ECONOMIC ANALYSIS OF LOCATION BEHAVIOUR FOR MARITIME SERVICE CLUSTER

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Economic Analysis of Location Behaviour for Maritime Service Cluster

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CERTIFICATE OF ORIGINALITY

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Abstract

Maritime service clusters benefit both business operations and the national economy. They have a long history, and have contributed significantly to both global and regional economic development, but only in recent decades has their research gained much attention. Recently, the shifting of maritime commercial centers from Europe to Asia has triggered the movement of maritime service businesses. As such businesses are globalized and footless, their location behavior has become a hot topic for researchers in many historical maritime countries, as well as emerging ones. Against this background, the following questions arise: What is the current situation with regard to studies of maritime clusters, especially maritime service clusters? What factors affect the formation of a maritime service cluster, and how do these factors in particular affect their development? What is the evolution pattern of maritime service clusters? To answer these questions, we have conducted three studies examining the location behavior for high-level maritime service clustering.

Firstly, a review study on current research into maritime clusters was conducted. We find that most of the researches into maritime clusters are similar to the studies of general industry clusters, with little consideration given to the unique nature of the shipping industry. This study analyses the key elements in maritime cluster studies over the past 20 years, including conceptual development, categories of maritime clusters, research methods, factors for clustering, studies on specific clusters, and the relationships among maritime businesses. From the study we find that research into maritime service clustering is lacking. Misunderstandings about the relationship

between the International Maritime Center and maritime clusters are also clarified. Such analysis allows us to identify possible problems in the current studies and to point out any insufficiencies so as to meet the needs of maritime cluster development.

Secondly, we utilized an empirical study to analyze important factors affecting the location selection decisions of maritime service businesses. Stated preference approaches and discrete choice models are utilized to analyze the contribution of factors to the preference of three alternative locations (Shanghai, Singapore and Hong Kong), taking into account the impact of the specific nature of the surveyed firm and current location. The results show that increasing government support in Hong Kong will have greater effect on improving its attractiveness to maritime business sectors than that in Singapore and Shanghai. Improving the business legal environment in Shanghai can increase its attractiveness more than that in Singapore and Hong Kong. Also, we find that firms in places other than Shanghai, Singapore and Hong Kong prefer to move into Shanghai, whereas firms in Hong Kong retain high loyalty to their own location. Finally, considering the trade-offs in policy alternatives, the possible ways for Hong Kong and Shanghai to increase their attractiveness is also provided. The findings of this research identify new directions for setting up public policies and corresponding measures for developing maritime service clusters in these three places.

Thirdly, a theoretical model was built to investigate how maritime service clusters develop and evolve under competition. The evolutionary cluster model consists of two parts: short-run equilibrium and long-term development. To model short-run equilibrium, two maritime service clusters compete for clients, based on Hotelling's model. To study long-term development, maritime service firms enter and exit clusters

according to their profits. Cluster effect is considered in the model. The short-term optimal condition of the model is identified, and long-term evolution of the maritime service cluster is discussed based on the simulation results. The study investigated maritime service clusters from the angle of competition. The forecast on the ultimate development of clusters provides policy makers with a reference for developing local maritime service clusters.

Key words: maritime service cluster; discrete choice models; policy trade-off; cluster competition; cluster evolution

Publications arising from the thesis

Academic journal papers:

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Chapter 1. Introduction

This chapter provides the background of this thesis work. The global maritime activity pattern is introduced first, followed by an introduction to the maritime service cluster. Then we raise three research questions. Finally, we present the structure of the thesis.

1.1 Background of the thesis work

Taking an overall view of the development history of all the famous maritime clusters, such as Hamburg, Hong Kong, New York, Piraeus, Rotterdam, Singapore, Shanghai, Oslo and London, most maritime clusters begin first with active trade, then industrial and port production in the early stage, which then evolves alongside the functions of the port into political and economic activities and finally globalization. When port production diminishes, the development of maritime service clusters becomes the target for many port cities, as seen in London and Hong Kong. The businesses in a maritime service cluster generally includes services such as ship financing and insurance, legal services, ship-brokering, chartering, and maritime education. The development of these businesses does not therefore largely depend on the concentration of cargo flow. This indicates that a maritime service cluster will not decline like a traditional maritime cluster. Rather, it can serve both regional and national maritime industries for much longer time. Therefore, a maritime service cluster is believed to be more sustainable than a traditional maritime cluster that is based on port throughput (Ma, 2011).

With this sustainable feature of maritime service clusters, many regions are being motivated to develop its maritime service industry. As the center of world economic activities moves to Asia, the concentration of cargo flow is also moving to Asia, and many ports in China have developed rapidly in recent years. As shown in Table 1-1, in 1980 and 1990, there was no Chinese port listed in the top 10. However, in 2019, seven Chinese ports are listed, with six of them being in Mainland China. Singapore used to top the list in 1990 but has dropped to second in recent years. Hong Kong port faces an even more severe decline from No.1 in 2000 to No.8 in 2019. Shanghai, on the other hand, developed step by step to reach the top in 2010, and has remained at the top in recent years. Seeing the benefits of developing a maritime service industry, regions like Shanghai, Hong Kong and Singapore all plan to develop their own maritime service cluster, triggering strong competition among these regions.

Table 1-1. Top 10 global container port rankings over the last four decades

Rank	1980	1990	2000	2010	2019
1	New York/New Jersey (U.S.)	Singapore (Singapore)	Hong Kong (China)	Shanghai (China)	Shanghai (China)
2	Rotterdam (Netherlands)	Hong Kong (Hong Kong)	Singapore (Singapore)	Singapore (Singapore)	Singapore (Singapore)
3	Hong Kong (Hong Kong)	Rotterdam (Netherlands)	Busan (South Korea)	Hong Kong (China)	Ningbo-Zhoushan (China)
4	Kobe (Japan)	Kaohsiung (Taiwan)	Kaohsiung (Taiwan)	Shenzhen (China)	Shenzhen (China)
5	Kaohsiung (Taiwan)	Kobe (Japan)	Rotterdam (Netherlands)	Busan (South Korea)	Guangzhou (China)

6	Singapore (Singapore)	Busan (South Korea)	Shanghai (China)	Ningbo-Zhoushan (China)	Busan (South Korea)
7	San Juan (Puerto Rico)	Los Angeles (U.S.)	Los Angeles (U.S.)	Guangzhou (China)	Qingdao (China)
8	Long Beach (U.S.)	Hamburg (Germany)	Long Beach (U.S.)	Qingdao (China)	Hong Kong (China)
9	Hamburg (Germany)	New York/New Jersey (U.S.)	Hamburg (Germany)	Dubai (U.A.E.)	Tianjin (China)
10	Oakland (U.S.)	Keelung (Taiwan)	Antwerp (Belgium)	Rotterdam (Netherlands)	Rotterdam (Netherlands)

Source: Gunnar K Sletmo, Gavin Boyd, Pacific Service Enterprises and Pacific Cooperation; Bureau of Transportation Statistics, U.S. Department of Transportation; Ranking of Container Ports of the World, Port and Maritime Statistics, Marine Department, HKSAR

However, the development of a maritime service cluster is not the same as that of a traditional maritime cluster, which focuses on cargo flow. The businesses engaged in maritime services can be footless and globalized, and the firms inside clusters operate differently compared to traditional maritime businesses. Maritime service providers are the critical components of a cluster, and their location behavior is the key determinant for the development of a maritime service cluster. Like many other businesses, maritime service businesses select a business location in the place that provides them highest utility. Such places are always equipped with particular environments, ones characterized by conditions such as a different tax policy, government policy, financial system, or legal environment, as well as existing maritime activities in the area. At the same time, the maritime service cluster itself also needs to evolve under a competitive environment in order to reach further development. We would like to ascertain which factors affect the location behavior of maritime service businesses and, furthermore, we would like to know how maritime service clusters evolve and develop under competition, which leads us to our research questions (see section 1.3).

1.2 Concept of a maritime service cluster

A maritime service cluster normally refers to a geographical concentration of maritime service businesses. Although the establishment of a maritime service cluster is an important strategic plan for many regions, a precise understanding of "maritime service" has not been clarified. Generally, maritime service refers to high value-added services provided especially for traditional maritime businesses. This notion has been further explained by a number of scholars from different aspects (Ren and Song, 2009; Wang and Ning, 2010). We here summarize three features of the business of maritime service.

1) **Maritime services do not directly rely on ports and a high level of cargo concentration.** According to Jacobs, Koster, and Hall (2011a), the development of maritime services rests on a network of advanced producer services (APS) such as financial services, insurance services, and consultancies — that is, of a city, but not necessarily of a port.

2) **Maritime service industry provides high value-added services.** With higher quality requirements, the services provided by the maritime service industry are often more flexible and need more interaction between service provider and clients. The process of providing services involves more professional skills and experience.

3) **Maritime service providers are largely equipped with more expertise** (Ren

and Song, 2009). Some service providers in the maritime service industry, such as in legal services and shipping finance, are experts in the use of technology and information, with knowledge and professionalism equipped together in one. They are well trained experts with years of experience in the maritime industry.

Based on the nature of maritime service businesses, six sectors with 11 subsectors are included according to the literature review and maritime experts' discussion results (see Table 1-2).

Table 1-2. Components of a Maritime Service Cluster

1. Shipping	(1) Ship Management
	(2) Ship Brokerage *(Sales & Chartering)*
2. Governance & Regulation	(1) Government Agency
	(2) Ship Registration
3. Intermediate Services	(1) Marine Insurance *(Hull & Cargo Insurance, P&I, Insurance Broker)*
	(2) Ship Finance
	(3) Legal Services *(Maritime Law, Court, Arbitration, Law Firm)*
4. Supporting Services	(1) Education
	(2) Maritime Related R&D
5. Classification Society	
6. Industry Association *(e.g. Shipowner Association, Seamen's Union, etc.)*	

1.3 Research questions and contributions

Given the background above, our research questions are threefold.

Question 1: The object of our study is the maritime service cluster. What is the current state of research and study progress on this topic? To understand the maritime service cluster, we first need to know what a maritime cluster actually is, and what the role is of a maritime service business in a maritime cluster. We also want to know what research methods have been applied in maritime industry cluster studies. After a comprehensive review of maritime cluster studies, we are then able to ascertain the research gaps in maritime service studies and narrow down our own study direction.

To solve this problem, a comprehensive review of current studies of maritime clusters was conducted. We reviewed a total of 57 published articles to study the key elements of maritime cluster studies, including definition, components, research method applied, determinants of clustering, studies on specific maritime clusters, and the relationships among players in cluster. The misunderstanding between International Maritime Center and maritime clusters are also clarified in this study. The findings of this review will help us to identify potential study topics in this field and to also point out deficiencies in catering for maritime cluster development.

Question 2: What factors affect the location behavior of maritime service businesses? To answer this question, we need to focus on the location behavior of firms inside a maritime service cluster. The location decision of a maritime service business is subject to numerous factors, so understanding the impact of such factors on the relocation decision is crucial for policy makers when developing maritime clusters.

To accomplish this aim, an empirical study was conducted. We analyzed a location choice model derived specifically for maritime service businesses. The data used for model estimation were collected from a stated preference survey completed by specialists in the senior management level of a range of different maritime service firms. The result of the model suggests that, in addition to the internal factors of the firm itself, the surrounding environment also plays an important role in the firm's location decision. The findings of this research provide some useful insights in terms of the strategies needed to attract different kinds of maritime service firms into a cluster within the region of Asia.

Question 3: How do maritime service clusters develop and evolve under competition？

From a cluster's point of view, its development is a long-term dynamic process. The development process should be modeled within a market mechanism. Besides the business environmental factors and internal factors we identified in the second study, firms inside a cluster also need to consider the cost and benefit relationship. Competition among clusters should also be considered.

Thus, we build a theoretical model to investigate the competition between two maritime service clusters and the growth of the clusters under competition. In the short-term equilibrium, the optimal condition of the model is identified based on the Hotelling model. In the long-term development, maritime service firms enter and exit clusters according to their profits. By using simulation, we also examined the long-term evolution determinants of a maritime service cluster. The study investigated maritime service clusters from the angle of competition, which makes the results of the study for this thesis more comprehensive.

1.4 Structure of the thesis

This thesis consists of five chapters. Chapter 1 introduces the background to the thesis, basic knowledge about maritime service clusters, and the research questions and contributions, together with the structure of the thesis. Chapter 2 analyzes current studies on maritime clusters by reviewing past papers. Chapter 3 investigates major factors affecting the location of maritime service businesses by using an empirical study. In chapter 4, a theoretical study on cluster competition and evolution is conducted. Chapter 5 concludes this thesis and points out limitations in the study, as well as suggestions for future study. The structure of this thesis work is shown in Figure 1-1.

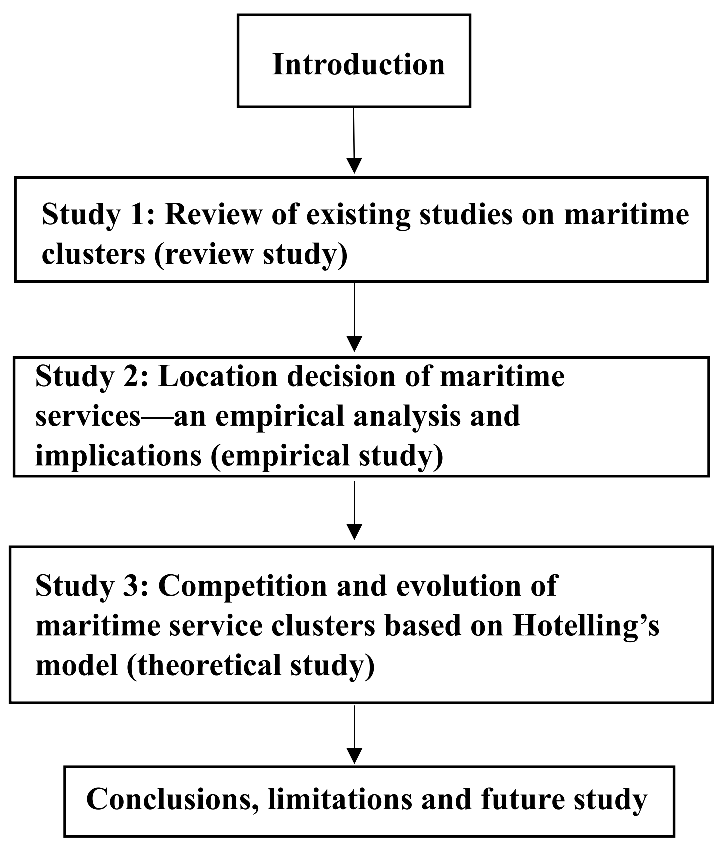


Figure 1-1. Structure of thesis work

Chapter 2. Review of existing studies on maritime clusters

2.1 Introduction

Maritime clusters are very important for both business operations and the national economy. From the perspective of business operations, companies can enhance their competitiveness by joining a maritime cluster, in which they can enjoy a skilled labor pool, share information, and have a closer relationship with clients. A comprehensive maritime cluster is an ecosystem in itself, one in which maritime-related companies and institutions can grow, develop and benefit each other. For example, in the Netherlands, many important suppliers are in the same maritime cluster, and over half of the firms' expenditure is spent within the maritime cluster (de Langen, 2002). It is also found that nearly 40% of business knowledge comes from actors inside a maritime cluster, which indicates that knowledge spillover exists within a maritime cluster (de Langen, 2002). Important suppliers pool and share expenditure inside the cluster, and knowledge spillover shows that benefits exist inside a maritime cluster that are vital for business operation.

From the perspective of the national economy, maritime clusters play a vital role in both regional and domestic economies. Many countries treat the development of a maritime cluster as an important strategy for regional development. Taking the Netherlands as an example, in 2017 the total production value of the Dutch maritime cluster was around €55.1 billion, and the total value added amounted to about €22.8 billion. About 3.1% of the total GDP of the Netherlands was supported by the maritime cluster in 2017, and 3.3% in 2016. The maritime sector also provided 260,000 jobs, which accounted for 2.85% of total employment in the Netherlands (Maritime by Holland, 2018). Also, as a traditional maritime country, UK maritime clusters contribute significantly to its national economy. In 2017, the maritime sector generated about £17 billion in Gross Value Added (GVA) and supported about 220,100 jobs for UK employees. The sector also contributed £5.3 billion in tax revenues, which represented 0.7% of total tax revenues. In terms of exported goods and services, the UK maritime sector accounted for 2% of total exports (Maritime UK, 2019). In addition, with a developed maritime cluster, Hong Kong is regarded as an international shipping center in the Asia-Pacific area, the maritime industry being one of the pillar industries in Hong Kong. In 2016, the maritime and port industry generated about HK$ 28.3 million towards the GDP, which is 1.2% of the total GDP, and provided 85,720 persons with employment, which accounted for 2.3% of the total employment in Hong Kong (THB, 2018). These examples highlight the significant contribution that maritime clusters make to national economies. As Shinohara (2010) pointed out, a maritime cluster has a "ripple" effect. Indeed, maritime clusters can contribute to the local economy, increase employment, and benefit both upstream and downstream industries, such as manufacturing and export-oriented businesses in coastal countries (de Langen, 2002). For many countries and regions, developing a maritime cluster not only has strategic importance for the regional economy and logistic development, but also for national economic development.

Important as they are, though, maritime clusters did not gain sufficient attention from the academic society until two decades ago, when the world commercial center shifted to Asia, even though shipping has a more than 5000-year history. This study aims to review the existing studies on maritime clusters and analyze their key elements, including conceptual development, industry sectors included, research methods, factors affecting clustering, studies of specific clusters, and the various maritime service businesses and their relationships. Although there have been a few reviews on maritime clusters, each has different perspectives. For example, Doloreux (2017)'s review emphasizes on the definition of maritime cluster. Koliousis, Papadimitriou, Riza, Stavroulakis, and Tsioumas (2019) analyzed the correlation between strategic management and academic impact in a review of existing studies. Shi, Jiang, Li, and Xu (2020) also summarized the existing studies using "what-why-how" logic, following the traditional method used by Maskell and Kebir (2006) in the conceptual analysis of a general industry cluster. In addition to the difference in perspectives, our analysis helps to identify possible issues in the current studies, as well as deficiencies that exist for meeting the needs of maritime cluster development.

Most of the current studies about maritime clusters are very general and largely similar to those of general industry clusters, not only in their definition, but also with regard to the clustering factors and research methods. The unique natures of maritime businesses, such as shipping companies being footless (they often relocate to find the best business environment) and maritime service companies being global (they serve global customers), have not therefore been fully considered. The relationship between different business sectors in the shipping industry and their contributions to a specific cluster, are also not well studied. In addition, there are misunderstandings over the differences between an International Maritime Center (IMC) and a maritime cluster. Further research is thus required to consider these specific features, so that support is given to both business clustering decisions and to public policies on maritime industry development.

This study first presents a brief review of maritime cluster studies over the past 20 years, using 57 papers written in English and published in peer-reviewed international journals. Then six key elements of maritime cluster studies are analyzed, including their conceptual development, industry sectors included, research methods, clustering factors, studies of specific clusters, and the relationships among various maritime businesses. This is followed by a clarification of the conceptual differences between an IMC and a maritime cluster. Finally, we present the summary and conclusion.

2.2 Description of existing research

To understand current developments in the study of maritime clusters, a systematic method is used to collect the publications on this topic from many databases, including ProQuest (about.proquest.com), ScienceDirect (www.sciencedirect.com), Dialnet (dialnet.unirioja.es), Taylor & Francis (www.tandfonline.com), and Sage Premier (journals.sagepub.com). These databases cover most of the journals involved in maritime cluster study, which ranges from business and economics to geography and regional science. The keywords used for searching are “maritime cluster”, “shipping cluster” and “maritime agglomeration”. The publication period is set from 1890 to 2020, since the study of industry clusters began in the 1890s. However, the first published study on maritime clusters as a specific branch of general industry clusters only appeared in 1999. A total of 56 papers are collected from 27 peer-reviewed international journals in the English language. Among them, 13 are Science Citation Index (SCI)/Social Science Citation Index (SSCI) indexed (see Table 2-1). Marine Policy and Maritime Policy & Management are the two main journals that have published most of the articles on this subject. The number of publications from 1999 to 2019 is shown in Table 2-2.

Table 2-1. Journals and number of publications in maritime cluster studies

Marine Policy (12)	Canadian Journal of Regional Science (1)
Business History Review (1)	Entrepreneurship & Regional Development (1)
European Planning Studies (1)	International Journal of e-Navigation and Maritime Economy (1)
Geoforum (1)	International Journal of Maritime History (2)
Journal of Transport Geography (1)	International Journal of Transport Management (1)
Maritime Economics & Logistics (1)	International Studies of Management & Organization (1)
Maritime Policy & Management (9)	Journal of East-West Business (1)
Sustainability (1)	Journal of Maritime Research (3)
Transportation Research Part A (3)	Ocean & Coastal Management (3)
Urban Studies (1)	Procedia-Social and Behavioral Sciences (2)
Research in Transportation Business & Management (1)	Revista de Estudios Regionales (1)
Technovation (1)	The Journal of Maritime Business (1)
Transport Policy (1)	Urban, Planning and Transport Research (1)
	WMU Journal of Maritime Affairs (1)
	Transportation research procedia (1)
	Transport Systems and Processes: Marine Navigation and Safety of Sea Transportation (1)
	Procedia Economics and Finance (1)

Table 2-2. Number of publications on maritime clusters from 1999

Year	Number	Year	Number
1999	1	2010	2
2000	1	2011	4
2001	0	2012	2
2002	1	2013	7
2003	2	2014	9
2004	0	2015	3
2005	3	2016	8
2006	2	2017	5
2007	0	2018	2
2008	1	2019	2
2009	1	2020	1

In addition to journal publications, some conference papers and reports from international conferences and related consulting companies are included. A total of 63 published articles and reports from the past two decades are collected. Many papers on maritime clusters have also been published in Chinese, due to the fast growth of the Chinese maritime industry over the past 5 years. Some are very inspiring, but due to the language problem have not been included in this study.

