05	770	25922	122	73	18473	3249	193.6	46631	4497.54
1	2018	Hainan	7454	587.2	774	26213	148	74	18282	3207	268	50263	4910.69
1	2019	Hainan	7885.32	619	1590.46	26907	148	78	19839	3395	271.26	53929	5330.84
1	2020	Hainan	8365.58	646.29	3625	26950	149	78	19895	3821	300	55131	5532.39
2	2011	Haikou	-	-	555.43	5647	52	10	5520.6	285	80.8	35338	733.91
2	2012	Haikou	-	-	621.92	4884	36	10	6122.89	252	100	39261	818.76
2	2013	Haikou	-	-	788.85	4372	31	10	7421.39	336	116.82	45890	904.6
2	2014	Haikou	-	-	924.65	6858	51	15	7581	319	134.82	49943	1091.7
2	2015	Haikou	-	-	668.42	6858	51	15	8209.9	344	127.5	52534	1161.96
2	2016	Haikou	-	-	620.06	8217	60	25	8866.93	283	140.18	56314	1257.67
2	2017	Haikou	-	-	402.17	9385	68	33	10112.8	325	163.6	61589	1390.58
2	2018	Haikou	-	-	442.37	9676	69	34	10764.9	353	197.26	66042	1510.51
2	2019	Haikou	-	-	1209.73	9676	69	34	11197.6	368	197.26	72218	1672
2	2020	Haikou	-	-	1444.46	9676	69	34	10466.6	479	197.06	63309	1791.58
3	2011	Sanya	-	-	0.09	715	-	-	143.4	0	0	40182	286.4
3	2012	Sanya	-	-	0.09	-	-	-	152.2	0	0	42561	330.96
3	2013	Sanya	-	-	0.09	-	-	-	143	0	0	45650	373.2

3	2014	Sanya	-	-	0.09	-	-	-	153.6	0	0	48447	402.3
3	2015	Sanya	-	-	0.07	-	-	-	327.4	0	0	51421	435.8
3	2016	Sanya	-	-	0.09	-	-	-	516.6	0	0	55770	475.56
3	2017	Sanya	-	-	0.09	-	-	-	582.8	0	0	59657	529.8
3	2018	Sanya	-	-	0.09	-	-	-	114.9	0	0	65841	622.27
3	2019	Sanya	-	-	0.09	2802	13	4	114.6	0	0	69624	678
3	2020	Sanya	-	-	0.09	2768	13	4	134	0	0	68656	695.41
4	2011	Danzhou	-	-	707.57	5197	29	14	3101	1513	31.2	18559	164.1
4	2012	Danzhou	-	-	807.08	5197	29	14	3225	1683	37	20297	181.37
4	2013	Danzhou	-	-	468.15	6273	33	18	2880	1641	25.18	22256	200.89
4	2014	Danzhou	-	-	569.35	6281	32	19	3525	1855	27.18	24011	215.16
4	2015	Danzhou	-	-	422.58	7955	39	23	3901	2262	26.5	26739	237.66
4	2016	Danzhou	-	-	352.94	8737	42	26	4058	2433	24.82	28937	258.95
4	2017	Danzhou	-	-	367.83	8676	42	26	4285	2585	30	32232	287.62
4	2018	Danzhou	-	-	331.63	8676	42	26	4206	2443	70.74	35569	322.97
4	2019	Danzhou	-	-	380.73	9370	42	30	5015	2677	74	39065	357.64
4	2020	Danzhou	-	-	2183.48	9447	43	30	5664	2992	102.94	41003	359.41
5	2011	Wenchang	-	-	0.01	-	-	-	54	0	0	25226	143.73
5	2012	Wenchang	-	-	0.01	-	-	-	13	0	0	27454	148.53
5	2013	Wenchang	-	-	0.01	-	-	-	-	0	0	28825	157.05
5	2014	Wenchang	-	-	0.01	-	-	-	98	0	0	29108	159.8
5	2015	Wenchang	-	-	0.01	-	-	-	82	0	0	30685	177.1
5	2016	Wenchang	-	-	0.01	-	-	-	269	0	0	33560	186.85
5	2017	Wenchang	-	-	0.01	-	-	-	619	0	0	36707	206.75
5	2018	Wenchang	-	-	0.01	-	-	-	596	0	0	40823	236.71
5	2019	Wenchang	-	-	0.01	848	5	0	672	0	0	44928	255.25
5	2020	Wenchang	-	-	0.01	848	5	0	727	0	0	46770	263.5
6	2011	Dongfang	-	-	0.01	1754	10	8	997	200	0	21753	89.11