Although journal papers on maritime clusters first appeared fairly recently in 1999, maritime clusters actually appeared much earlier in history. The use of steamships in cargo trade in the late 18th century marked the start of the era of the modern shipping industry and stimulated modern trade and rapid industry development throughout the 19th century. Maritime clusters had already appeared in many regions at that time, such as in London and Rotterdam.

Finally, we find that researches into maritime clusters are often motivated by government policy. Table 2-3 shows the first appearance of “maritime cluster” in the government policy of different regions. However, there is always a lag between the publication of government policy and industry development. For example, the EU's global maritime strategy "Maritime Policy Green Paper" in 2006 encourages private maritime sectors to reorganize and *form into networks of maritime excellence, or "clusters"* to achieve long-term development ("Maritime Policy Green Paper," 2006). This strategy was later adopted by many member countries to enhance maritime clusters, which then attracted researchers. This largely explains the recent surge in maritime cluster studies (Shinohara, 2010; Ortega, Nogueira, and Pinto, 2014; Doloreux, Shearmur, and Figueiredo, 2016; Flitsch, Herz, Wolff, and Baird, 2014), which is the result of a top-down approach in economic planning (Flitsch et al., 2014).

Table 2-3. Maritime cluster policies

Country/ Region	First proposal of maritime cluster	Document	Note	Reference
Japan	2000	Ministry of Transport of Japan	The ministry named the Japanese cluster 'Maritime Japan'.	Shinohara, 2010
Portugal	2007	ALGARVE 21 – Regional Operational Programme for 2007-2013		Ortega; Nogueira; Pinto; 2014
Québec	2015	Québec's Maritime Strategy	Major policy initiatives have cluster component	Doloreux; Shearmur; Figueiredo; 2016
Europe	2006	Green Book on Maritime Europe	"European Network of Maritime Clusters" was launched in 2005	"Maritime Policy Green Paper", 2006
North Sea region	2012	Maritime Transport and Future Policies – Perspectives from the North Sea Region		Flitsch; Herz; Wolff; Baird; 2014
Panama	2006	Intracorp and Asesores Estratégicos, 2006		Pagano, Wang, Sánchez, Ungo, & Tapiero, 2016

2.3 Key elements in maritime cluster studies

In this section, we analyze the key elements involved in the research of maritime clusters, namely: What are maritime clusters? What industry sectors are included in a maritime cluster? What methods are used in existing studies? What are the determinants of a maritime cluster? What studies have been made of specific clusters? What are the relationships between players inside a cluster? As a maritime cluster is a specific industry cluster, we study it by comparing it with studies of general industry clusters, thereby hoping to identify research gaps in the specific research on maritime clusters.

2.3.1 The general concept of a maritime cluster

Maritime clusters have a long history, although who used the term first is not known, due to the lack of a written record. It first appeared in de Langen (2002) referring to the performance of the Dutch maritime cluster. Brett and Roe (2010) defined it as a selection of industries that are usually located at, or originally centered on, the trading activities of a port. This specifies the importance of a port in order to start a maritime cluster. However, such maritime clusters are heavily reliant on physical cargo movement, whereas maritime service clusters are not. Thus, a new concept is required.

Chang (2011) defined a maritime cluster as a network of firm, research, development and innovation units and training organizations which cooperate with the aim of technology innovation and of increasing maritime industry's performance. This included the many entities in a maritime cluster, which gave to the word cluster an 'aim' on innovation. It does not require a port, which provides some flexibility.

Doloreux et al (2016) formulated the definition of a maritime cluster as a geographic concentration of firms in maritime sectors, of research and education organizations which are active in related fields, and of public support mechanisms operated by the government and regional stakeholders. Like Porter's, this definition focuses on the geographical agglomeration. Doloreux (2017) further described it from three aspects: as an industrial complex, as an agglomeration, and as a community-based network, this being based on the concept of a general industry cluster. However, the unique nature of maritime clusters, such as the global nature of the world shipping usiness, is not reflected here. A new concept of “supercluster” was then proposed by Doloreux and Shearmur (2018), focusing on the complete value-chain of the maritime industry and encouraging cross sector collaboration. However, the difference between maritime cluster and “supercluster” is not made clear in their paper.

In short, although many studies have discussed the concept of maritime clusters, their definition is still evolving. The consensus is that it is a concentration of maritime-related firms and organizations, with innovation and knowledge spillovers, and possibly involves government policy. However, the unique nature of a maritime cluster has not yet been considered. For traditional maritime clusters, the key player is shipping companies, not ports, although they are always developed around a port. Such clusters are not stable, as shipping companies are “footless”. However, maritime service clusters, although developed from traditional maritime clusters, are more likely located in the place with the best business environment. Therefore, it is necessary to distinguish the concept of these two types of maritime clusters, as they need different policies for cluster development.

2.3.2 Industry sectors within a maritime cluster

Many people use maritime clusters to refer to different industry sectors. In existing studies, the following industry sectors are included in maritime clusters, though each maritime cluster is made up very differently.

a) *Marine biological resources*: Industries such as fishery and aquaculture (Fernández-Macho, Murillas, Ansuategi, Escapa, Gallastegui, González, Prellezo, and Virto, 2015; Morrissey, 2014);

b) *Physical maritime transportation activity*: Port and shipping activities such as port logistics and liner shipping industries (Shinohara, 2010; Othman, Bruce, and Hamid, 2011; Makkonen, Inkinen, and Saarni, 2013);

c) *Maritime services*: Sectors that serve the transportation of goods, which can be divided into traditional maritime services (e.g. freight forwarder) and high-end maritime services (e.g. legal services and maritime education) (Morrissey and Cummins, 2016; Benito, Berger, De la Forest, and Shum, 2003);

d) *Maritime technologies:* Shipbuilding and ship repair (Shinohara, 2010; Salvador, Simões, and Soares, 2016; Pagano, Wang, Sánchez, Ungo, and Tapiero, 2016);

e) *Others:* Off-shore activity/navy/sea-related recreation/others (Shinohara, 2010).

Among all the papers and reports we reviewed, 23 papers and 3 reports have discussed at least one specific sector. Figure 2-1 presents the distribution on the number of papers in the above five sectors. The number of times a paper is counted depends on the number of sectors it includes.

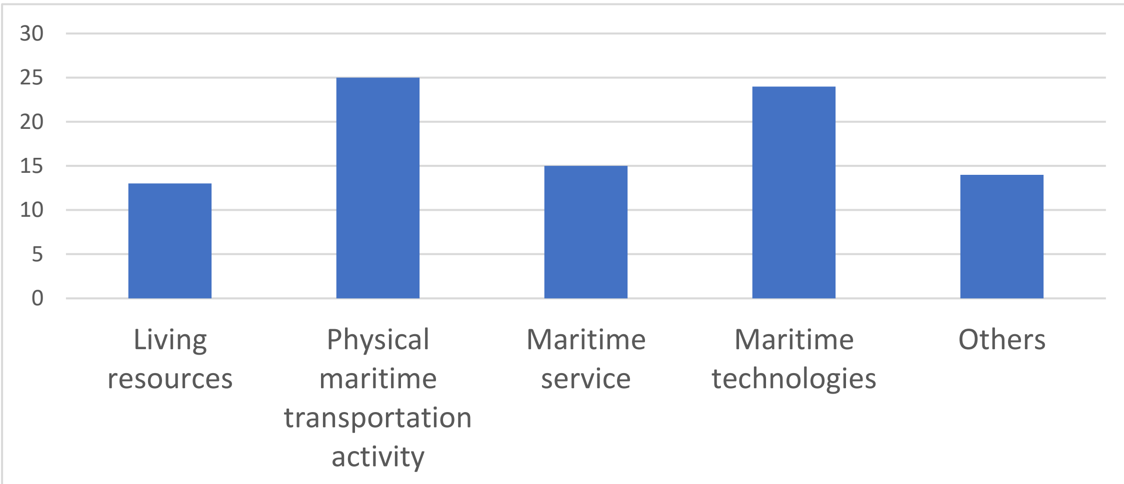


Figure 2-1. Number of publications in five sectors in maritime clusters

Among these five sectors, two have been studied by the highest number of publications: physical maritime transportation activity, and maritime technologies. These are the traditional sectors of the maritime industry and nearly all the port cities and historical maritime clusters have stemmed from them. The first and fifth industries are often not included within the maritime industry, because they are not related to the transportation of cargo.

It is worth noticing that the third sector, maritime service businesses, has the least number of publications. This sector is derived from and can be located away from the transport of cargo or ship operations, which is the major content in traditional maritime clusters. Recently, these have become a hot topic, as London and Hong Kong, famous for their traditional maritime clusters in the past, continue to develop their maritime industry in the service sector. From the empirical study by Jacobs, Koster, and Hall (2011b), the location of maritime services is largely determined by its clients, shipowners and port-related industry, but not necessarily by port throughput. Ghiara and Caminati (2017) also found that Advanced Maritime Producer Services (AMPS) would like to position its international office closer to their customers — global liner shipping companies. As maritime service clusters are new in the evolution of maritime clusters, and are also an important element for regional economic development, the popularity of maritime services will no doubt increase in future studies.

2.3.3 Research methods used in current literature

The methods used in existing studies can be divided into four phases, as shown in Table 2-4. In the early stage (1999-2003), the studies are mostly descriptive, based on survey and evaluation, and some qualitative studies using the Porter Diamond model (Benito et al., 2003). Later on (2004-2008), some new methods were adopted, including input-output analysis (Kwak, Yoo, and Chang, 2005), and comparative case study analysis (de Langen and Visser, 2005). Between 2009 and 2013, diversified research methods were applied, including not only the descriptive approach, but also quantitative modeling, data evaluation, and regression, etc. Some new approaches emerged during this stage, including social network analysis (Pinto and Cruz, 2012), the Delphi method (Brett and Roe, 2010) and SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis (Chang, 2011).

Table 2-4. Evolution of methods used in the study of maritime clusters

1999-2003	2004-2008	2009-2013	2014-2020
• Descriptive (3)	• Comparative case studies (2)	• Actor-network theory (1)	• Comparative analysis (2)

• Porter Diamond model (1) • Survey & evaluation (1)	• Computer assisted telephone interviews (1) • Descriptive (2) • Input-output analysis (1)	• Benchmark analysis (1) • Case study (1) • Comparative case studies (1) • Data evaluation (1) • Delphi Method (1) • Descriptive (3) • Empirical analysis (regression) (1) • Porter Diamond model (1) • Proposal (1) • Social network analysis (1) • Strength Indicator Model (1) • Survey & Descriptive statistics (1) • SWOT analysis (1) • Symbiosis theory and Lotka-Volterra model (1)	• Crosstab methodologies and/or Markov chains (1) • Data evaluation (1) • Delphi method & Analytic hierarchy process (1) • Descriptive (8) • EFA and CFA (1) • Empirical analysis (2) • Input-output analysis (3) • Interview (1) • Location quotients (1) • Logit model (1) • Lotka-Volterra model (1) • Marnet theoretical framework/agglomerative hierarchical clustering approach (1) • Qualitative research (1) • Review (2) • Scarcity theory (1) • Survey (1) • Typology (1)

During the last period (2014-2020), the studies are not only descriptive studies but are also quantitative and analytical studies. Many new methods, such as statistical evaluation, review study, logit model, Markov Chains and the agglomerative hierarchical clustering approach appeared in this period. Lee, Wan, Shi, and Li (2014) utilized an analytic hierarchy process (AHP) to identify and evaluate five major factors affecting the competitiveness of a country's maritime industry. Pinto, Cruz, and Combe (2015) used a logit model to study the important factors leading to cooperation among the maritime sectors. They found that innovation and absorptive capacity can help to promote cooperation. Stavroulakis and Papadimitriou (2017) formulated a model to evaluate the strategic management of maritime clusters and applied it on the case of the European maritime cluster. Zhang and Lam (2017) introduced symbiosis theory and the Lotka-Volterra model to study the inter-relationship among shipping sectors in a maritime cluster. Koliousis, Papadimitriou, Riza, Stavroulakis, and Tsioumas (2018) discussed the condition that allows maritime cluster development under limited resources. Recently, Djoumessi, Chen, and Cahoon (2019) utilized Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) to evaluate the factors affecting innovation in a maritime cluster. Factor analysis is seldom used in maritime cluster studies, but Djoumessi's try paved the way for future study.

Many papers in the latest period applied input-output (IO) analysis. Morrissey and Cummins (2016), Salvador (2016) and Pagano et al. (2016) studied intra-cluster linkages in the Irish maritime cluster, Portuguese Maritime Cluster and Panama's maritime cluster, respectively. Morrissey and Cummins (2016) investigated four pillar sectors of the Irish maritime cluster, namely: Shipping, logistics and transport; marine energy; maritime safety and security; and yachting products and services. They found that these four pillars have low correlation with each other, but they share similar inputs and outputs. Salvador et al. (2016) also found that the Portuguese maritime cluster has weak intra-cluster linkages. Pagano et al. (2016) revealed the low correlation of sectors in Panama's maritime cluster.

Examining the methods used in existing studies, one can hardly spot any special features aimed at maritime cluster analysis. For example, many applied Porter's theory in the study of maritime clusters, but this is more like analyzing competitiveness strategies rather than cluster theory. Just like the observation of Harrison (1992) that industrial agglomeration is just "old wine in new bottles", which means just taking existing cluster theories for granted, the research into maritime clusters also lacks innovation and just follows that used for general cluster study. Also, very few (Koliousis et al., 2018) conducted analytical modeling on the dynamics inside a cluster, how firms benefit from a cluster, how utility differs between a cluster and a non-cluster, and what really attracts firms to join a cluster. The most popular research method in this field is that of descriptive study, maybe due to the difficulties in obtaining firsthand quantitative data in this field. With regard to quantitative methods, only regression analysis and IO approaches have been applied.

2.3.4 Factors affecting the emergence and development of maritime clusters

As far as general industry clusters go, there have been extensive studies on the factors leading to their emergence and development. These factors can basically be divided into two main categories: intrinsic and extrinsic factors. Intrinsic factors, including natural resource endowment, are important for starting a cluster. Extrinsic factors, such as government policy, legal support, financial support, and economic conditions, can help the cluster grow. As one type of industrial cluster, maritime clusters are found to have similar driving forces for cluster formation and development (de Langen, 2002; Viederyte, 2016; Viederytė, 2014; Djoumessi et al., 2019). These factors are summarized in Table 2-5.

Many have also studied the intrinsic factors behind maritime clusters. Jacobs et al. (2011b) found that advanced maritime services must start with a port, whereas their growth may not actually depend on it. Similarly, Ghiara and Caminati (2017) found that being a port city is an intrinsic factor for a maritime cluster. Chang (2011) stated that a manufacturing industry is a prerequisite for port development, and hence a required condition for a maritime cluster. da Silva Monteiro, Neto, and Noronha (2014) described the major factors driving development of the Algarve maritime cluster, namely, its natural conditions, maritime history and culture.

As for extrinsic factors, Pinto and Cruz (2012) found that regional authorities and research institutions such as a university are the key to a local maritime cluster. Othman et al. (2011) find that competition, effective connections between sectors, and chance can affect the competitiveness of Malaysian maritime clusters. Viederyte (2016) found that innovation, skill transmission and bargaining power are critical for European maritime clusters. Zhang and Lam (2017) concluded that interplay and inter-influence among individual firms are essential for the development of maritime clusters. A report by British Maritime Technology (BMT, 2014) listed 11 potential factors supporting maritime clusters, with the factors directly affecting the shipping industry being the labor pool, professional services, tonnage owned within a cluster, the presence of regulatory bodies, and the physical proximity of shippers and charterers. Lee et al. (2014) identified factors that can enhance competitiveness of the maritime industry, including specialization and market share in shipping services, the number of shipping firms, competence, and quality of services. Stavroulakis and Papadimitriou (2016) concluded that factors such as agglomeration economies, domestic industry, and culture affect the competitiveness of a maritime cluster. Gailitis and Jansen (2011) analyzed the Latvian maritime cluster and concluded that geographical concentration, critical mass, and active business channels between stakeholders are very important for its development. Benito et al. (2003) discussed factors related to cluster conditions, such as strategy, structure and rivalry, demand conditions, suppliers and related industries, government, and chance.

Table 2-5. Factors for emergence and development of maritime clusters

	Factors
Intrinsic factors	near a port or manufacturing centers; natural conditions; maritime history, and culture.
Extrinsic factors	regional authorities and research institutions; competition, effective connections between sectors, and chance; innovation, skill transmission, and bargaining power; interplay and inter-influence among individual firms; labor pool, professional services, tonnage owned within a cluster, the presence of regulatory bodies, and physical proximity of shippers and charterers; specialization and market share in shipping service, the number of shipping firms, competence and quality of service; agglomeration economies, domestic industry, and culture; geographical concentration, critical mass, and active business channels; cluster conditions, strategy, structure and rivalry, demand conditions, suppliers and related industries, government, and chance.
Both	factor conditions; strategy, structure, and rivalry; demand conditions; suppliers, and related industries; government, and chance.

Three observations can be made on such studies about the factors for maritime clustering. Firstly, most of the factors are general, like those for general industry clusters, such as its location condition, innovation and culture. Very few factors are specific to the shipping industry. Secondly, although many have studied both the intrinsic and extrinsic factors, they have not studied the interactions among the different factors. For example, many have studied the contribution of preferential tax to a cluster's development. Is there a minimum market size for it to be effective? What is the substitution between the tax and the market size? Such studies could help a decision on the tax policy at different stages of a cluster's development. Thirdly, the combination of intrinsic and extrinsic factors may vary in different clusters. For example, for traditional maritime clusters, public policies on trade facilitation and logistics services are very important. However, for maritime service clusters, such as one specializing in ship financing, the financial services environment would be more important.

2.3.5 Studies of specific maritime clusters

A total of 56 published papers have studied 19 maritime clusters (Table 2-6). Most of them are focused on Europe, because European maritime clusters have been around for nearly 200 years, ever since the emergence of steamships. The papers are regional specific, as their purpose is to help formulate public policies on maritime industry development. Brett and Roe (2010) investigated the potential clustering of maritime sectors in the Greater Dublin Region, and found that actually the Greater Dublin maritime transport sector had already formed a maritime cluster instead of just a simple agglomeration of firms. Fernández-Macho et al. (2015) examined Spanish maritime clusters, and also found that maritime clusters are region specific. Doloreux et al. (2016) studied Québec’s maritime cluster and its impacts on the local economy. They concluded that the sectors covered inside Québec's cluster policies developed slower than those not covered. Viederytė (2014) evaluated the Lithuanian maritime cluster using the number of employees, turnover and added value in the maritime industry. The study identified the most competitive sectors and sub-sectors in the Lithuanian maritime cluster. Other researchers in maritime studies, such as Morrissey and Cummins (2016), Pagano et al. (2016), and Kwak et al. (2005) explored intra-cluster linkages in Irish maritime clusters, Portuguese maritime clusters, Panama’s maritime cluster and Korea’s maritime industry respectively.

Table 2-6. Studies on specific maritime clusters

	Maritime Cluster	Location	Number of papers	References
1	Dutch maritime cluster	Netherlands	2	Langen, 2002; Nijdam & de Langen, 2003
2	Japanese maritime cluster	Japan	1	Shinohara, 2010
3	Norwegian maritime cluster	Norway	4	Benito, Berger, De la Forest, & Shum, 2003; Karlsen, 2005; Fløysand, Jakobsen, & Bjarnar, 2012; Amdam & Bjarnar, 2015
4	Greek shipping industry	Greece	1	Grammenos & Choi, 1999
5	Malaysian maritime cluster	Malaysia	1	Othman, Bruce, & Hamid, 2011
6	English maritime cluster	United Kingdom	4	Chang, 2011; Morrissey, 2014; Stavroulakis, 2017; Zhang & Lam, 2017
7	Korean maritime cluster	Korea	1	Kwak, Yoo, & Chang, 2005
8	Canadian maritime cluster	Canada	4	Doloreux & Shearmur, 2006, 2009; Doloreux & Melançon, 2008; Doloreux, Shearmur, & Figueiredo, 2016
9	Spanish maritime cluster	Spain	2	Ortega, Nogueira, & Pinto, 2014; Fernández-Macho et al., 2015
10	Finnish maritime cluster	Finland	2	Makkonen, Inkinen, & Saarni, 2013; Laaksonen & Mäkinen, 2013
11	Portuguese maritime cluster	Portugal	5	Pinto & Cruz, 2012; da Silva Monteiro, Neto, & Noronha, 2014; Ortega et al., 2014; R Salvador, 2014; Regina Salvador, Simões, & Soares, 2016
12	Irish maritime cluster	Ireland	2	Brett & Roe, 2010; Morrissey & Cummins, 2016
13	Atlantic maritime cluster	Portugal, Spain, Ireland and Scotland	1	Pinto, Cruz, & Combe, 2015
14	Panama's maritime cluster	Panama	1	Pagano, Wang, Sánchez, Ungo, & Tapiero, 2016
15	Lower Mississippi port cluster	United States	1	De Langen & Visser, 2005
16	Hong Kong maritime cluster	Hong Kong S.A.R.	1	Zhang & Lam, 2017
17	Lithuanian maritime cluster	Lithuania	1	Viederytė, 2014
18	Australian maritime clusters	Australia	1	Djoumessi et al, 2019
19	Latvian Maritime cluster	Latvia	1	Gailitis & Jansen, 2011

As the world shipping center has only just, in recent decades, shifted to Asia, the number of papers focusing on Asia is small. Another possible reason is the research funding. Europe has many research programs granted for maritime study and even maritime cluster study, such as the North Sea Region Program 2014–2020, and the EU Strategy for Marine and Maritime Research (2008). The European Commission has also offered many funding opportunities to support maritime related researches. The number of papers shows an obvious increase after these programs. As one of the world famous maritime centers, the Hong Kong maritime cluster has had few appearances in an academic journal (Zhang and Lam, 2017). Hong Kong has no research funding targeted specifically at maritime studies, only a General Research Fund (GRF). The percentage of GRF grants awarded to shipping-related projects in 2013 was 0.08%, in 2014 it was 0.19%, in 2015 it was none, in 2016 it was 0.05% and in 2017 it was 0.09% (University Grants Committee, 2017). The funding support for Hong Kong maritime research neither matches its status as a maritime center in Asia, nor is it comparable with the government funding for maritime research in other maritime centers, such as Singapore.

2.3.6 Maritime service businesses and their relationships

As discussed in section 2.3.2, existing studies on maritime clusters are focused on traditional sectors such as ports, shipping activities and shipbuilding, with little attention being paid by academics to maritime service sectors. However, clustering of maritime services has been around for years in many historical port cities, and has now become a hot topic in the maritime industry. The development of traditional maritime clusters depends on cargo flow. Maritime service clusters, however, are relatively independent of port throughput (Jacobs, Koster, & Hall, 2011). For example, even though London does not have a large port throughput, its high-end maritime services, such as shipping finance and law, still make it the leading international maritime capital

(Shi et al., 2020). Therefore, developing maritime service clusters has become an aim of many port cities, including Hong Kong, even though their port throughputs may be declining.

To help with understanding the business components of maritime service clusters, this section summarizes the service-customer relationships within the shipping industry (Figure 2-2), which is centered on shipowners—the key player in the shipping industry. All other businesses serve shipowners, either directly or indirectly, as marked by the lines with arrows pointing to the customers being served. The direct service providers are shipbuilders, ship financers (Grammenos and Choi, 1999), shipbrokers, ship operators, ship management companies, and ship insurance brokers, as marked with purple arrows in Figure 2-2. In the past, they used to be located close to shipowners. Now, due to the developments in transportation and telecommunication facilities, where they are located is no longer a problem (Shi et al., 2020). For example, ship operators and ship financing banks, no matter where they are, can all serve the Greek shipowners. Because of this, service providers will now grow in a place with the best business environment for their development. For example, ship financing businesses will likely thrive in a global financial center, such as London or Hong Kong (Jacobs et al., 2011b).

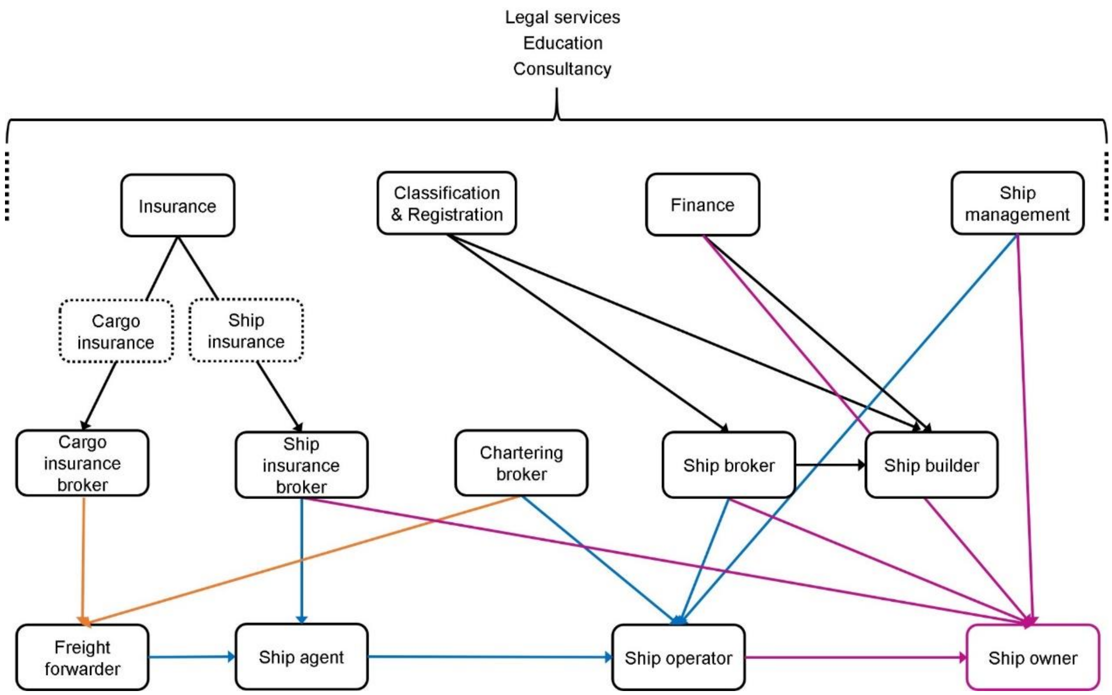


Figure 2-2. Service-customer relationship in shipping industry

Ship operators are the ones who actually use the ship in the shipping business. They can either own the ship or charter it from other shipowners (Grammenos and Choi, 1999). They are playing an increasingly bigger role in the shipping industry. For example, Maersk, Mediterranean Shipping Company (MSC), and China Ocean Shipping (Group) Company (COSCO), are now the main operators in the liner shipping market. These are multinational enterprises with headquarters in their home country and regional offices all over the world. They employ services directly from ship management companies, ship brokers, chartering brokers, and ship agents. A ship agent is a representative of the operators in a specific port, to help the operators in dealing with local businesses (Ghiara and Caminati, 2017). The service-customer relationships are marked with blue links in Figure 2-2.

Freight forwarders (FFs) bridge the gap between ship operators and shippers (or cargo owners), help shippers to deal with the tedious exporting formalities, and help operators to secure the cargoes in the local area. Therefore, they must be located around the port, in the cargo generation area (Ghiara and Caminati, 2017). The service providers of FF are marked with orange links in Figure 2-2. Its businesses depend on cargo volume. Therefore, it is a typical attribute of maritime clusters based on port throughputs.

In addition to the maritime businesses stated above, many other specific businesses have developed to serve the industry, such as insurance, finance, legal, education, information and consultancy services (Benito et al., 2003; da Silva Monteiro et al., 2014). These require specific knowledge and skills in a particular field, as well as in the shipping industry. They are usually grouped under high-end maritime services—a very important direction for the future development of maritime clusters. The service-customer relationships among them are shown with black links in Figure 2-2. Since education, legal and consultancy services can serve every maritime business, they are put at the top of the whole network.

To sum up, the four traditional sectors at the bottom of Figure 2-2 are the clients of maritime services. Above them, the maritime service clusters can grow given the business environment of the region. With the development of information technology and transportation facilities, the physical distance between maritime service businesses and their clients is now less important. Maritime service businesses can locate wherever the best business environment is. Therefore, to formulate policies for the development of maritime service clusters, it is important to study the best business environment that a place can offer to the maritime service businesses, including tax policies, the legal system, government support, and access to the global financing resources.

2.4 International Maritime Centre

In the process of reviewing the existing studies on maritime clusters, we find that many have mixed up the concept of a maritime cluster with that of an International Maritime Centre (IMC), or have used the terms interchangeably. For example, Xiong (2010) claims that Wuhan is building its international maritime center. However, its maritime industry is localized, and can only be called a maritime cluster, not an IMC. Similar confusion occurs frequently in Chinese publications when discussing maritime clusters. This section aims to clarify these two concepts.

As pointed out by Ma (2011), the development of an IMC includes three generations. The first is the traditional maritime clusters represented by concentrated cargo flow or ship building activity. The second generation includes some services to shipping, such as freight forwarding, a ship agency, crew training and management, shipping finance, brokering, registration, insurance, legal services and arbitration. The third generation of an IMC is knowledge based, and its functions are to stipulate international laws and regulations, and to publish worldwide standards to the shipping industry. Clearly, maritime clusters are the starting point of an IMC. However, they have different functions. For the former, the main function is to enable businesses to grow better. It is not really a concern if the cluster does not have international influence. For the latter, the main attributes are international influence and control. For example, London is recognized as an IMC because many international laws and regulations, professional standards, headquarters of shipping insurance companies, and ship financing banks are from there, and their activities have world-wide influence. Hong Kong is referred to as an IMC in Asia because its maritime service sectors have an influence on the shipping industries in this region. London and Hong Kong are both referred to as an IMC because they have international influence, in addition to having a maritime cluster. Generally, London is recognized as a leading maritime cluster not only the scope, but also the geographical region and extent (Shi et al., 2020).

2.5 Current issues and future directions in maritime cluster study

To help with future research into maritime clusters, this section summarizes the identified issues in existing research and proposes possible ways to address these issues. The issues and relevant suggestions are listed below.

1) Unique natures of maritime businesses are not fully considered. As discussed in Section 2.3.1, the existing definitions of a maritime cluster are rather broad and ambiguous, being very similar to those of general industry clusters. It is a good start, but a better concept is required, one more pertinent to the maritime industry. This observation is echoed in Shi, Jiang, Li, and Xu (2020), which commented that a clear definition of "maritime cluster" is lacking. Therefore, in future studies about maritime clusters, the specific nature of the shipping industry should be given more consideration. Taking a traditional maritime cluster as an example, the businesses are mostly global or non-local, such as shipping companies (Ghiara & Caminati, 2017). Although often labelled as footless businesses with higher movability, they are the key to maritime clusters. It is, then, useful to incorporate this attribute into cluster research,

not just with regard to its definition, but also about its stability and contribution to the local economy, as well as on policies for the future development of such clusters.

2) Lack of studies on maritime service clusters. Unlike traditional maritime clusters that rely heavily on port throughput, maritime service businesses do not have this limitation (Jacobs, Koster, & Hall, 2011), and hence are more stable for the regional economy. However, maritime service clusters have not gained enough attention from academia, even though their importance has already been recognized by governments with a maritime tradition, such as Hong Kong and Singapore, as they are competing to attract maritime service businesses and build international maritime service clusters. Thus, research by academics needs to catch up with actual practice, and thus support the government decision processes.

3) Research methods in maritime clusters needs to be expanded. The research methods are mostly descriptive, or just borrowed from research on general industry clusters. Very few studies (Koliousis, Papadimitriou, Riza, Stavroulakis, & Tsioumas, 2018; Zhang & Lam, 2017) have adopted a modelling (theoretical analysis) approach. For example, analytical modelling on the interactions among different factors are very common in industrial economics, but there are very few of such for maritime clusters. Although many factors have been identified (Table 2-5), the interactions among them have not been studied. For example, government policies on preferential tax to attract maritime services should consider the current condition of the region, strategic behavior of the competition from other regions, and the behavior of the maritime service providers. This may require analytical modeling and empirical analysis, which methods are not commonly used in maritime cluster studies.

4) The confusion between maritime cluster and IMC. It is understandable that many port cities are trying to build an IMC. As discussed in Section 2.4, though, although an IMC is developed from a maritime cluster, it is more than just a maritime cluster, in that it has international influence. The study of traditional maritime clusters should focus on cargo flow, whereas that of maritime service clusters should emphasize the attractive business environment of a region. For the study of an IMC, the focus should be on its international influence.

2.6 Chapter Summary

A "maritime cluster" is one specific branch of "general industry cluster". With 200 years of history, theories about general industry clusters have been well developed in many directions. Compared with that, theory development over maritime clusters is still in its initial stage, even though much effort has gone into examining maritime clusters closely. Therefore, understanding the evolution of maritime cluster study and its current status can help future researchers grasp the context of its development and fill this research gap. In addition, it can also provide a reference for policymakers with regard to regional planning for maritime industry development.

This study first described how the 56 publications over the past 20 years were collected, the distribution of publication numbers over time, the major journals, and governmental policies for the development of maritime clusters. Then six key elements in maritime cluster study were discussed. This was followed by a clarification over the misunderstanding of the difference between an IMC and a maritime cluster. A discussion of the current issues in maritime cluster studies and future research directions are provided, to help the readers in their respective further research.

As maritime clusters are important for both business development and the national economy, research into maritime clusters can help not only business decisions in the private sector, but also public policies for maritime industry development. Hopefully, this review can help future researchers in identifying existing problems and deficiencies, determining maritime cluster research directions, and supporting business clustering decisions as well as public policies to assist maritime industry development.

Chapter 3. Major factors for the location of maritime service businesses: an empirical analysis

3.1 Introduction

Maritime services, such as ship financing & brokering, maritime legal services, and ship management, are very important for the development of both the shipping industry and the local economy and are also major job providers to the local community. Due to the nature of their business, they are not required to locate at port cities having a high concentration of cargo flow (Li and Luo, 2020). Instead, it is best for them to locate and grow at those places with the best business environment. This puts much pressure on traditional port cities to provide a competitive business environment, so as to develop and keep these business sectors. However, different countries/regions have different socioeconomic, political and legal systems, as well as different histories. It is often difficult for a country to match all the conditions offered by other countries. Therefore, how can Maritime services select the best location from among different alternatives that each have a different business environment? For public policies at port cities, what policy alternatives may attract Maritime services, given the limitations of their own country/region and the competition from other regions？

As China became the world’s workshop approximately 30 years ago, its container ports experienced very fast growth. Among the top 10 busiest container ports in the world, seven are in China (Alphaliner monthly monitor, 2019). To fully reap the benefit for local economies, the Chinese government approved the development of five international shipping centers (ISCs), in Shanghai (SH), Dalian, Tianjin, Xiamen, and Guangzhou, and designated SH for the development of high-end maritime centers capable of global resource allocation. However, most business activities there are still associated with cargo flow. The scale of Maritime services in all of these five ISCs is still not comparable with that of the Maritime services in Hong Kong (HK) and Singapore (SG) – two of the traditional ISCs in Asia. Since HK and SG are also trying very hard to attract Maritime services (TuscorLloyds, 2018; Kapila, 2012), how do Maritime services select whether to locate in SH, HK or SG? Which factors can policy makers in these places use to attract more Maritime services in such a competitive environment?

According to industrial relocation theory, three categories of factors, namely internal, external and location factors, can affect the relocation decision of a firm (Lloyd & Dicken, 1977; Van Dijk & Pellenbarg, 2000). Internal factors are the firm's specific conditions, such as the age and size of a firm, while external and location factors are the conditions of the business environment around the firm. Although there is abundant literature on industrial relocation, very few of these studies have focused on the location decision of an Maritime service.

In this study, we design a stated preference (Cooper and Millspaugh, 1999) survey to obtain the choices of Maritime services among the alternatives, namely, SH, HK, SG, or NC (no choice), when facing hypothetical changes in the business environment, and then apply discrete choice models (DCMs) to analyze the impacts of and possible substitution among the major factors. Our results show the unequal impacts of different factors for each alternative location in attracting Maritime services: Improving the legal environment is more effective in SH, active government support is more important in HK, and tax reductions are more attractive in HK and SG. Different levels of location loyalty are revealed for the companies already located in each city—compared to companies in SG and SH, companies in HK have the highest level of location loyalty. Also, contrary to common belief, Maritime services do not have as high a preference for places with a high number of ship owners (their clients) as other businesses in shipping. These results can be used to analyze the potential policy instruments that a city can use to improve its attractiveness. As an illustration of substitution among different factors, we analyze how different policies can be adopted in HK and SH to increase their respective competitiveness compared to SG.

Although DCMs have been widely applied in analyzing the choices of decision-makers in business location selection (Train, 2009; Kogut and Singh, 1988), this study is the first to apply such a model to analyze the location behavior of Maritime services while explicitly considering the alternative-specific impacts of business environmental factors, and to use such impacts to further analyze the trade-off among different factors. Not only does this help Maritime services in determining where to go for their business, but it also allows policy makers to formulate effective strategies that take into account the difficulties in changing certain existing conditions in their business environment.

This paper is organized as follows. In section 3.2, we review previous literature regarding business location selection in the maritime industry and discrete choice models applied to business location selection. Section 3.3 discusses the environmental factors related to the location choice of maritime businesses and defines the levels of each factor. Section 3.4 introduces the survey design, followed by the data description in Section 3.5. In Section 3.6, the model used for data analysis is introduced, and the estimation results are discussed. A policy trade-off analysis is also conducted in this section. Based on the results of the model and the factor trade-off analysis, policy implications are provided in Section 3.7, and finally, the summary and conclusion of the study are presented in Section 3.8.

3.2 Literature review

There are many existing works trying to identify the factors affecting maritime business location decisions. After collecting location information from advanced maritime producer services (AMPSs) in the Mediterranean, Ghiara and Caminati (2017) found that the location and networks of AMPSs are determined by three factors. First, direct proximity to seaports is important for an AMPS to conduct business such as legally representing ship or cargo owners when damage occurs. However, using data in the world shipping register, Jacobs et al. (2011a) found that the location selection of an AMPS is not influenced by a port and its throughput. Li and Luo (2020) also found that being near a port is a factor affecting the formation of a maritime industry at an early stage. However, with technological progress, the distance to a port is no longer a major factor for an AMPS to consider when making a location decision. Second, proximity to major business nodes is important. Ghiara and Caminati (2017) emphasized the importance of the general advanced service providers of a city, such as financial services, to capital intensive services in AMPSs. Third, proximity to the customers of an AMPS, such as shipowners and other port related industries, was seen as important.

This is consistent with Jacobs et al. (2011a), who found that the location of an AMPS is largely influenced by the presence of its clients, shipowners and port-related industry. However, the location decision of Maritime services depends on a complex set of business environmental factors, and there is no hierarchical order among these factors, especially when there are different alternatives.

Discrete choice models (DCMs) have been developed to analyze the choice of decision-makers when faced with limited alternatives (Train, 2009). They have been applied in many location selection problems, such as residential location (Rashidi, Auld, and Mohammadian, 2012; Lee and Waddell, 2010), and the bed site selection of elk (Cooper and Millspaugh, 1999). They have also been used in business location selection analysis. Alamá-Sabater, Artal-Tur, and Navarro-Azorín (2011) used a spatial discrete choice model to investigate "neighbourhood effects" on industrial location selection in Murcia, Spain, using the location choice data of 8,429 firms from the Regional Statistical Office. The results showed that human capital, agglomeration economies and land availability are important when making a location decision. Bodenmann and Axhausen (2012) studied the location choice of 54,000 firms and plants in Switzerland using a nested logit model. They found that variables such as tax burden and distance exert much influence on the decision-making process. Also revealed in this study is the heterogeneity among different sectors. For example, manufacturing sectors tend to move out of cities, but retailers like to find new sites in a city. However, neither tried to identify the alternative-specific impacts.

Kronenberg (2013) adopted a nested logit model to identify the factors affecting business relocation, using data from Statistics Netherlands (CBS). They found that there are behavior differences between knowledge-intensive sectors and less intensive sectors, and that firms prefer places with dense population and high salary levels.

Fukuda, Kidokoro, Seta, and Sato (2019) investigated the impacts of institutional factors on location selection by small and medium size companies, using a nested logit model. The results show that the relationship among firms is important when making relocation decisions.

Although DCMs have been used successfully to solve business location problems, they have never been applied in the location problem of maritime services. In addition, the existing empirical studies of location selection are largely reliant on observed data, which cannot reflect the decision environment when an actual decision is made. Stated preference (SP) data, on the other hand, includes both the decision and the hypothetical business environment. With such information, it is possible to analyze decision changes with a change in business environment.

3.3 Factors in maritime business location decision

HK and SG are two traditional maritime centers in Asia that both had British control in the past. Therefore, they both operate under a common law system. After returning to China in 1997, HK maintained its legal system and continued to adopt the “laissez-faire” economic system. After its independence in 1965, SG also maintained its common law system. However, SG has a very powerful and active government, which is very useful for maritime industry development.

As the busiest container port in the world, SH is trying very hard to attract more maritime services to locate there. For a maritime service to serve its customers in Asia, it can select any of these three places, as they are not far away from each other (Figure

3-1). However, due to their respective histories, socioeconomic environments, and legal systems, they have different levels of attractiveness for maritime services. Therefore, we need to explore the location factors that attract maritime service firms. Before deciding on the location factors, we conducted a series of literature reviews. Since the number of studies on maritime service businesses is very limited, we also collected factors from general service industries. Then, 11 experts from the shipping industry were invited to be interviewed. During the interviews, factors gleaned from the literature review were used as references. We stopped the interviews when no new factors were put forward by the experts. There were a total of 19 factors raised by different experts. Since the model we applied cannot deal with such a large number of different factors, we merged the factors according to the opinions of the experts and finally generated five important factors affecting the location decisions of maritime services, namely, tax policies, government support, market openness, the commercial legal system, and the number of large shipowner headquarters.