6	2012	Dongfang	-	-	0.01	1754	10	8	1068	271	0	28291	109.61
6	2013	Dongfang	-	-	0.01	2154	12	9	1685	393	0	28958	119.58
6	2014	Dongfang	-	-	0.01	2154	12	9	1400	417	0	32360	134.5
6	2015	Dongfang	-	-	0.01	2053	10	9	1767	357	0	34546	155.35
6	2016	Dongfang	-	-	0.01	2488	12	9	1516	339	0	35195	149.82
6	2017	Dongfang	-	-	0.01	2488	12	9	1605	339	0	37014	157.76
6	2018	Dongfang	-	-	0.01	2488	12	9	1396	348	0	41572	184.44
6	2019	Dongfang	-	-	0.01	2488	12	9	1507	411	0	44684	192.96
6	2020	Dongfang	-	-	0.01	2488	12	9	1501	350	0	41826	186.5

Source:

1. China Logistics Yearbook, 2015-2020 Development of Logistics Industry in Hainan Province
2. 2021 Hainan Province modern logistics industry operation information - Hainan Provincial Development and Reform Commission
3. Hainan Provincial Department of Transport
4. China Statistical Abstract
5. Hainan Yearbook
6. China Transport Yearbook

Appendix B Stata Codes and Commands

```
clear all
set more off

use data.dta,clear
destring a1 a2 a3 b1 b2 b3 m1 m2 m3 m4 m5 y1 y2,replace force
encode pro,gen(id)
xtset id year

tab year,gen(YEAR)
keep year pro id a3 b3 m1 m2 y1 y2
** Descriptive Statistics **
asdoc sum a3 b3 m1 m2 y1 y2

** Correlation coefficient matrix **
pwcorr_a a3 b3 m1 m2 y1 y2 ,star1(.01)star5(.05)star10(.10)
logout,save(Correlation coefficient matrix)excel replace:pwcorr_a a3 b3 m1 m2 y1
y2 ,star1(.01)star5(.05)star10(.10)

** Heteroskedasticity test **
qui xtreg y1 b3 ,fe
xttest3

** Baseline regression **
xtscc y1 a3
outreg2 using Regression results 1.doc,replace bdec(3)sdec(2)addstat(F,`e(F)')

xtscc m2 a3
outreg2 using Regression results 1.doc,append bdec(3)sdec(2)addstat(F,`e(F)')

xtscc y1 m2 a3
outreg2 using Regression results 1.doc,append bdec(3)sdec(2)addstat(F,`e(F)')

xtscc y1 b3
outreg2 using Regression results 2.doc,replace bdec(3)sdec(2)addstat(F,`e(F)')

xtscc m1 b3
outreg2 using Regression results 2.doc,append bdec(3)sdec(2)addstat(F,`e(F)')

xtscc y1 m1 b3
outreg2 using Regression results 2.doc,append bdec(3)sdec(2)addstat(F,`e(F)')

xtscc m1 a3
outreg2 using Regression results 3.doc,replace bdec(3)sdec(2)addstat(F,`e(F)')

xtscc b3 a3
outreg2 using Regression results 3.doc,append bdec(3)sdec(2)addstat(F,`e(F)')
```

```
xtscc m1 b3 a3  
outreg2 using Regression results 3.doc,append bdec(3)sdec(2)addstat(F,'e(F)')
```

```
** Robustness tests **
```

```
xtscc y2 a3  
outreg2 using Robustness tests 1.doc,replace bdec(3)sdec(2)addstat(F,'e(F)')
```

```
xtscc m2 a3  
outreg2 using Robustness tests 1.doc,append bdec(3)sdec(2)addstat(F,'e(F)')
```

```
xtscc y2 m2 a3  
outreg2 using Robustness tests 1.doc,append bdec(3)sdec(2)addstat(F,'e(F)')
```

```
xtscc y2 b3  
outreg2 using Robustness tests 2.doc,replace bdec(3)sdec(2)addstat(F,'e(F)')
```

```
xtscc m1 b3  
outreg2 using Robustness tests 2.doc,append bdec(3)sdec(2)addstat(F,'e(F)')
```

```
xtscc y2 m1 b3  
outreg2 using Robustness tests 2.doc,append bdec(3)sdec(2)addstat(F,'e(F)')
```