Figure 3-1. Location of Shanghai, Hong Kong, and Singapore

3.3.1 Effective tax rate

Tax incentives are one of the major factors behind the location decision of a firm (Laamanen et al., 2012, Devereux and Griffith, 2003, Barrios et al., 2012). Usually, the government will offer preferential tax policies to promote the development of certain industrial sectors. According to Thomas (cited in Jensen et al., 2015), state and municipal governments in the US used tax incentives amounting to approximately $46.8 billion a year to attract foreign and domestic investors and to retain existing investment. Zolt (2015) stated that almost all countries, both developing and developed, use tax incentives to attract business and investment.

Taking into account the differences between the taxation system in each of the three regions, we designed a hypothetical variable, TAX, to analyze the impact of tax on the location decisions of maritime services. TAX measures the tax change in the current effective tax rate (ETR). The ETR for a corporation is the average rate at which its pretax profits are taxed, namely, the ETR = total tax/earnings before tax (Fullerton, 1983). HK's profit tax rate is 16.5% (GOVHK, 2019), and the tax rate in SG is 17% (Singapore, 2019). These two cities have similar simple and consistent tax rates across different business types. However, during the expert interviews, it was generally recognized that SH has a complicated tax system, one that varies for different business types, and that the ETR is much higher. Therefore, it is necessary for SH to make changes, so that the ETR is sufficiently attractive for maritime services to move there. According to the expert interviews, a 20% change from the base ETR (i.e., current ETR*(1±20%)) is required to motivate people to select SH. However, for HK and SG, this rate is only 10% (i.e., current ETR*(1±10%)).

3.3.2 Government support

In addition to tax policies, government support is another important factor in a firm's location decision (MacCarthy and Atthirawong, 2003). Although tax policy has been included as a government support policy in some studies (Ellram, Tate, and Petersen, 2013), the government support in this study refers to other policy measures, such as providing funds or platforms to foster the development of local clusters or firms. For the maritime industry, government support can take on many different forms, such as establishing specific governmental organizations to lead maritime sector development, providing funding for research and development in specific areas, and hosting maritime trade and technology fairs. The governments in both SG and SH are very active in attracting maritime services, while the one in HK is not comparable due to its long history of “small government, large market”. For the government support (GOV) variable, two levels were assigned to each of the three locations. The “active support” level indicates that the government has programs to support maritime services (tax policies excluded), actively promotes the local shipping industry and often conducts investment promotion, while “less support” means that there are very few such programs or very little promotion.

3.3.3 Market openness

Market openness of a country or a region refers to how easily a company can establish itself in the country or region for activities such as marketing, trading, financing, and exchanging or remitting currencies. Market openness is one of the factors that can drive a firm’s decision regarding the selection of one location over another between two neighboring countries (Capik and Dej, 2018). HK and SG are generally recognized as very open, while SH is subject to many restrictions. Therefore, we hypothesize that improving openness is more important in SH than in HK or SG. In this study, openness specifically indicates the ease of investment approval, financial openness, flexibility of labor regulations and the level of government price control in a region, as well as freedom in regard to foreign currency and remittances. The market openness variable, OPEN, has two levels: “open” means a simple and transparent foreign investment approval system, financial openness, flexibility of labor regulations and less governmental control over prices, while “less open” means the opposite.

3.3.4 Commercial legal environment

The commercial legal environment refers to the rules of running businesses and the procedures for settling disputes. Its stability and efficiency are another factor in the location decision of a firm or a business. This may involve different kinds of laws and regulations, such as insurance laws, compensation laws, and regulations on transfers of earnings out of the country (MacCarthy and Atthirawong, 2003). MacCarthy and Atthirawong (2003) found that "protection of patents" is becoming more and more important in international location decisions. In our study, the commercial legal environment refers to local commercial laws, regulations, and dispute settlement mechanisms. In the shipping industry, it is well recognized that HK and SG have a very good and similar commercial legal environment for maritime services to develop, due to their tradition of a common law system, whereas that in SH is not as good as that in the other two cities. Therefore, the variable for measuring the commercial legal environment, LEG, also has two levels. The level "good" refers to the current situation in HK and SG, while "unsatisfactory" refers to the status quo in SH.

3.3.5 The number of large shipowner's headquarters

Capik and Dej (2018) pointed out that the location decision of a firm can also be affected by the presence of other firms in the same industry sector. Such firms do not have to be a market leader; rather, they can be a partner, client, or supplier of the firm. Ghiara and Caminati (2017) emphasize that advanced maritime producer services (AMPSs) and their clients (liner shipping companies) tend to set their organizations and international firms closer to each other. This result is also supported by Jacobs et al. (2011), who found that the location of AMPSs is largely influenced by the presence of clients and shipowners.

In the expert interviews, the consensus was that shipowners are very important for the development of maritime services. Therefore, in this study, we designed a variable, COM, to capture the impact of this factor. We hypothesize that maritime services prefer places with a high number of ship owners. Currently, the number of large shipowners in the three clusters is available from Owner Fleet Top 100 in the Clarkson Shipping Intelligence Network (2019). At present, the number of large shipowners in SG is 5, followed by 4 in SH and 3 in HK.

All the aforementioned factors and their definitions in this study are summarized in Table 3-1 below, and these are used both to generate the survey and for model estimation in the following sections. Since these factors are external factors, or location factors, in classic location theory (Brouwer et al., 2004), they are referred to as business environmental factors in this study. Among the five factors, GOV, OPEN, and LEG are qualitative variables and are coded using effect coding (Haaijer et al., 2001). Compared to the use of dummy variables, in effect coding the impact of the base level is not added to the impact of the intercept (Hensher et al., 2005). In addition, as shown in later sections, the use of effect coding allows more interactive terms to be estimated compared to the situation where all are dummy variables. Since the change in ETR in SH is different from that in HK and SG, we use two variables, TAXSH and TAXHK/SG, to separate their impacts. The number of large shipowners (COM) and TAX are continuous variables.

Table 3-1: Business environmental factors in location decisions and coding

Factors	**Description**	**Levels**		**Coding**	
Effective tax rate (TAX)	-The ETR for a corporation is the average rate at which its pretax profits are taxed; ETR = total tax/earnings before taxes	$TAX^{HK/SG}$ 1. increase by 10% 2. no change	TAX^{SH} 1. increase by 20% 2. no change	SH 1. [20] 2. [0]	HK/SG 1. [10] 2. [0]

	-Different among the three locations	3. decrease by 10%	3. decrease by 20%	3. [-20]	3. [-10]
Government support (GOV)	-Supports other than preferential tax policy, such as the provision of funding or platforms intended to foster the development of local clusters or firms	1. active support 2. less support		1. [1] 2. [-1]	
Market openness (OPEN)	-How easily a firm or a business can access this place for activities such as marketing, trading, financing, and remitting foreign currency	1. open 2. less open		1. [1] 2. [-1]	
Commercial legal environment (LEG)	-The stability and efficiency of the legal system -Includes different kinds of laws and regulations such as industrial relation laws, insurance laws, compensation laws, and regulations on transfers of earnings out of the country	1. good 2. unsatisfactory		1. [1] 2. [-1]	
Number of large shipowner company headquarters (COM)	-The presence of other firms in the same sector - Obtained from Owner Fleet Top 100 in the Clarkson Shipping Intelligence Network	1. no headquarters 2. 5 headquarters 3. 10 headquarters		1. [0] 2. [5] 3. [10]	

3.3.6 Company Information

In addition to the business environmental factors, the attributes of maritime service businesses also have significant impacts on their location decisions (Brouwer et al., 2002, Van Dijk and Pellenbarg, 2000, Buckley and Casson, 2019). Therefore, company-specific attributes, such as the business type, firm size, firm age, company location, annual revenue, and experience of the respondents, are also collected in the survey and used together with the external factors in the empirical analysis.

3.4 Stated preference experimental design

The stated preference method (Cooper and Millspaugh, 1999) is widely used in behavioral science. Although its appearance in the study of location selection is less common, there are still quite a few successful applications of it (Rietveld, 1994; Hayashi, Isobe, and Tomita, 1986; Leitham, McQuaid, and Nelson, 2000). The process of designing an SP survey is called experimental design, and it typically starts with the selection of attributes that describe each choice option, known as the alternative. In Section 3, we have introduced a set of environmental factors that are important for the location choice decision, and these are the attributes and attribute levels that describe the alternatives used for the SP survey.

The next step is to assign attribute levels to each alternative in a series of choice sets in the experiment. In theory, this can be done by incorporating every possible combination of attribute level into the experiment, and such a method is known as the full factorial design. However, this would make the survey too long. In this study, we adopt a fractional efficient design using the method of Rose and Bliemer (2009), where the combination of attribute levels was determined based on a criterion known as the D-error. An experiment producing a smaller D-error, in theory, provides a more accurate result for model estimation. Equation 1 below shows the definition of the D-error:

$$D - error = \left(det \left(- \left[\frac{\partial^2 L(X, \beta)}{\partial \beta \partial \beta'} \right]^{-1} \right) \right)^{\frac{1}{K}} \quad (1)$$

where in parentheses are the determinants of the asymptotic variance-covariance

(AVC) matrix, or negative inverse of the second order derivative of the likelihood function $L(X, \beta)$ of the model (McFadden, 1974), where K is the number of parameters. In this study, we generated an efficient design for the pilot study and the main wave survey by minimizing the D-error. The design contains 12 choice sets, with a different combination of attribute levels. Therefore, each choice set presents a unique set of business environments for each location, and a respondent was asked to choose one of the locations or to opt out, and this process continued until the respondent evaluated all the choice sets in the survey. In real life, changes in business environment often occur over a long period of time, and are normally captured by time series panel data. SP data, on the other hand, are able to collect repeated choices from each respondent, allowing the estimation of the impact of environmental changes on the decision-making process in a similar way to panel data, but with considerably lower cost. Figure 3-2 below presents a sample choice set from the main wave survey.

Assuming the business environment for Shanghai, Hong Kong and Singapore are shown below, please choose a region to conduct your business. (If none of the following three options meet your expectations, please select "No answer")

	Shanghai	Hong Kong	Singapore
Effective tax rate (ETR)	no change	decreased by 10%	no change
Government support	active support	active support	less support
Market openness	open	open	repressed
Commercial legal environment	good	unsatisfactory	unsatisfactory
The no. of large shipowners' headquarters	no company	10 companies	10 companies
Please indicate your choice:	□	□	□
	No choice □		

Figure 3-2. A sample choice set in the SP survey

3.4.1 Pilot study

For the pilot study, an online SP survey with 16 participants was conducted between February and April of 2019. They were specialists with more 10 years of experience in the fields of shipowning, ship insurance, legal services, ship management, government and maritime education. The main purpose of the survey was to test the environmental factors identified for the location decision, and to obtain prior knowledge on model parameters. The experiment used in the survey was designed using the aforementioned method, assuming zero priors for all the parameters to be estimated ($\beta = 0$). The estimated parameters from the pilot study are used as the priors in the main survey design.

3.4.2 Main survey

In the main survey, an efficient design with 12 scenarios was used for the main wave survey. 12 is the smallest number that allows an analysis of all the external environmental factors identified in section 3. The main wave survey was conducted online between April and August 2019. During the survey, a total of 235 questionnaires were distributed, with 87 effective questionnaires returned by the end of August, 2019. The 87 questionnaires provided us with 1044 usable observations for model estimation. The sample of respondents used in our study was collected in a totally random way.

3.5 Data Description

Table 3-2 summarizes the company information given by the respondents. There are three categories of business types, denoted using B_n ($n \in [1, 3]$). Type 1 is shipowners

(28%), who are the main clients of maritime services. Type 2 is maritime services (MSs), including ship brokers (10%), ship management companies (21%), classification societies (10%), marine insurance providers (11%), ship finance companies (6%), and legal service providers (5%). Type 3 is maritime-related businesses or institutions, including consultancies (14%), government agencies (2%), and others (11%), including logistics, non-vessel operating common carriers (NVOCCs), fuel traders, port operators, ship suppliers, and freight forwarders.

In terms of company location, 47% of the companies are in HK, 18% in SH and 22% in SG. A total of 25% are located in other places, including 16% in mainland China. The numbers add up to more than 100% because some companies are located in more than one place. The company locations are denoted using L_n (n∈[1,4]). In terms of firm size, most of them (62%) are small and medium-sized enterprises with fewer than 500 employees. Company size are divided into two categories and denoted using S_n (n∈[1,2]). Nearly half (47%) of the companies have revenue less than US$ 10 million, and 38% of them make more than US$ 100 million. The revenues of the company are also divided into three categories, and represented using R_n ($n \in [1, 3]$). In addition, most of the companies (75%) have more than 15 years of history. The company history is divided into two groups and denoted using H_n ($n \in [1,2]$). Finally, most of the respondents (66%) are senior managers with more than 15 years of work experience. Respondents' experience are represented by E_n (n∈[1,2]) in the model.

Table 3-2: Summary of respondent information

Information	**Levels**
Company background	
Business type (B_n)*	1: Shipowner (28%) 2: MSs: ship brokers (10%), ship management companies (21%), classification societies (10%),

	marine insurance providers (11%), ship finance companies (6%), legal service providers (5%) 3. Maritime-related education and R&D (consultancies included) (14%), marine-related government agencies (2%), other businesses (11%)
Location (L_n)	1: SH (18%) 2: HK (47%) 3: SG (22%) 4: other (25%, 16% of total from mainland China)
Size (No. of employee) (S_n)	1: Small and medium-sized (≤ 500 employees) (62%), 2: Large (> 500 employees) (38%)
Revenue (previous year) (R_n)	1: Less than US$ 10 million (47%) 2: US$ 10-100 million (22%) 3: More than US$ 100 million (31%)
Company history (years) (H_n)	1: Less than or equal to 15 years of history (26%) 2: More than 15 years of history (74%)
Sociodemographics of the respondents	
Title & experience (E_n)	1: Upper management (with more than or equal to 15 years of experience) (66%) 2: Middle- and lower-level management (with less than 15 years of experience) (34%)

**: The total percentage is not equal to 100% because of overlaps (there are 11 companies that are both shipowners and ship management companies)*

3.6 Model specification and estimation results

3.6.1 Model development

3.6.1.1 The multinomial logit model

As reviewed in Section 2, discrete choice modeling is widely used in the field of industrial location. Among all the models, the multinomial logit (MNL) is the most popular one (Alamá-Sabater et al., 2011; Bodenmann and Axhausen, 2012). In an MNL model, the utility of each location is a linear additive function of a series of factors and a residual that represents any information that was not identified by the analysis. For each location, the residual is independently and identically distributed with extreme distribution. Also, as the utility function considers only fixed parameters, no random taste variations can be captured. Under this specification, the probability for decision-maker m to choose alternative i in choice set s can be written as:

$$P_{mis} = \frac{e^{V_{mis}}}{\sum_j e^{V_{mjs}}}, \tag{2}$$

in which V_{nis} the observed utility for each location.

In this study, there are three locations of interests, namely Shanghai (SH), Hong Kong (HK) and Singapore (SG). Given the environmental factors in Section 3, the utility function of each location can be specified as follows. Here the subscript m, s was dropped for simplicity. In this model, we have also incorporated a no-choice alternative for realistic consideration – in real life, a respondent does not always make a choice when none of the options offered was preferred (Vermeulen et al., 2008).

$$\begin{aligned} V_i = \alpha_i + \beta^{tax_{in}} \times TAX_i^{IN} + \beta^{tax_{de}} \times TAX_i^{DE} + \beta^{gov} \times GOV_i \\ + \beta^{open} \times OPEN_i + \beta^{leg} \times LEG_i + \beta^{com} \times COM_i, i \\ \in \{SH, HK, SG\} \\ V_{nc} = 0 \end{aligned} \tag{3}$$

in which α_i denotes the alternative specific constant (ASC) for alternative i, the levels of tax rate were represented by two effect coded variables, namely TAX_i^{IN} and TAX_i^{DE}, with $TAX_i^{IN} = 1$ and $TAX_i^{DE} = 0$ as 'tax increase' , with $TAX_i^{IN} = 0$ and $TAX_i^{DE} = 1$ as 'tax decrease', with $TAX_i^{IN} = -1$ and $TAX_i^{DE} = -1$ as 'not change'. The variable GOV_i refers to government support, with 1 indicating 'active support'. The variable $OPEN_i$ refers to openness, with $OPEN_i = 1$ as 'open'. The variable LEG_i refers to the legal environment, with $LEG_i = 1$ as 'good'. The variable COM_i refers to the number of headquarters, and it is a quantitative variable taking one of the three levels shown in

Table 1. β s refers to the parameter estimates to each alternative and they are treated as generic parameters in this model.

The above utility specification considers only the environmental factors. For comparison purpose, we also derived a utility function incorporating information of the company.

$$
\begin{aligned}
V_{SH} = \alpha_{SH} &+ \beta_{SH}^{tax_{in}} \times TAX_{SH}^{IN} + \beta_{SH}^{tax_{de}} \times TAX_{SH}^{DE} + \beta_{SH/SG}^{gov} \times GOV_{SH} \\
&+ \beta^{open} \times OPEN_{SH} + \beta_{SH}^{leg} \times LEG_{SH} + \beta^{com} \times COM_{SH} \\
&+ \delta_{SH-SH}^{L} \times L_1 + \delta_{others-SH}^{L} \times L_4 + \delta_{SH}^{H} \times H_2 + \delta_{SH}^{B} \times B_2 \\
&+ \delta_{SH}^{s} \times S_2 + \gamma^{GE} \times GOV_{SH} \times E_1, \\
V_{HK} = \alpha_{HK} &+ \beta_{HK/SG}^{tax_{in}} \times TAX_{HK}^{IN} + \beta_{HK/SG}^{tax_{de}} \times TAX_{HK}^{DE} + \beta_{HK}^{gov} \times GOV_{HK} \\
&+ \beta^{open} \times OPEN_{HK} + \beta_{HK/SG}^{leg} \times LEG_{HK} + \beta^{com} \times COM_{HK} \\
&+ \delta_{HK-HK}^{L} \times L_2 + \delta_{others-HK}^{L} \times L_4 + \delta_{HK}^{H} \times H_2 + \delta_{HK}^{B} \times B_2 \\
&+ \gamma^{GE} \times GOV_{HK} \times E_1, \\
V_{SG} = \alpha_{SG} &+ \beta_{HK/SG}^{tax_{in}} \times TAX_{SG}^{IN} + \beta_{HK/SG}^{tax_{de}} \times TAX_{SG}^{DE} + \beta_{SH/SG}^{gov} \times GOV_{SH} \\
&+ \beta^{open} \times OPEN_{SH} + \beta_{HK/SG}^{leg} \times LEG_{SG} + \beta^{com} \times COM_{SG} \\
&+ \delta_{SG-SG}^{L} \times L_3 + \delta_{SG}^{H} \times H_2 + \delta_{SG}^{B} \times B_2 + \gamma^{GE} \times GOV_{SG} \times E_1, \\
V_{nc} = 0 &
\end{aligned} \tag{4}
$$

In addition to the environmental factors, this model also considers the impacts of company information. Since company information is fixed for all the choice sets in the survey completed by the company, to avoid being cancelled out, we let them interact with the alternative specific constant (ASC) or the environmental factors (Hensher, Rose, and Greene, 2005). In this study, we applied both methods. For example, we let the variable L_n ($n \leq 3$) interact with the ASC to estimate location loyalty, while the variable L_4 is to estimate the preference of companies in other places as to these three alternatives. Variables H_n B_n and S_n are also company information that have interaction with the ASC. Variable E_n is allowed to interact with the environmental factor GOV.

3.6.1.2 The mixed logit model

As mentioned previously, an MNL does not allow for the estimation of unobserved correlations between alternatives or random taste variations among respondents. However, in reality, such a strong assumption may not hold. In selecting a location, a respondent might consider Shanghai and Hong Kong as closer substitutes, as they belong to one country. Others might consider Hong Kong and Singapore as closer substitutes, as they provide a similar business environment. This induces unobserved correlations between alternatives. Taste variations, on the other hand, are even more common in reality, because different people do not behave exactly the same. The incorporation of randomly distributed coefficients in a model allows the analyst to capture such variations and improve the explanatory power of the model.

By definition, an ML model is any discrete choice model with choice probabilities specified in the following way (Train 2009):

$$P_{im} = \int L_{im}(\beta) f(\beta) d\beta \tag{5}$$

where $L_{im}(\beta)$ is an MNL probability given the parameter value β,

$$L_{im}(\beta) = \frac{exp\big(V_{im}(\beta)\big)}{\sum_{j=1}^{J} exp\left(V_{jm}(\beta)\right)} \tag{6}$$

and $f(\beta)$ is the probability density function of certain distribution and $V_{im}(\beta)$ is the observed utility dependent on β.

In an ML model, both parameters in the observed and unobserved utility can be randomly distributed. The former structure is also known as a random parameter logit (RPL) model, while the latter is known as an error component model (ECM). McFadden and Train (2000) show that an ML model with appropriate choice variables and mixing distribution can approximate any RUM-consistent discrete choice models to any degree of accuracy.

In this study, we have analyzed the RPL model, which is used to test the existence of unobserved correlations between the locations. For the ECM model, the result is not significant, and therefore we did not include the ECM model within our thesis. The utility function of the RPL model is specified as follows.

The main model is the same as the MNL model (Eq .4).

$$
\begin{aligned}
V_{SH} = \alpha_{SH} &+ \beta_{SH}^{tax_{in}} \times TAX_{SH}^{IN} + \beta_{SH}^{tax_{de}} \times TAX_{SH}^{DE} + \beta_{SH/SG}^{gov} \times GOV_{SH} \\
&+ \beta^{open} \times OPEN_{SH} + \beta_{SH}^{leg} \times LEG_{SH} + \beta^{com} \times COM_{SH} \\
&+ \delta_{SH-SH}^{L} \times L_1 + \delta_{others-SH}^{L} \times L_4 + \delta_{SH}^{H} \times H_2 + \delta_{SH}^{B} \times B_2 \\
&+ \delta_{SH}^{s} \times S_2 + \gamma^{GE} \times GOV_{SH} \times E_1, \\
V_{HK} = \alpha_{HK} &+ \beta_{HK/SG}^{tax_{in}} \times TAX_{HK}^{IN} + \beta_{HK/SG}^{tax_{de}} \times TAX_{HK}^{DE} + \beta_{HK}^{gov} \times GOV_{HK} \\
&+ \beta^{open} \times OPEN_{HK} + \beta_{HK/SG}^{leg} \times LEG_{HK} + \beta^{com} \times COM_{HK} \\
&+ \delta_{HK-HK}^{L} \times L_2 + \delta_{others-HK}^{L} \times L_4 + \delta_{HK}^{H} \times H_2 + \delta_{HK}^{B} \times B_2 \\
&+ \gamma^{GE} \times GOV_{HK} \times E_1, \\
V_{SG} = \alpha_{SG} &+ \beta_{HK/SG}^{tax_{in}} \times TAX_{SG}^{IN} + \beta_{HK/SG}^{tax_{de}} \times TAX_{SG}^{DE} + \beta_{SH/SG}^{gov} \times GOV_{SH} \\
&+ \beta^{open} \times OPEN_{SH} + \beta_{HK/SG}^{leg} \times LEG_{SG} + \beta^{com} \times COM_{SG} \\
&+ \delta_{SG-SG}^{L} \times L_3 + \delta_{SG}^{H} \times H_2 + \delta_{SG}^{B} \times B_2 + \gamma^{GE} \times GOV_{SG} \times E_1, \\
V_{nc} = 0 &
\end{aligned}
\tag{7}
$$

where $\beta_i = \bar{\beta}_i + \eta z \quad + v_i$, $\beta_i \sim f(\beta_i \,|\, \theta)$. , $i \in \{SH, HK, SG\}$ The heterogeneity of population consists of two parts, ηz is the fixed part that will influence the mean of population through company information, and v_i is the random parts following a certain distribution.

In the model, all environmental factors β are assumed to be normally distributed random parameters, since we do not know the taste variation of the population. It is interesting to test whether or not there are taste variations among respondents' attitudes toward environmental factors. Then, backward elimination is adopted due to the limitation of sample size. The statistical non-significant attributes were eliminated to save additional degree of freedom (Louviere, Hensher, and Swait, 2000). Parameters with random effect are further explained by company information based on the interviews with the experts. The result is presented in a later section.

3.6.2 Statistical results

In the SP survey, the hypothetical environment of each location changes over choice sets, allowing the impact of environmental factors to be estimated. For this reason, we begin with the estimation of the MNL model, which utility is specified in Eq. 3 (estimation result in Model 1, Table 3-3), and this result is compared to an extended MNL model (Eq. 4) that incorporates company information as well (result in Model 2, Table 3-3). As shown in Model 1, all the environment parameters were treated as generic parameters across alternatives, and they were all highly significant with correct sign. An increase of the tax rate, in general, leads to a reduction in preference for that location, and vice versa. A positive change of the institutional environment caused by the improvement of government support, market openness, and the commercial legal environment enhances the preference for that location.

In addition, the Alternative Specific Constant (ACS) is estimated to be the highest for Singapore, lowest for Shanghai, with Hong Kong in the middle. This reflects the general preference towards the three cities without considering the environmental factors.

It should be noted that people's sensitivity to tax increase and decrease is symmetric from the results of the estimation, which is different from our hypothesis at the beginning. To test the linearity of the TAX variables, a likelihood ratio test was applied to test the hypothesis of a restriction model as in equation 4.

$$V_i = \alpha_i + \beta^{tax_{in}} \times TAX_i^{IN} - \beta^{tax_{in}} \times TAX_i^{DE} + \beta^{gov} \times GOV_i + \beta^{open} \times OPEN_i + \beta^{leg} \times LEG_i + \beta^{com} \times COM_i, i \in \{SH, HK, SG\} \quad (8)$$

$$V_{nc} = 0$$

Since the Syntax language cannot recognize a negative sign in the utility function, we created a new variable $TAX_i = TAX_i^{IN} - TAX_i^{DE}$.

The result shows that the parameter of TAX_i^{IN} and TAX_i^{DE} have no significant difference. Therefore, we change the base model to equation 9.

$$V_i = \alpha_i + \beta^{tax} \times TAX_i + \beta^{gov} \times GOV_i + \beta^{open} \times OPEN_i + \beta^{leg} \times LEG_i + \beta^{com} \times COM_i, i \in \{SH, HK, SG\} \quad (9)$$

$$V_{nc} = 0$$

The same tests are conducted for all models in this study, so the linearity of TAX will not be discussed again in other model results.

Of course, due to the different histories of the three cities and the current levels of their external factors, the impacts of the environmental factors on the preferences for these cities may not be equal. Therefore, we extended the MNL model by incorporating alternative-specific and company-specific impacts. Likelihood ratio tests are applied to test the significance of the alternative-specific parameters of each environmental factor. Company-specific information is also included. The results are shown in Model 2 (Table 3-3).

For the external factors, the alternative-specific parameters for TAX, GOV and LEG are significant according to the results of the likelihood ratio test. HK and SG have similar impacts for TAX and LEG, as they have similar tax and legal systems. SH and SG have similar impacts for GOV, as they have very active government support. Reducing the ETR by 1% in HK and SG is more attractive than doing so in SH, as HK and SG already have a very low ETR. For GOV, the impact for SH and SG is smaller than that for HK. As government support in HK is not active, an improvement in government support could make it more attractive. Similarly, for LEG, improving the legal environment in SH could contribute more to attracting maritime services compared to HK and SG. For OPEN and COM, the alternative-specific parameters are not significant. Although the market is generally less open in SH compared with HK and SG, the maritime industry in SH usually has strong government support and has special arrangements whenever there is any problem due to market openness. Therefore, among the three alternatives, their responses to an increase in openness show no significant differences.

For company-specific attributes, five factors are considered. First, location loyalty is represented by the preference of companies for their own location. Companies in all three cities have location loyalty. However, $L^{HK-HK} >$

$L^{SH-SH/SG-SG}$; thus, companies in HK show the highest level of location loyalty. This result indicates that it is hard to induce companies in HK to relocate to SH or SG. For companies in other places, $L^{Others-SH} > L^{Others-HK}$, and most of them prefer SH over HK, which may be because most of them (16 out of 25) are from Mainland China. Company history significantly impacts location preferences, which is consistent with the industrial location literature (Brouwer, Mariotti, and Van Ommeren, 2004; Bodenmann and Axhausen, 2012). The results suggest that older companies (>15 years) have a relatively higher preference for SH or HK. In terms of firm size, large firms (>500 employees) tend to have a stronger preference for SH, which may be due to the huge demand for shipping services in China. In terms of business types, maritime services have a higher preference for SH. This may be due to the enormous business opportunities for maritime services in SH in recent years. The preferences for HK and SG are the same, as they are both developed regions with similar backgrounds. The interaction term, GOV*E, is positive and significant, indicating that younger managers (<15 years) like more government support and that such government support may provide more opportunities for younger managers than for more experienced managers.

Table 3-3: Estimation results of the three models

Model 1 (MNL)		Model 2 (Extended MNL)		Model 3 (RPL)	
Variables	Coefficients	Variables	Coefficients	Variables	Coefficients
ASC(α_i)		ASC(α_i)		ASC(α_i)	
SH	0.22*	SH	-1.30***	SH	-1.74***
HK	0.69***	HK	-0.69***	HK	-1.09***
SG	0.80***	SG	-0.05	SG	-0.27
Environmental factors		Environmental factors		Environmental factors	
TAX	-0.05***	TAX^{SH}	-0.04***	TAX^{SH}	-0.06***
GOV	0.69***	$TAX^{HK/SG}$	-0.07***	$TAX^{HK/SG}$	-0.08***
OPEN	0.62***	$GOV^{SH/SG}$	0.33***	$GOV^{SH/SG}$	0.46***
LEG	0.60***	GOV^{HK}	0.53***	GOV^{HK}	0.70***
COM	0.07***	LEG^{SH}	0.67***	$^{\#}LEG^{SH}$	0.61***

		LEG$^{HK/SG}$	0.52***	#LEG$^{HK/SG}$	0.71***
		OPEN	0.57***	#OPEN	0.84***
		COM	0.06***	#COM	0.12***
		Location loyalty		Location loyalty	
		L$^{SH-SH/SG-SG}$	0.58***	L$^{SH-SH/SG-SG}$	0.70***
		L^{HK-HK}	0.77***	L^{HK-HK}	0.99***
		L$^{Others-SH}$	0.83***	L$^{Others-SH}$	1.06***
		L$^{Others-HK}$	0.42*	L$^{Others-HK}$	0.49*
		Company history		Company history	
		H$^{SH/HK}$	0.80***	H$^{SH/HK}$	0.88***
		H^{SG}	0.57**	H^{SG}	0.59**
		Firm size		Firm size	
		S^{SH}	0.58***	S^{SH}	0.71***
		Type of business		Type of business	
		B_{MS}^{SH}	0.72***	B_{MS}^{SH}	0.92***
		$B_{MS}^{HK/SG}$	0.56***	$B_{MS}^{HK/SG}$	0.90***
		Interaction		Interaction	
		*GOV*E*	0.32***	*GOV*E*	0.39***
				Deviation of MSs from the mean	
				$LEG^{SH}	0.42*
				LEG^{HK/SG}$	0.00
				$OPEN	-0.23*
				$COM	-0.06**
No. of obs.	1044		1044		1044
Log likelihood	-1217.09		-1153.95		-1138.48
$R^2_{McFadden}$	0.16		0.20		0.21

Based on the result of Model 2, an RPL model (Model 3) is designed to study the parameter deviations of maritime services. Following the mixed logit model, the parameters of the five external factors are assumed to be $\beta_{ni} = \bar{\beta_i} + ŋ z_n + v_{ni}$, where $\bar{\beta_i}$ is the mean of the alternative-specific parameters (marked with #), z_n is the business type of the company, ŋ is the deviation of maritime services from the mean (market with $), and v_{ni} is a normally distributed random variable. The likelihood ratio test is applied to test the significance of this specification. The results are shown in the right panel in Table 3-3.

The random parameters are significant only for OPEN, LEG and COM. Compared with the results of Model 2, the estimated coefficients of the other variables in the RPL model have the same sign, but with a larger impact and significance level.

This result indicates an improvement in the regression model using RPL. The estimated mean coefficients of the random parameters are all positive and significant, consistent with the MNL results. The coefficient of LEG_{SH} is lower than that of $LEG_{HK/SG}$ (0.61<0.71), which is different from that in Model 2 (0.67>0.52), because the estimated deviation of maritime services for SH is 0.42. This result indicates that maritime services have a higher preference for SH compared with other business types provided that the legal environment in SH can be improved. For the deviation from the mean, the most significant result is found for COM. The estimated coefficient of $COM * B_{MSB}$ is -0.06 and is significant at the 5% level. Compared with other business types, the preferences of maritime services are less sensitive to COM. This result contrasts with the common belief that it is better for maritime services to be closer to ship owners, as they are the main clients of maritime service businesses. Unlike maritime services, the other business types are not directly involved in serving shipowners, and their opinion on the importance of large shipowners is mostly influenced by the media. However, for the three cities (HK, SG, SH), the maritime services in one city can also serve the shipowners in other cities. Therefore, they may not be that sensitive to an increase in COM. The estimated deviations of maritime services from the mean are significant at the 10% level only for OPEN and LEG. Since most maritime services are already in very open areas, a further increase in OPEN, which can only happen in SH, cannot increase the preference for HK/SG. Therefore, the sign on the deviation for OPEN is negative. The estimated parameter for LEG_{SH} is positive, indicating that further improvements in the LEG in SH can increase its attractiveness to maritime services.

However, further improving the legal environment in HK/SG will not have much impact on maritime services.

3.7 The trade-off between different environmental factors

In reality, it is often impossible for a country or region to match the conditions of all the external factors with other countries due to their different histories and backgrounds. Thus, it is critical to check whether a weakness in one factor can be compensated for by better conditions in other factors. For example, the commercial legal environment in China is determined by the legal system of the country, and it is unlikely that SH will adopt a legal environment similar to that in HK or SG. However, is it possible for SH to make some improvements in other external factors so that its overall competitiveness in attracting maritime services will be comparable to that of HK and SG?

The results of our study can be used to analyze the policy trade-off between different factors, which can be used to increase the competitiveness of a region. As a starting point, the current conditions of the five external factors at the three alternatives are listed in Table 3-4. The results from the RPL model (Model 3) are used to calculate the probabilities that each alternative will be selected.

Table 3-4: The current conditions of three cities

	SH	HK	SG
TAX	high ETR	low ETR	low ETR
GOV	active support	less support	active support
OPEN	less open	open	open
LEG	unsatisfactory	good	good
COM	4 companies	3 companies	5 companies

For each participating company, we calculate its choice probability for four alternatives (SH, SG, HK or NC) based on company-specific information and the current attribute levels of the five external factors at these alternatives. Then, by aggregating all the probabilities of all the companies for each of the four choice alternatives, the choice probabilities for each alternative can be obtained, and these are shown in (a) of Figure 3-3. It can be seen that, under the current business environment, only 5.48% will select SH, compared with 20.23% for HK and 67.51% for SG.

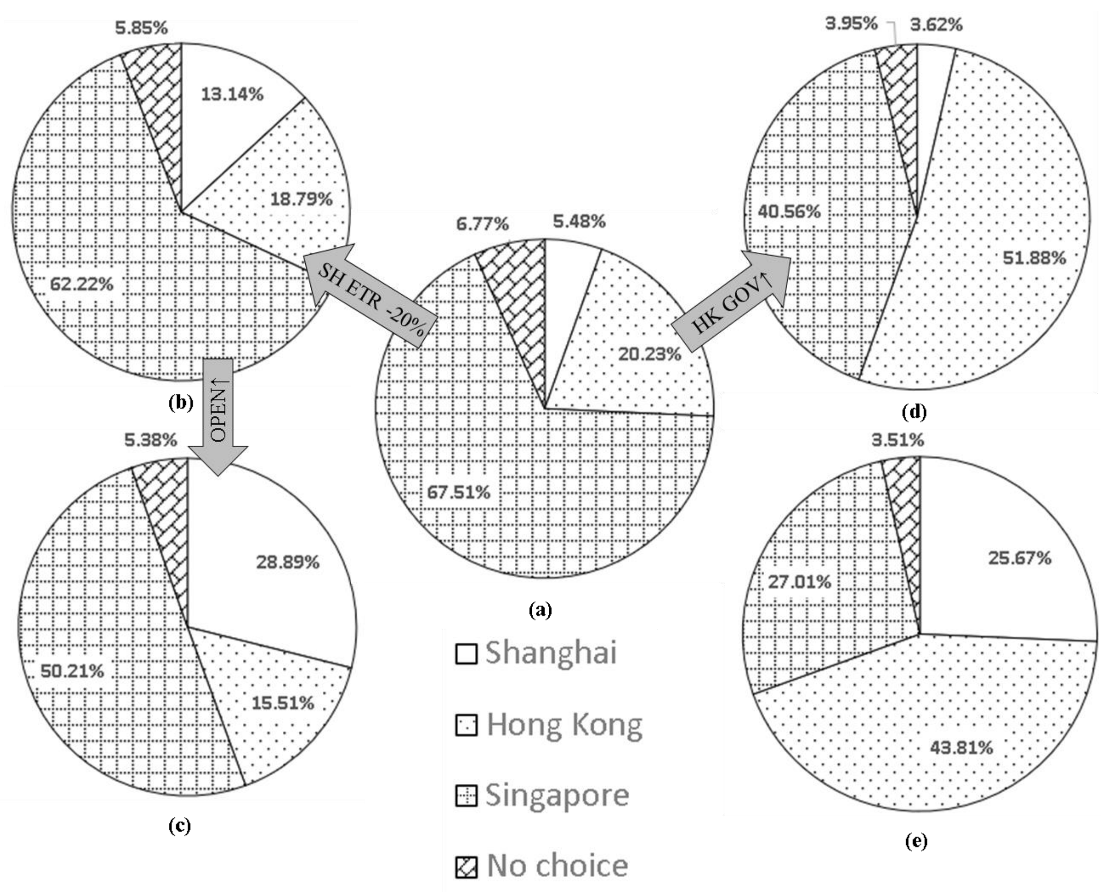


Figure 3-3. Results of trade-off analysis

As it is very difficult to improve the LEG in China, possible ways of increasing the attractiveness of SH are through TAX and OPEN. If SH can lower its ETR by 20%, its probability of being chosen will increase to approximately 13.14% ((b) in Figure 3-3), which is still lower than the probability that HK will be chosen (18.79%). To further increase the attractiveness of SH, in addition to the 20% reduction in its ETR, if OPEN can improve (from “less open” to “open”), its probability of being chosen can increase to 28.89%, which is higher than the probability that HK will be chosen ((c) in Figure 3-3).

Under the current conditions ((a) in Figure 3-3), SG is more attractive than HK. To increase HK’s competitiveness, if government support becomes “active”, HK can increase the probability of its being chosen to 51.88%, which is higher than the probability that SG will be chosen (40.56%). This result highlights the importance of active government support for the development of maritime services in HK.

Pie chart (e) in Figure 3-3 illustrates the necessary policy changes for making the attractiveness of these three places comparable. To this end, HK should improve its government support for the maritime industry. For SH, in addition to a 20% reduction in its ETR and an increase in its market openness, it needs to increase the number of shipowners to 25, since the commercial legal environment is very difficult to change under the current legal system in China. This result highlights SH’s difficulties in competing with HK and SG in the development of maritime service sectors if the current legal system remains unchanged.

3.8 Policy implications

The results from this study are significant, both for maritime services in selecting business locations, and for countries in setting up public policy that attracts such businesses. For maritime services, their location strategy is one of the central questions in maritime cluster studies, and maritime services prefer global cities with an attractive business environment, or pull factors (Jacobs et al., 2011). However, these pull factors are different for each global city. As each country/region has its own nature, it is not realistic to evaluate all alternatives using the same scale. How to weigh the conditions of these factors in different countries/regions is important when there are several competing choices for business location. To select a business location, the possibility of a trade-off between different factors should be allowed for. In addition, the importance of each factor may vary across different companies. Specifically, for maritime services that serve Asian customers, our three alternatives have different attributes. HK and SG are very similar in terms of their legal and tax systems, while SH and SG are very similar in terms of government support. Market openness and the number of large ship owners are also important. However, even though SH is less open than HK or SG, it is still attractive for some maritime services, especially new companies, as government support for the maritime industry there is very active.

In addition to the implications for the relocation decisions of maritime services, this study also contributes to the development of public policy for attracting maritime services. Although a country cannot improve certain very important pull factors in a short period of time, it can still try to increase its attractiveness by improving other factors. For example, due to their different legal systems, the LEG in SH is not as attractive to maritime services as those in HK and SG. However, it is not really realistic to expect SH to improve its LEG in a short period of time, as doing so would require fundamental changes to the legal system in China. However, if SH can reduce its ETR by 20% and at the same time increase its market openness, it still has the potential to compete with HK and SG. On the other hand, for HK, its weakness in attracting maritime services lies in the lack of active support from the government. The government of SG is very active in enticing businesses in the maritime industry, using many attractive schemes, such as the maritime sector incentive (MSI), withholding tax exemption (WHT) and maritime cluster fund (MCF) (MPA, 2020). Therefore, it is very important that HK changes its usual practice of "small government, big market" and actively supports the maritime industry to be as competitive as SG and SH, where government support is very active.

In order to gain more support from the HK government, increasing promotion of the HK maritime industry is the key and should be given top priority. Although in recent years, the HK government has tried to meet all the requirements of the industry, they are still not doing enough. For example, HK maritime week was inaugurated in 2016, ten years after that in Singapore. In 2019, the 4th HK maritime week was unfortunately impacted by the social situation in HK, as many activities were canceled. In addition, the HK government should adopt diverse ways to promote the HK maritime industry and actively find a method to cope with the social environmental changes.

Second, it is necessary to further cooperate with Mainland China in developing its maritime service cluster. As we know, the throughput of HK port is declining, and a large market share is going to ports in Mainland China. But HK has a very good foundation to further develop its maritime services. As the Mainland and Hong Kong Closer Economic Partnership Arrangement (CEPA) has been signed between the two governments, HK maritime suppliers have been given more flexibility (HKTDC, 2020).

For example, HK registered maritime companies and ships are allowed to operate maritime transportation between Hong Kong and Mainland's ports that are open to foreign vessels (GOVHK, 2020). However, the agreement is related more to shipping transportation at the current stage, so the regulations on maritime service businesses are very limited. This is a good chance for HK to develop its maritime service businesses, if the government could provide more flexibility on maritime service sectors under the CEPA.

Third, more funding should be provided for the maritime industry and research institutions. The HK government approved a $100 million Maritime and Aviation Training Fund (MATF) in 2014, and injected another $200 million into the MATF as training schemes and scholarships for the maritime and aviation sectors, with many maritime services being included in the schemes (HKTDC, 2020). These schemes are helpful for maritime education, but the sectors that benefit are practitioners and students. Research funding for maritime study is vital for maritime education and innovation, but is still very limited, as discussed in Chapter 2. Therefore, the government should put more emphasis on increasing maritime research funding, as research reflects innovation power, which is also a goal for industry development.

3.9 Chapter conclusions

Many researchers have studied the important factors affecting a maritime service’s selection of the best business location (Jacobs et al., 2011). However, when there are many alternatives, the influence of these factors may not be equal across different locations, and it may not therefore be feasible to evaluate the attractiveness of all locations using the same scale. In addition, for some locations, it might be impossible to change the condition of certain factors in just a short period of time. Understanding these differences and limitations can not only help maritime services in making their location decisions, but also influence the public policies of each region so that it can improve its attractiveness to maritime services. This study analyzes the business location behavior of maritime services, using the stated preference method. A hypothetical experimental environment with changing attribute levels in five major factors is provided to maritime business leaders to solicit their decision on the selection of three potential cities (SH, HK and SG). Discrete choice models are applied to analyze the data obtained from 87 valid surveys. The estimation results of these models show that most of the factors contained in this study are significant. Compared with the MNL models, the RPL models generally provide a better fit due to the incorporation of random taste variations among firms. The estimated alternative-specific parameters for the legal system, tax and government support in the three cities are consistent with reality—the impacts of the legal system and tax are similar in HK and SG, while the impacts of government support are similar in SG and SH. Companies in HK have the highest level of location loyalty, but maritime services overall have a higher preference for SH, especially if the LEG there can be improved. Business managers with less experience prefer active government support. Compared with other maritime industry sectors, maritime services do not view market openness and the number of large ship owners as important. Using the estimation results, the market share of each city can be evaluated using their current conditions in each of these major factors. On this basis, the necessary policy changes are identified that each region should make in order to increase its attractiveness. Finally, this analysis finds that it would be very hard for SH to become as competitive as HK and SG due to weaknesses in terms of its legal system, market openness, and high ETR.

This study contributes to both business location decisions and public policy in establishing effective policies to attract businesses, especially when there is competition from other cities. Businesses in the maritime industry can use the empirical results to evaluate the attractiveness of HK, SG and SH, and to select the best place for serving their customers in Asia. For each of the three cities, this study can help each local government to understand the relocation behavior of shipping businesses, especially maritime services, and to identify the necessary policy changes needed to keep or promote its competitiveness.

Chapter 4. Competition and evolution of maritime service clusters based on Hotelling's model

4.1 Background introduction

4.1.1 Introduction to maritime clusters and the maritime service cluster

Maritime cluster refers to *a geographic concentration of maritime-related firms, including research and education units and maritime-related public support institutions* (Chang, 2011). These firms choose to agglomerate together to gain higher utility. Specifically, firms from the same maritime sectors in a cluster share the same supply and demand, labor pool and knowledge spillover, while those from different sectors are linked by the supply and demand relationship. The sectors inside a maritime cluster can typically be divided into two types: 1) Traditional maritime industries, such as ports, shipping, shipbuilding and repairing. These industry sectors rely greatly on geographical factors, and their development is limited by location constraints. 2) The maritime service industry, which is an especially important part of a maritime cluster. The businesses in this category have a broad coverage, including ship finance, brokerage, legal services, marine insurances, ship management and maritime education. Maritime service sectors provide services featuring their experience, intellectual capability and high added value. Some of them participate in maritime activities directly and some of them do not. They provide services to the traditional maritime industry and also support the industry with information. A thriving maritime service industry often occurs in developed regions that have the powerful support of local advanced producer services such as a financial and insurance system (Jacobs et al., 2011a). Figure 4-1 lists some famous maritime clusters. It can be seen that some maritime clusters include large proportions of traditional maritime industries, such as the Dutch and Norwegian maritime clusters, and others rely more on maritime service industries, such as in the Hong Kong and London maritime clusters.

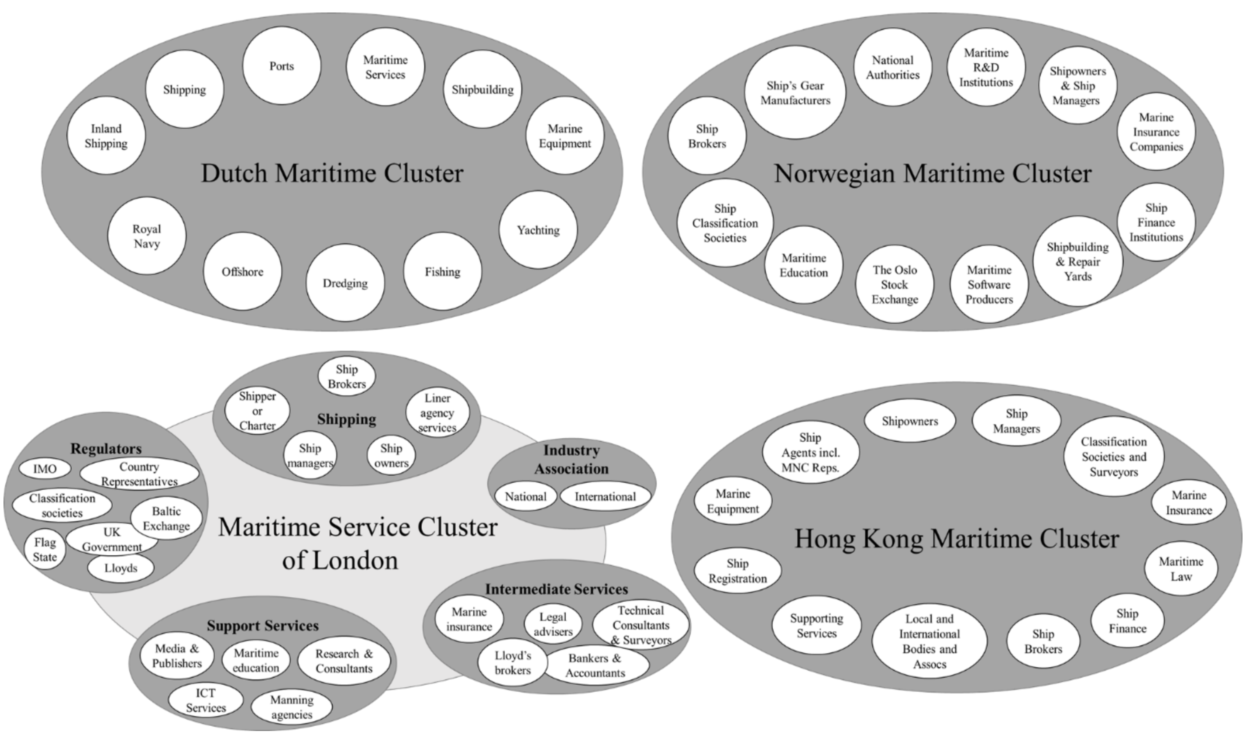


Figure 4-1. World famous maritime clusters' structure

Source: Han, 2006

4.1.2 Development of a maritime service cluster

The function of a maritime cluster changes as the function of a port changes. According to port generation theory (Beresford, Gardner, Pettit, Naniopoulos, and Wooldridge, 2004), a port's function normally evolves from being cargo-intensive to knowledge-intensive, which is the same as the development pattern of a maritime cluster. A cargo-intensive maritime cluster will have a higher concentration of more traditional maritime firms, whereas a knowledge-intensive maritime cluster will include a larger proportion of maritime service firms. When a cluster has evolved to a higher generation and focuses on its maritime service development, a maritime service cluster will be formed. Many famous maritime clusters, such as Hong Kong and London, have grown up and passed the age of having top port throughput, and are instead now concentrating on development of their maritime service clusters. In a maritime service cluster, service providers, such as P&I clubs and legal companies, are playing the role of supplier. Their demand come from shipowners or linear shipping companies. Such a supply and demand relationship is the foundation of a maritime service cluster's market operation.

Unlike a traditional maritime cluster, who's development relies heavily on cargo flow, the development of a maritime service cluster is more sustainable. Taking London as an example, the port of London was the busiest port in the 18th and 19th centuries (Port of London Authority, 2020). Nowadays, London is not famous for its port throughput anymore but for its maritime service cluster. With a long history of experience in maritime service businesses, London has established an advanced maritime service cluster, one that leads maritime service businesses all over the world. The BDI provided by the Baltic Exchange is now the guide for the whole shipping industry. With the benefits that come from developing a maritime service cluster, many historical port cities with declining cargo throughput are now considering developing their own maritime service business to maintain longer development, Hong Kong being one of them. As an international maritime center in Asia, Hong Kong has both the reason and foundation to develop its maritime service cluster. Hong Kong is the world's fourth-largest region, with ships totaling 125 million gross tones in 2019 (HKMPB, 2019). In that same year, 14.4% of registered cases in Hong Kong International Arbitration Centre (HKIAC) were from the maritime sector (HKIAC, 2020). Hong Kong is also leading in ship finance and marine insurance. However, the pressure of development comes from its competitor, Singapore. Singapore has a similar social, economic, and political environment to Hong Kong. At the same time, Singapore is also an Asian country with a good foundation of maritime service businesses. In 2009, the Singapore Chamber of Maritime Arbitration (SCMA) was reconstituted, and Singapore was added as an arbitral seat on BIMCO's forms. With each facing such a strong competitor, both regions are prepared to gain more from this competition.

Against this background, the competition between maritime service clusters is worthy of being studied, yet little attention is paid to this area. Modeling studies on competition in the maritime industry are mainly focused on port competition (Luo, Liu, and Gao, 2012; Zhou, 2015). On the other hand, a few studies have explored the location factors of maritime service clusters (Jacobs et al., 2011a; Ghiara and Caminati, 2017), but no attempts have been made to examine the competition between maritime services cluster. This may be due to London's status as the leading international maritime cluster over a long history without any competitor. Hong Kong and Singapore have only in the last decade or so emerged as potential international maritime service clusters.

4.1.3 The purpose of this study

The aim of this study is to investigate the equilibrium between two maritime service clusters in terms of temporary equilibrium and long-term development. The model is thus composed of temporary equilibrium and long-term development. The temporary equilibrium is based on Hotelling's mode (Hotelling, 1990) in which two maritime service clusters are located at different cities and each cluster is formed by a number of maritime service providers or suppliers. The two clusters are competing for the same source of customers. The long-term development assumes that the number of suppliers in each cluster is dynamic with respect to time, where the entry and exit process is determined by their profits. If a cluster has the potential for maritime service firms to make considerable profit, then firms will move in. As mentioned in section 1.1, firms will gain additional benefit from moving into a cluster because of external effects, such as knowledge spillover and a shared labor pool. In this study, we use "scale efficiency" to convey this notion. A higher cluster effect will raise the competition of a cluster. At the same time, the increasing number of companies leads to more intense competition, which lowers the profit of each company since demand is finite. Two maritime clusters thus compete for clients and reach the ultimate equilibrium.

4.2 Literature review

4.2.1 Theoretical studies on the evolution and competition of a general industrial cluster

Locational pattern is a popular topic in academic fields. It studies firms' spatial agglomeration behavior according to externalities of the location and increasing returns (Bottazzi, Dosi, Fagiolo, and Secchi, 2007). The theory has been studied by many scholars using different methods, and has been applied to various industries.

Bottazzi and Dindo (2008) conducted an evolutionary model for firms' long-run selection decisions between two agricultural locations. The model was built on three assumptions. First, interactions among the firms should take place. Second, flow of time should be present. Third, the heterogeneity of firms should be captured (i.e., the firms manufactured heterogeneous products). The dynamic model is based on profit maximization and the entry-exit process of firms. In their settings, firms revise their location decision according to profit in their new location choice. The cost in their model applied economies of scale, such that an increase in output would decrease the average cost to each firm. To ascertain the evolution pattern of agglomeration, numerical simulation was adopted. The results show a metastable state due to the stochastic nature of the dynamics.

Bottazzi et al. (2007) established an industrial evolution model. In this model, finite firms choose from finite locations to do business. New firms are selected randomly from the potential entrants, and then firms choose to relocate based on the expected benefits. The benefit to each firm consists of two parts: one is the "geographic attractiveness" of a particular location, another is an "agglomeration benefit", which is in proportion to the number of firms already located there. Then, the firm's entry and exit process is modeled by a Markov Chain. The general model is illustrated, together with the results of simulation on a few small economics.

Brinkman, Coen-Pirani, and Sieg (2015) established a dynamic general equilibrium model to investigate firms' entry and exit in one location. They collected information about business districts with a high density of firms in USA. Stationary equilibrium was discussed. Their study considered agglomeration externalities and found that it can increase firms' productivity. They also found that agglomeration externalities will increase if the government subsidizes firms who relocate to a certain business district.

Soubeyran and Thisse (1999) examined the development of industrial districts within which a large number of small firms producing similar products benefit from knowledge spillover. In their model, firms are identical and need to choose a location in the first period. In each subsequent period, firms choose to relocate to another place to maximize their profit. The study is rooted in Marshallian districts theory and considers the learning-by-doing process of labor. Therefore, the cost function decreases with the total output in this location. The entry of firms in one location will trigger competition and reduce the number of firms that come. The short-run equilibrium and long-run evolution process are characterized by the author.

4.2.2 Application of Hotelling's model

The Hotelling Model (Hotelling, 1990) is a game model on locational equilibrium in duopoly. According to the Hotelling model, competition between services provided at two locations in a linear city is determined by consumers' distribution and transportation costs. This model has been popularly adopted in different fields as a method of analyzing the competition problem. Many attempts have previously been made to apply the Hotelling Model to port competition.

Czerny, Höffler, and Mun (2014) adopted a two-stage Hotelling model to investigate competition between two ports. In the first stage, ports decide whether or not to apply privatization. In the second stage, port prices are decided. The results show that national welfare is higher when both ports choose privatization rather than being public. In their study, the transportation is assumed to be sufficiently high to ensure that demand is larger than zero. This condition was also considered in our study.

Yu and Shan (2013) used a Hotelling model to study the competition of two container ports. This study analyzes two different models, port competition with competing terminals and port competition with centralized terminals. In their study, ports compete in port dues and terminals control service price and quality. The result suggests that the terminal should apply a centralized approach instead of competition if it does not have any service advantages.

Zhou (2015) adopted a Hotelling model to analyze the best strategies for port competition. The results show that location is important for competitive ports that have the same service level. They also indicated that ports tend to form alliances to capture market share.

4.3 Model basics

The research framework is based on a Hotelling model (Figure 4-2) where two cities, A and B, each separated with a unit distance, and each having a maritime cluster, are competing to attract customers that are uniformly distributed between the two cities.

The number of existing maritime service firms at cluster A is a, while that at cluster B is b.

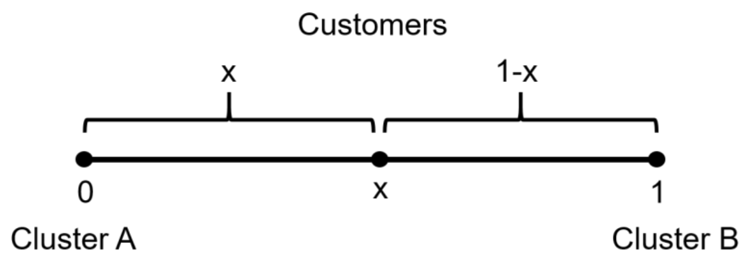


Figure 4-2. Scheme of the customer allocation based on Hotelling's model in this study

The service prices in cluster A and cluster B are S_1 and S_2, respectively. In a classical Hotelling model, customers have a constant per distance transportation cost t for travelling to the producers. Although modern technology, such as video conferencing, provides convenient communication tools between service providers and customers, face-to-face contact is considered essential for high quality service (Cook, Pandit, Beaverstock, Taylor, and Pain, 2007). Therefore, for the sake of simplicity, the transportation cost remained the same in our model, where the customers have the transportation cost t for travelling to the cities and using the service from one of the two clusters. For a customer located at position x, $x \in [0,1]$, the total cost of using the service from cluster A or B is $S_1 + tx$ or $S_2 + t(1 - x)$, respectively. Let $\tilde{x}$ be the situation where the customer is indifferent to choosing between the two services from the two clusters, then $\tilde{x}$ satisfies

$$S_1 + t\tilde{x} = S_2 + t(1 - \tilde{x}) \quad (1)$$

Therefore, the ratio of customers going to cluster A is

$$\tilde{x} = \frac{S_2 - S_1 + t}{2t}. \tag{2}$$

Equation (2) implies that $S_2 - S_1 + t \geq 0$.

And the ratio of customers going to cluster B is

$$(1 - \tilde{x}) = \frac{-S_2 + S_1 + t}{2t}. \tag{3}$$

Let the total transferable demand, i.e. the total amount of the business need from the customers in the system be D. Hence, we can obtain the total demand for cluster A as being

$$\frac{S_2 - S_1 + t}{2t} \cdot D \tag{4}$$

Then the total demand for cluster B is

$$\frac{S_1 - S_2 + t}{2t} \cdot D \tag{5}$$

The cost function for a maritime service firm is assumed to have two parts—the variable cost and the fixed cost. The variable cost is a function of the number of customers serviced. To reflect the scale efficiency of maritime clusters, we assume that the unit variable cost is a decreasing function of the number of firms in the cluster. Using O to denote the base unit cost per service, $z > 0$ represents the scale efficiency, and with a fixed cost F_1 and F_2 for firms in clusters A and B respectively, the cost function for cluster A can be written as

$$C_0 = e^{-z_1 a} O Q_1 + F_{1.} \tag{6}$$

Assuming that the firms in the cluster are homogeneous and each firm serves an equal number of customers in the cluster, the customers served by a firm in cluster

A, Q_1, can therefore be defined as

$$Q_1 = \frac{\tilde{x}D}{a} = \frac{(S_2 - S_1 + t)D}{2at} \tag{7}$$

Hence, the profit before tax of a firm in cluster A, denoted as Π_0, is as follows:

$$\begin{aligned} \Pi_0 = {} & S_1 Q_1 - e^{-za} O Q_1 - F_1 \\ & = (S_1 - e^{-z_1 a} O) \frac{(S_2 - S_1 + t)D}{2at} - F_1. \end{aligned} \tag{8}$$

Consider that the firm needs to pay a tax ratio of T_1 to the government, then its profit function after tax, denoted as Π_1, will be

$$\Pi_1 = [(S_1 - e^{-z_1 a} O) \frac{(S_2 - S_1 + t)D}{2at} - F_1](1 - T_1), \tag{9}$$

where $T_1 < 1$.

The condition for positive profit requires $(S_1 - e^{-z_1 a} \cdot O) \frac{(S_2 - S_1 + t)D}{2at} - F_1 > 0$.

4.4 Equilibrium analysis

4.4.1 Short-run equilibrium between the clusters

In this section, we analyze the equilibrium prices of the service firms in each cluster and the customers attracted to each of them. The firms in the two clusters determine their best prices so as to maximize their respective profit. The first order condition (FOC) for profit maximization at cluster A is

$$\frac{\partial \Pi_1}{\partial S_1} = \frac{De^{-z_1 a}(\,O + e^{z_1 a}(S_2 - 2S_1 + t))(1 - \,T_1)}{2at} \tag{10}$$

The second order condition is satisfied as the derivative $\frac{\partial^2 \Pi_1}{\partial {S_1}^2} = \frac{D(-1+T_1)}{at} < 0$. Then, the best price of the firms at cluster A can be written as a function of the price at cluster B, i.e.,

$$S_1 = \frac{1}{2}S_2 + \frac{1}{2}t + \frac{1}{2}Oe^{-z_1 a} \tag{11}$$

Similarly, for cluster B, the best price can also be expressed as:

$$S_2 = \frac{1}{2}S_1 + \frac{1}{2}t + \frac{1}{2}Oe^{-z_2 b} \tag{12}$$

From the two equations in (11) and (12), we can solve the equilibrium optimal prices for the firms in each cluster:

$$S_1^* = (\frac{2}{3}e^{-z_1 a} + \frac{1}{3}e^{-z_2 b})O + t \tag{13}$$

$$S_2^* = \left(\frac{1}{3}e^{-z_1 a} + \frac{2}{3}e^{-z_2 b}\right)O + t \tag{14}$$

Thus, the difference in optimal price $S_1^* - S_2^* = \frac{1}{3}(e^{-z_1 a} - e^{-z_2 b})O$ is proportional to the difference in unit cost. The sign of unit cost difference $e^{-z_1 a} - e^{-z_2 b}$ depends on the scale efficiency and cluster size, leading to the scenario that if a cluster has larger scale or higher efficiency, it would charge a lower price. For example, if $a > b$ or $z_1 < z_2$ while the other parameters all remain the same, S_1^* would be lower than S_2^*.

The demand (customers) allocated to each firm in a cluster are:

$$Q_1^* = \frac{[\frac{1}{3}(e^{-z_2 b} - e^{-z_1 a})O + t]D}{2at} \tag{15}$$

$$Q_2^* = \frac{[\frac{1}{3}(e^{-z_1 a} - e^{-z_2 b})O + t]D}{2bt} \tag{16}$$

To ensure no-negative Q_1^*, it is required that $S_2^* - S_1^* + t \geq 0$; similarly, the non-negativity of Q_2^* requires $S_1^* - S_2^* + t \geq 0$. From this, it can be concluded that it is necessary to have $S_1^* - t \leq S_2^* \leq S_1^* + t$. The equilibrium profit of a firm in two clusters is:

$$\Pi_1^* = (1 - T_1)[\frac{D\left(\frac{1}{3}e^{-z_2 b}O - \frac{1}{3}e^{-z_1 a}O + t\right)^2}{2at} - F_1] \tag{17}$$

$$\Pi_2^* = (1 - T_2)[\frac{D\left(\frac{1}{3}e^{-z_1 a}O - \frac{1}{3}e^{-z_2 b}O + t\right)^2}{2bt} - F_2] \tag{18}$$

We then conduct comparative static analysis on the impact of cluster scales (a, b) on the i) optimal price, ii) demand allocated to each firm, iii) demand allocated to each cluster, and iv) the profit of each firm.

i) For the optimal price, it is straightforward to see that $\frac{\partial S_1^*}{\partial a} < 0$, i.e., increasing the scale of a shipping cluster will reduce the service price. Also, $\frac{\partial S_1^*}{\partial b} < 0$, increasing the size of one cluster will also reduce the price of the competitor.

ii) For the demand allocated to each firm, since $Q_1^* = \frac{(S_2^* - S_1^* + t)D}{2at}$, we have

$$\frac{\partial Q_1^*}{\partial a} = \frac{D}{2at}\left(\frac{\partial(S_2^* - S_1^* + t)}{\partial a} - \frac{(S_2^* - S_1^* + t)}{a}\right) \quad (19)$$

The first part in the parentheses is the marginal change of $S_2^* - S_1^* + t$ with respect to a, while the second part is the average change with respect to a. As shown in Figure 4-3, if $f(a) = S_2^* - S_1^* + t$ is a concave function, the marginal change will be smaller than the average change. If $f(a) = S_2^* - S_1^* + t$ is a convex function, the marginal change will be larger than the average change.

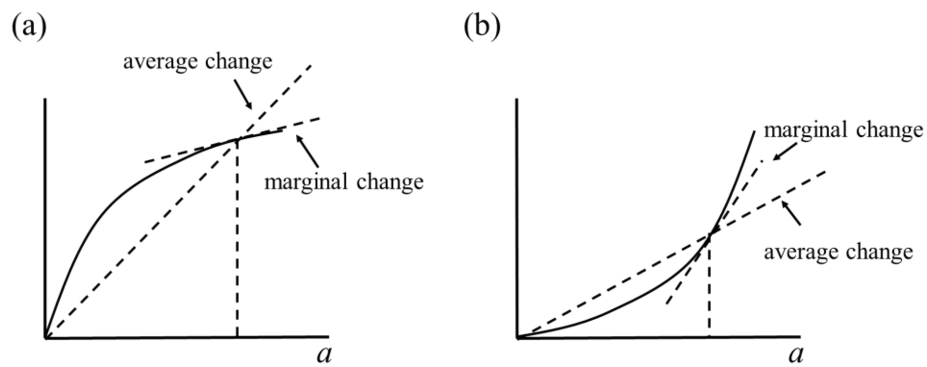


Figure 4-3. Marginal change and average change of (a) concave and (b) convex function

Since $\frac{\partial(S_2^* - S_1^* + t)}{\partial a} = \frac{1}{3} e^{-z_1 a} O z_1 > 0$ and $\frac{\partial^2(S_2^* - S_1^* + t)}{\partial a^2} = -\frac{1}{3} z_1^2 O e^{-z_1 a} < 0$, $f(a) = S_2^* - S_1^* + t$ is a concave function. Therefore, we deduce that $\frac{\partial Q_1^*}{\partial a} < 0$. Meanwhile, $\frac{\partial Q_1^*}{\partial b} = \frac{-z_2 D}{6at} e^{-z_2 b} < 0$. We will come back to the implication of these later.

iii) For the demand allocated to each cluster, we have

$$\frac{\partial Q_1^* a}{\partial a} = \frac{D}{2t}\left(\frac{\partial(S_2^* - S_1^* + t)}{\partial a}\right) > 0 \quad (20)$$

which means that an increase in cluster size will attract more customers to the cluster. Since $Q_1^* a + Q_2^* b = D$, the increased size of the cluster would definitely lower the number of customers attracted to another cluster.

iv) We now analyze the impact of firm numbers on the profit of each firm. Since we know that $S_1^* - S_2^* = (\frac{1}{3}e^{-z_1 a} - \frac{1}{3}e^{-z_2 b})O$, we express the equilibrium profit function in the following way:

$$\Pi_1^* = (1 - T_1)(\frac{D(S_2^* - S_1^* + t)^2}{2at} - F_1) \tag{21}$$

And the first derivative of the equilibrium profit with respect to the number of firms can be simplified as

$$\frac{\partial \Pi_1^*}{\partial a} = \frac{D(1 - T_1)}{2at}\left(\frac{\partial (S_2^* - S_1^* + t)^2}{\partial a} - \frac{(S_2^* - S_1^* + t)^2}{a}\right) \tag{22}$$

By referring back to Figure 4-3 to check the nature of equation (21), we only need to check whether $f(a) = (S_2^* - S_1^* + t)^2$ is concave or convex by doing the following calculation:

$$\frac{\partial (S_2^* - S_1^* + t)^2}{\partial a} = \frac{2}{3}e^{-z_1 a} O z_1 (\frac{1}{3}e^{-z_2 b} O - \frac{1}{3}e^{-z_1 a} O + t)$$

$$= \frac{2}{3}e^{-z_1 a} O z_1 (S_2^* - S_1^* + t) > 0$$

$$\frac{\partial^2 (S_2^* - S_1^* + t)^2}{\partial a^2} = \frac{2}{3}e^{-z_1 a} O {z_1}^2 (\frac{2}{3}e^{-z_1 a} O - \frac{1}{3}e^{-z_2 b} O - t)$$

Since $\frac{2}{3}e^{-z_1 a} O {z_1}^2 > 0$, we obtain

$$\frac{\partial \Pi_1^*}{\partial a}\begin{cases} > 0, & if\ \frac{2}{3}e^{-z_1 a}O - \frac{1}{3}e^{-z_2 b}O - t > 0 \\ = 0, & if\ \frac{2}{3}e^{-z_1 a}O - \frac{1}{3}e^{-z_2 b}O - t = 0 \\ < 0, & if\ \frac{2}{3}e^{-z_1 a}O - \frac{1}{3}e^{-z_2 b}O - t < 0 \end{cases} \quad (23)$$

Then we need to test whether the $\frac{2}{3}e^{-z_1 a}O - \frac{1}{3}e^{-z_2 b}O - t$ is positive. If $\frac{2}{3}e^{-z_1 a}O - \frac{1}{3}e^{-z_2 b}O - t$ >0, then we have

$$\frac{1}{3}e^{-z_2 b}O - \frac{2}{3}e^{-z_1 a}O + t < 0$$
$$\frac{1}{3}e^{-z_2 b}O - \frac{1}{3}e^{-z_1 a}O + t - \frac{1}{3}e^{-z_1 a}O < 0$$

This is equal to:

$$S_2^* - S_1^* + t - \frac{1}{3}e^{-z_1 a}O < 0$$

Since the optimal price should also follow the FOC (eq. 10 equals to 0), and the FOC is $S_2^* - 2S_1^* + t = -e^{-z_1 a}O$, then

$$S_2^* - S_1^* + t - \frac{1}{3}e^{-z_1 a}O = S_2^* - 2S_1^* + t - \frac{1}{3}e^{-z_1 a}O + S_1^*$$
$$= (S_1^* - e^{-z_1 a}O) - \frac{1}{3}e^{-z_1 a}O$$

Now we can see that $S_1^* - e^{-z_1 a}O$ is the unit earning under optimal conditions and that $\frac{1}{3}e^{-z_1 a}O$ is one third of the unit cost under optimal conditions (without considering the fixed cost). If the unit earning under optimal conditions is smaller than one third of the unit cost under optimal condition, the optimal profit will increase with a. The criteria can be written as

$$\frac{\partial \Pi_1^*}{\partial a}\begin{cases} > 0,\ \ if\ S_1^* - e^{-z_1 a}O < \dfrac{1}{3}e^{-z_1 a}O \\ = 0,\ \ if\ S_1^* - e^{-z_1 a}O = \dfrac{1}{3}e^{-z_1 a}O \\ < 0,\ \ if\ S_1^* - e^{-z_1 a}O > \dfrac{1}{3}e^{-z_1 a}O \end{cases} \quad (24)$$

For the impact of cluster scale on the profit of a firm in another cluster, we can obtain it from $\frac{\partial \Pi_1^*}{\partial b} = -e^{-z_2 b}O(1 - T_1)z_2 \frac{D\left(\frac{1}{3}e^{-z_2 b}O - \frac{1}{3}e^{-z_1 a}O + t\right)}{3at} < 0$. Therefore, an increase of cluster scale in one cluster will lead to a decrease in firms' profit in another cluster.

We now come back to the impact of cluster scale on the demand allocated to each firm. While the profit might increase or decrease as a function of its own cluster scale, and decrease as a function of another cluster scale, the demand allocated to each firm will decrease while the cluster scale of either cluster increases. Since the total customer number (demand) is constant, it is reasonable that an increase in cluster size will lead to a direct average decrease of its own firms' demand, or indirectly to less market share of another cluster's firms.

To summarize the short-term equilibrium, we can obtain the following:

i) For a larger cluster or a cluster with higher scale efficiency, firms in the cluster are allowed to charge a lower price, thus attracting more customers to the cluster;

ii) During competition, an increase in size of either cluster will lower the number of customers attracted to all firms in each cluster;

iii) If the unit earning under optimal conditions is less than one third of the unit cost under optimal conditions, the optimal profit will increase with cluster size.

4.4.2 Evolution of the clusters

We now proceed to study the evolution of the maritime service cluster. In the last section, the firms in both clusters maximize their profit by determining the service prices. Next, we want to study the evolution of the cluster assuming more firms will enter if there is positive profit in each cluster, or will exit if there are losses. We denote the following notations according to the time period: Π_{1i}^* and Π_{2i}^* are the equilibrium profits of individual firms in cluster A and B at time i; a_i and b_i are the number of firms in the two clusters at that time; S_{1i}^* and S_{2i}^* are the optimal prices of those firms; Q_{1i}^* and Q_{2i}^* are the total demand (customers) attracted to each cluster; where $i = 0, 1, 2, 3$ ....

Assumption: The development follows the entry and exit process. New firms are free to enter both clusters, while existing firms are also free to exit the clusters. Several new firms will choose to enter one of the clusters, the one having the higher profit per firm during the last time period. Also, a number of existing firms will exit the clusters if the profit per firm is negative.

The development of the cluster follows the rules below:

If $\Pi_{1i}^* > \Pi_{2i}^* > 0$, then $a_{i+1} = a_i + n$, where n is the number of firms entering the cluster in the next time period.

If $\Pi_{2i}^{*} > \Pi_{1i}^{*} > 0$, then $b_{i+1} = b_i + n$, where n is the number of firms entering the cluster in the next time period.

If $\Pi_{1i}^{*} < 0$, then $a_{i+1} = a_i - n$, n firms will exit the cluster in the next time period. If $\Pi_{2i}^{*} > 0$, then $b_{i+1} = b_i - n$, n firms will exit the cluster in the next time period.

To capture the main properties of our model, we consider some scenarios, as shown in Table 4-1. The parameter values are for qualitative analysis and illustration purposes only, and do not reflect the actual values in maritime service clusters. The variable of the parameters can be divided into two groups, namely, cluster specific and general, which define whether the parameter is for a specific cluster. For simplicity of comparison, we set all variations of the cluster specific parameters leading to unfavorable results for cluster A.

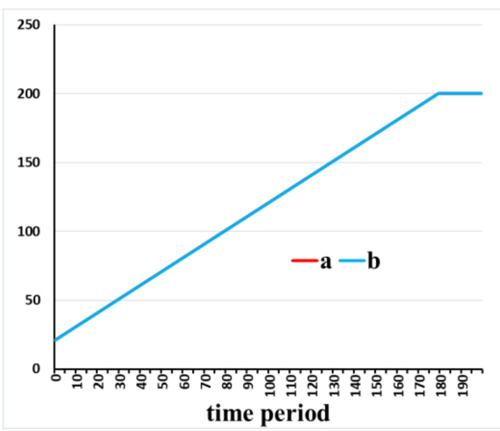
Table 4-1. Initial parameters in the numerical simulation

Condition	*Varied Parameter*	a	b	n	T_1	T_2	z_1	z_2	F_1	F_2	D	O	t
1	-	21	21	1	0.2	0.2	0.05	0.05	10	10	2000	10	2
Cluster-specific													
2	*Firm number*	11	31	1	0.2	0.2	0.05	0.05	10	10	2000	10	2
3	*Tax*	21	21	1	0.4	0.2	0.05	0.05	10	10	2000	10	2
4	*Scale efficiency*	21	21	1	0.2	0.2	0.03	0.05	10	10	2000	10	2
5	*Fixed cost*	21	21	1	0.2	0.2	0.05	0.05	20	10	2000	10	2
General													
6	*Customer*	21	21	1	0.2	0.2	0.05	0.05	10	10	5000	10	2
7	*Operational cost*	21	21	1	0.2	0.2	0.05	0.05	10	10	2000	20	2
8	*Transportation cost*	21	21	1	0.2	0.2	0.05	0.05	10	10	2000	10	5

Condition 1

Consider the simplest cases, with equal initial parameters of cluster A and cluster B (Table 4-1, condition 1).

The evolution of the number of firms and the profits are iterated for 200 periods of time. The curves of the number of firms are shown in Figure 4-4a, while the curves of the profits are shown in Figure 4-4b. The two curves overlap due to the identical parameter set. Cluster scales keep increasing until time period ~180 (Figure 4-4a). This is because firms in the clusters have positive profit at the beginning and thus attract the entry of new firms. The profit decreases as cluster size increases with time. Starting both clusters with 21 firms at the beginning, both clusters reach an ultimate number of firms at ~ 200.

(a) 

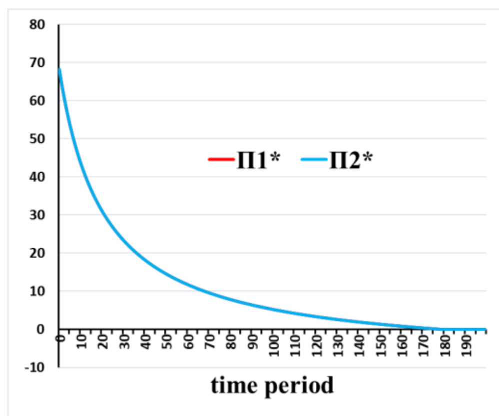
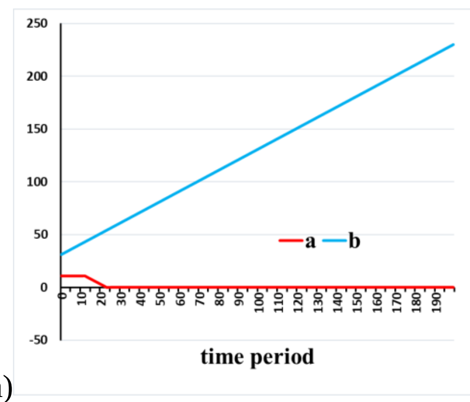
(b) 

Figure 4-4. Evolution of the (a) firm numbers and (b) profits under condition 1

Condition 2

We then consider the case where the two clusters have different initial sizes—the size of cluster A is smaller than that of B. The other parameters are equal for the two clusters.

As shown in Figure 4-5a, the size of cluster B increases as a function of time, while the size of cluster A decreases from time period ~10 and drops to 0 at time period ~25. The contraction of cluster A is because Π_{1i}^{*} decreases as a function of time and becomes negative at time period ~10. Π_{2i}^{*} also decreases as a function of time, except from time period ~10 to ~25. The temporary increase of Π_{2i}^{*} can be explained by the contraction of cluster A leading to a higher unit cost in cluster A, making cluster B more competitive, and therefore the firms in cluster B can charge a higher price and earn more profit. Upon the disappearance of cluster A, the further growth of cluster B will lead to the same averaging effect as before.

(a) 

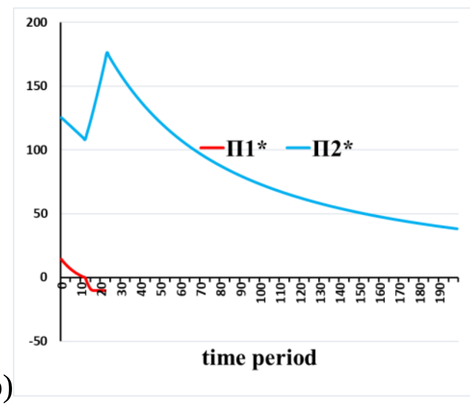
(b) 

Figure 4-5. Evolution of the (a) firm numbers and (b) profits under condition 2

Condition 3

This case starts with the governments of cluster A and cluster B having different tax rates for the firms (Figure 4-6). The size of cluster B keeps expanding, while that of cluster A remains unchanged. This is because the lower tax rate of cluster B allows the firms to earn more profit.

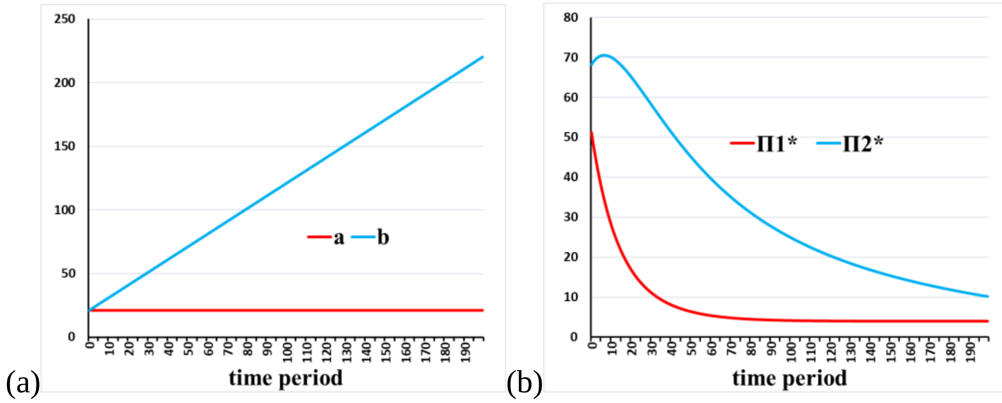


Figure 4-6. Evolution of the (a) firm numbers and (b) profits under condition 3

Condition 4

Under this condition, the scale efficiency of the two clusters are different. Cluster A has a lower scale efficiency than cluster B. In other words, firms in cluster A will experience a lower cost reduction benefit from firm agglomeration. The results are shown in Figure 4-7. The behavior is similar to that of condition 2, in which cluster B will continue to grow while cluster A will not be able to survive.

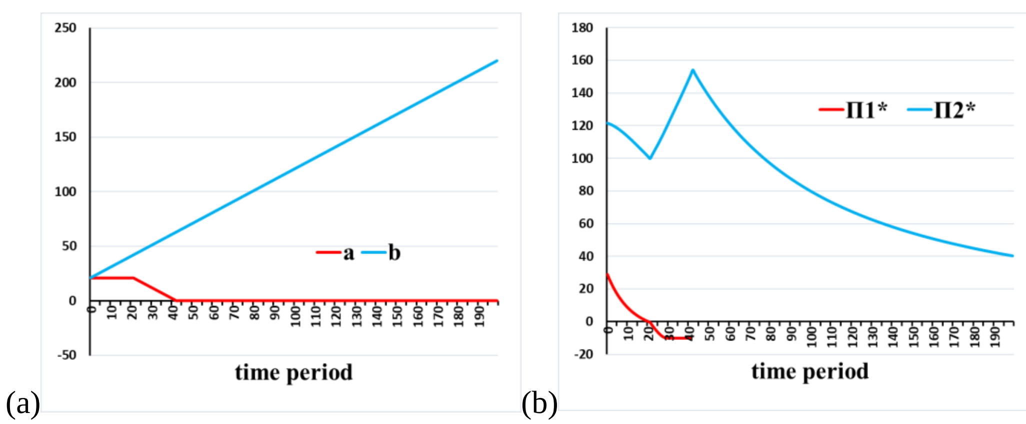
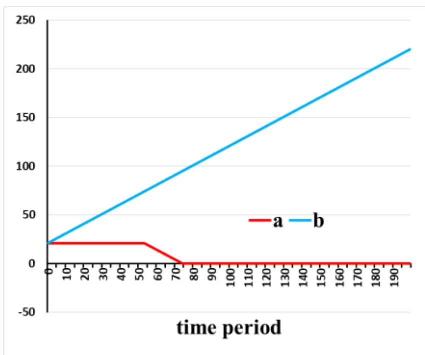


Figure 4-7. Evolution of the (a) firm numbers and (b) profits under condition 4

Condition 5

The initial parameters of fixed cost are set to be different in this case. Firms in cluster A experience a higher fixed cost than cluster B. In the early stages, cluster B grows while cluster A remains unchanged. In the later stages, cluster A begins to contract and will not be able to survive, while cluster B will continue to grow (see Figure 4-8). At a particular period, the decreasing size of cluster A leads to an increased profit for cluster B, since the firms in cluster B can charge a higher price.

(a) 

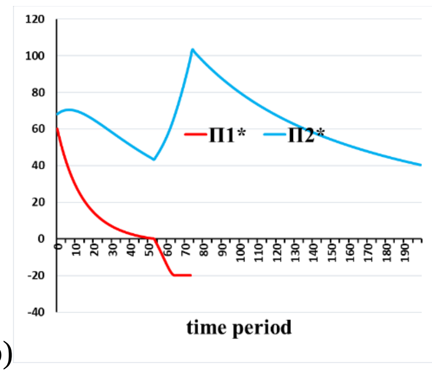
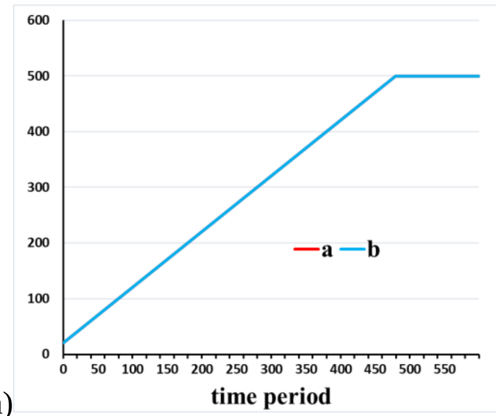
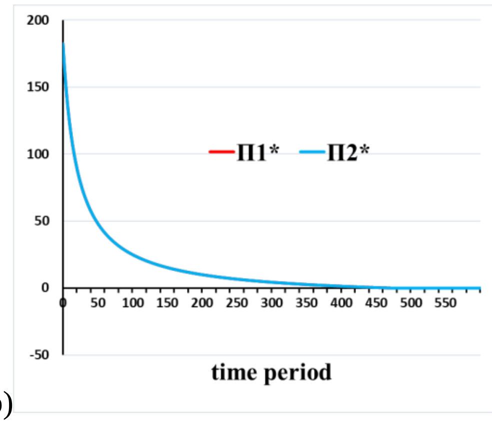
(b) 

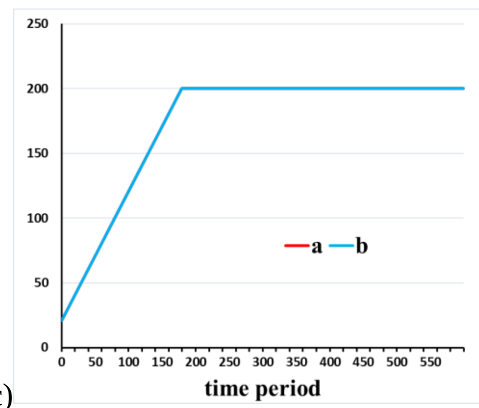
Figure 4-8. Evolution of the (a) firm numbers and (b) profits under condition 5

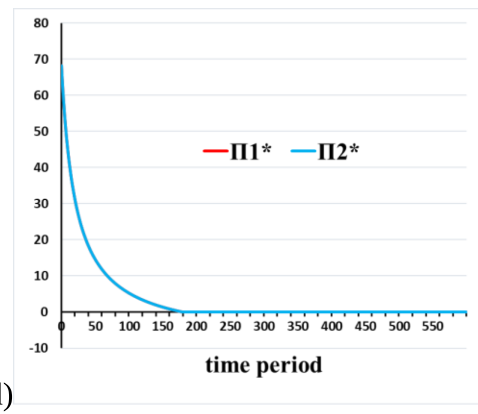
Conditions 6-8

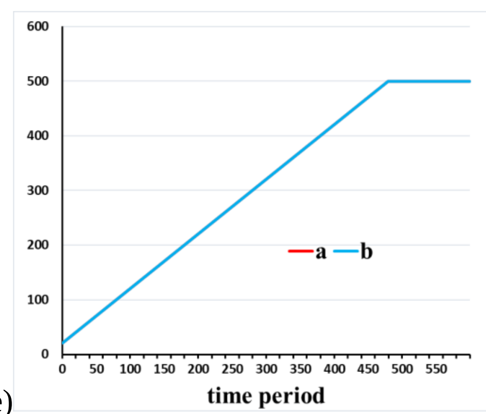
We group conditions 6-8 for discussion, as the non-specific parameters for both clusters are all changed (Figure 4-9). We allow the simulation to iterate to 600 time periods in order to understand the effect of the parameters when compared with condition 1. While the effect from operational cost does not affect the development of the clusters (Figure c-d), the effects of total number of customers (Figure a-b) and transportation cost (Figure e-f) both indicate that ultimate cluster size are proportional to these two parameters. For the number of customers, it is clear that an increase in the number of total customers will compensate for the average effect of reducing the profit. For the transportation cost, it is consistent with the general observation in Hotelling's model (Hotelling, 1990) that firms compete less intensely under higher transportation cost and therefore each firm can set a higher service price ($S_1^* = (\frac{2}{3}e^{-z_1 a} + \frac{1}{3}e^{-z_2 b})O + t$).

(a)


(b)


(c)


(d)


(e)


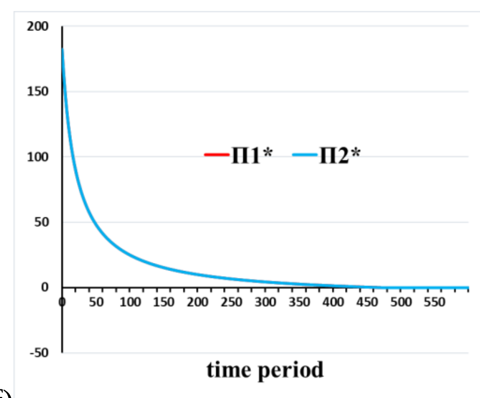
(f)


Figure 4-9. Evolution of the (a) firm numbers and (b) profits of cluster A under conditions 6-8

From the above analysis, we can conclude the following points with regard to the development of two maritime service clusters under competition:

1) Service firms continue to enter each cluster until the profit in the firm, as an average effect, decreases to zero.

2) Smaller clusters, clusters with lower scale efficiency, higher fixed costs, or a higher tax rate, are not able to survive.

3) Total number of customers, and transportation cost, are the determinants of a cluster size, while unit operational cost is unlikely to affect the cluster size.

4.5 Implications for the development of world maritime service clusters

According to the Xinhua-Baltic International Shipping Centre Development Index Report 2020 (Baltic Exchange, 2020), London, Singapore, Shanghai and Hong Kong remain the top 4 maritime service clusters over the last 5 years. London and Singapore continue to occupy the first and second positions, respectively, while Shanghai becomes number three after surpassing Hong Kong in 2019. Despite their relatively stable positions, the Asia-pacific market provides further development room for the three Asian cities, and they are still far from mature. For example, while London has around 80 shipping brokerage companies as of 2020, Singapore, Shanghai and Hong Kong have only around 40, 25 and 20, respectively (Baltic Exchange, 2020). As for maritime arbitrators, London has more than 400 maritime arbitrators while the numbers in Hong Kong, Shanghai and Singapore are all less than 50 (Baltic Exchange, 2020). Therefore, the three Asian maritime clusters fall into the very scenario where development and competition both take place. It is anticipated that the clusters will continue to grow, provided they promote more scale efficiency or reduce more of the fixed costs, and thus they might ultimately become larger.

4.6 Chapter conclusions

In this study, we build a theoretical model to investigate the competition between two maritime service clusters, and the growth of the clusters under competition. We adopt Hotelling's model to study the customer allocation to each cluster, by which the firms in clusters can determine their price. The optimal conditions for both the price and profit are identified. During growth of the cluster, the firms' profits increase with an increase in the number of firms if their unit earning is less than one third of the unit operational cost. Upon further growth, the optimal profit of the firm decreases until it approaches zero. Our numerical simulation on the growth of maritime service clusters suggests that smaller clusters, and clusters with lower scale efficiency or higher fixed costs, are not able to survive. The firms' fixed costs, total number of customers and transportation cost, are the determinants of the ultimate cluster size. This study enhances our understanding as to how maritime service clusters compete with each other, and how to forecast the ultimate development of the clusters. The study also provides references for policy makers, so they can focus on enhancement of the determinants identified in our study.

Chapter 5. Conclusions

5.1 Conclusions and contributions

The past decades have witnessed dramatic changes in global trade patterns, along with the shifting of shipping centers from Europe to Asia. The maritime service cluster, as a relatively higher level of maritime cluster, has already developed very maturely in London, whereas in Asia it has only emerged in recent years as the decline in throughput of some historical ports such as Hong Kong and Singapore has taken place. The importance of shipping digitization and maritime soft power continues to increase, providing further opportunities for the development of maritime services. However, during our research we found very few studies on maritime service clusters. The reason may be twofold. First, clusters specializing in service businesses are only suitable for a few port cities whose traditional maritime industry has already been developed and perfected, and the changes, therefore, may not have raised enough attention. Second, competition between maritime service clusters have only occurred in recent years when many Asian ports passed their Golden Age and are now facing a decline in cargo flow. Therefore, our study has filled this research gap. In this thesis, we analyzed the shipping service industry from different perspectives. This thesis is dedicated to solving three problems: What is the current situation with regard to studies of maritime clusters, especially high-level maritime service clusters? What factors affect the formation of a maritime service cluster, and how do these factors in particular affect their development?

What is the evolution pattern of maritime service clusters under competition? To answer these questions, we conducted three studies.

The first study is a review of current research into maritime clusters. We analyzed studies on maritime clusters over the past 20 years, and find that most research on maritime clusters is similar to the studies of general industry clusters, with little consideration for the unique nature of the shipping industry. Therefore, this study analyzes the key elements of a maritime cluster, including the definition of a maritime cluster, its components, research methods, determinants, studies on specific clusters, and the relationships of maritime businesses. From our study we find that research into maritime service clusters is lacking. We also clarified the relationship between the International Maritime Center and maritime clusters, since there are some misunderstandings about this in the academic field. This study provides a comprehensive analysis of current studies on maritime clusters from different aspects. Such analysis allows us to identify possible problems in the current studies, and to point out the insufficiencies, so that the needs of maritime cluster development can be met.

The second study is an empirical study analyzing the important factors affecting the location selection decision of maritime service businesses. In this study, we used the Stated Preference approach and Discrete Choice models to analyze the contribution of factors affecting the preference for either Shanghai, Singapore or Hong Kong. The result shows that increasing government support in Hong Kong improves its attractiveness to maritime business sectors more than that in Singapore and Shanghai. Also, improving the business legal environment in Shanghai could increase its attractiveness over Singapore and Hong Kong. The results also show the location loyalty of firms. We find that firms in places other than Shanghai, Singapore and Hong Kong prefer Shanghai, while Hong Kong firms have higher loyalty to its own location. Most importantly, we also conducted a policy trade-off analysis and provide some suggestions for helping Hong Kong and Shanghai to increase their attractiveness. This is the first empirical study to use Stated Preference Data and a Discrete Choice Model to analyze problems related to maritime service clusters. The findings of this research can point out further directions for setting up public policies and corresponding measures for developing the maritime service clusters in these three places.

The third study is a theoretical study. A cluster evolutionary model was built to investigate the competition between and evolution of two maritime service clusters. It modeled short-run competition between the two clusters and long-term evolution of each cluster. The short-run competition was built based on the Hotelling model, with two maritime service clusters competing from the same source of clients by adjusting their service price until they reach the optimal condition. In the long-term evolution, firms enter a cluster when it is profitable and exit when it is not, until the point that both clusters reach their ultimate size. In our study, the short-term optimal condition is identified, and the long-term evolution of a maritime service cluster is discussed, based on the results of the simulation. This study is the first research into the competition within a maritime cluster. Being a theoretical study, it enhances the thesis with a theoretical foundation, and at the same time enriches the literature on industrial cluster evolution. The forecast as to the ultimate size of clusters provides policy makers with a reference to better develop local maritime service clusters.

5.2 Limitations and future study

Our work clearly has some limitations.

1. Sample size. Since study 2 aims to examine the location decision of firms, the target sample should be managers with a certain decision power. This requirement increases the difficulties in finding a large sample to survey. In our study, only 87 valid surveys were collected, which provided us with 1044 observations. This sample size was the basic requirement for analyzing with a discrete choice model, but estimation with an RPL model was largely limited by sample size. In a future study, we expect to see an improvement in the explanatory power of the model when follow-up surveys can be conducted.

2. Limitation of adopted model. In study 3, we based our research on the Hotelling model, which requires a sufficiently high transportation cost. However, in a maritime service cluster, there may exist some businesses that have very small transportation costs. In a future study, more consideration should be given to transportation costs by adopting different transportation costs.

This thesis has investigated the location behavior of maritime service clusters. The results enrich the literature and provide policy makers with plenty of suggestions on developing maritime service clusters. Despite the limitations, we believe our work could be a starting point for maritime service cluster study. With an increase in sample size and improved research methods, we believe that in the future even more findings will come to light, enabling many more explanatory powers.

References

Alamá-Sabater, Luisa, Andrés Artal-Tur, and José Miguel Navarro-Azorín. 2011. "Industrial location, spatial discrete choice models and the need to account for neighbourhood effects." *The Annals of Regional Science* 47 (2):393-418.

Alphaliner monthly monitor. 2019. "Top 30 Ports." *Alphaliner monthly monitor*.

Baltic Exchange. 2020. "Xinhua-Baltic International Shipping Centre Index (2020)." China Economic Information Service Baltic Exchange.

Benito, Gabriel RG, Eivind Berger, Morten De la Forest, and Jonas Shum. 2003. "A cluster analysis of the maritime sector in Norway." *International Journal of Transport Management* 1 (4):203-15. doi: https://doi.org/10.1016/j.ijtm.2003.12.001

Beresford, Anthony Kenneth Charles, Bernard M Gardner, Stephen John Pettit, A Naniopoulos, and Christopher Frederick Wooldridge. 2004. "The UNCTAD and WORKPORT models of port development: evolution or revolution?" *Maritime Policy & Management* 31 (2):93-107.

BMT. 2014. "Consultancy Study on Enhancing Hong Kong's Position as an International Maritime Centre." BMT Asia Pacific. https://www.hkmpb.gov.hk/document/8870_IMC_Final_Report.pdf.

Bodenmann, Balz R, and Kay W Axhausen. 2012. "Destination choice for relocating firms: A discrete choice model for the St. Gallen region, Switzerland." *Papers in Regional science* 91 (2):319-41.

Bottazzi, Giulio, and Pietro Dindo. 2008. "An evolutionary model of firms location with technological externalities." LEM Working Paper Series.

Bottazzi, Giulio, Giovanni Dosi, Giorgio Fagiolo, and Angelo Secchi. 2007. "Modeling industrial evolution in geographical space." *Journal of Economic Geography* 7 (5):651-72.

Brett, Valerie, and Michael Roe. 2010. "The potential for the clustering of the maritime transport sector in the Greater Dublin Region." *Maritime Policy & Management* 37 (1):1-16. doi: https://doi.org/10.1080/03088830903461126

Brouwer, Aleid E, Ilaria Mariotti, and Jos N Van Ommeren. 2004. "The firm relocation decision: An empirical investigation." *The Annals of Regional Science* 38 (2):335-47.

Capik, Paweł, and Magdalena Dej. 2018. *Relocation of Economic Activity: Contemporary Theory and Practice in Local, Regional and Global Perspectives*: Springer

Chang, Yen-Chiang. 2011. "Maritime clusters: What can be learnt from the South West of England." *Ocean & coastal management* 54 (6):488-94. doi: http://dx.doi.org/10.1016/j.ocecoaman.2011.03.005

Cook, Gary A S, Naresh R Pandit, Jonathan V Beaverstock, Peter J Taylor, and Kathy Pain. 2007. "The Role of Location in Knowledge Creation and Diffusion: Evidence of Centripetal and Centrifugal Forces in the City of London Financial Services Agglomeration." *Environment and Planning A: Economy and Space* 39 (6):1325-45. doi: 10.1068/a37380. https://journals.sagepub.com/doi/abs/10.1068/a37380

Cooper, Andrew B, and Joshua J Millspaugh. 1999. "The application of discrete choice models to wildlife resource selection studies." *Ecology* 80 (2):566-75.

da Silva Monteiro, João Pedro Valadas, Paulo Alexandre Neto, and Maria Teresa Noronha. 2014. "Understanding the ways and the dynamics of collaborative innovation processes: the case of the maritime cluster of the Algarve region (Portugal)." *Urban, Planning and Transport Research* 2 (1):247-64. doi: http://dx.doi.org/10.1080/21650020.2014.909739

de Langen, Peter W, and Evert-Jan Visser. 2005. "Collective action regimes in seaport clusters: the case of the Lower Mississippi port cluster." *Journal of Transport Geography* 13 (2):173-86. doi: https://doi.org/10.1016/j.jtrangeo.2004.04.010

de Langen, PW. 2002. "Clustering and performance: the case of maritime clustering in The Netherlands." *Maritime Policy & Management* 29 (3):209-21. doi: https://doi.org/10.1080/03088830210132605

Djoumessi, Armand, Shu-Ling Chen, and Stephen Cahoon. 2019. "Factors influencing innovation in maritime clusters: An empirical study from Australia." *Marine Policy*:103558. doi: https://doi.org/10.1016/j.marpol.2019.103558

Doloreux, David. 2017. "What is a maritime cluster?" *Marine Policy* 83:215-20. doi: http://dx.doi.org/10.1016/j.marpol.2017.06.006

Doloreux, David, and Richard Shearmur. 2018. "Moving maritime clusters to the next level: Canada's Ocean Supercluster initiative." *Marine Policy* 98:33-6. doi: https://doi.org/10.1016/j.marpol.2018.09.008

Doloreux, David, Richard Shearmur, and Diego Figueiredo. 2016. "Québec'coastal maritime cluster: Its impact on regional economic development, 2001–2011." *Marine Policy* 71:201-9. doi: https://doi.org/10.1016/j.marpol.2016.05.028

Ellram, Lisa M, Wendy L Tate, and Kenneth J Petersen. 2013. "Offshoring and reshoring: an update on the manufacturing location decision." *Journal of Supply Chain Management* 49 (2):14-22.

Fernández-Macho, Javier, Arantza Murillas, Alberto Ansuategi, Marta Escapa, Carmen Gallastegui, Pilar González, Raul Prellezo, and Jorge Virto. 2015. "Measuring the maritime economy: Spain in the European Atlantic Arc." *Marine Policy* 60:49-61. doi: https://doi.org/10.1016/j.marpol.2015.05.010

Flitsch, Verena, Nico Herz, Jutta Wolff, and Alfred J Baird. 2014. "Maritime policy in the North Sea region: Application of the cluster approach." *Maritime Economics & Logistics* 16 (4):484-500. doi: https://doi.org/10.1057/mel.2014.12

Fukuda, Ryo, Tetsuo Kidokoro, Fumihiko Seta, and Ryo Sato. 2019. "Relocations are determined by firms' relationships with financing institutions: A paper based on network data for Japanese firms." *Papers in Regional science* 98 (4):1685-712.

Gailitis, R, and M Jansen. 2011. "Development of the Latvian Maritime Policy; A Maritime Cluster Approach." *Transport Systems and Processes: Marine Navigation and Safety of Sea Transportation*:111. doi: https://doi.org/10.1201/b11347-19

Ghiara, Hilda, and Marco Caminati. 2017. "Maritime and logistics advanced producer services within the Mediterranean: the liner shipping companies' positioning strategies in new market areas." *Transportation research procedia* 25:165-86. doi: https://doi.org/10.1016/j.trpro.2017.05.388

GOVHK. 2020. "Mainland and Hong Kong Closer Economic Partnership Arrangement (CEPA)." Accessed 31 August. https://www.tid.gov.hk/english/cepa/tradeservices/marit_liberalization.html#note1.

Grammenos, Costas T, and Chong Ju Choi. 1999. "The Greek shipping industry: Regulatory change and evolving organizational forms." *International Studies of Management & Organization* 29 (1):34-52. doi: https://doi.org/10.1080/00208825.1999.11656756

Harrison, Bennett. 1992. "Industrial districts: old wine in new bottles?" *Regional Studies* 26 (S1):S107-S21. doi: https://doi.org/10.1080/00343400701232264

Hayashi, Yoshitsugu, Tomohiko Isobe, and Yasuo Tomita. 1986. "Modelling the long-term effects of transport and land use policies on industrial locational behaviour: A discrete choice model system." *Regional Science and Urban Economics* 16 (1):123-43.

Hensher, David A, John M Rose, and William H Greene. 2005. *Applied choice analysis: a primer*: Cambridge University Press

HKIAC. 2020. "2019 Statistics." Accessed 29 April. https://www.hkiac.org/about-us/statistics.

HKMPB. 2019. "Summary Statistics on Maritime Industry of Hong Kong."

HKTDC. 2020. "Maritime Services Industry in Hong Kong." Accessed 31 August. https://research.hktdc.com/en/article/MzExMzA4Mzc2.

Hotelling, Harold. 1990. "Stability in competition."

Jacobs, Wouter, Hans Koster, and Peter Hall. 2011a. "The location and global network structure of maritime advanced producer services." *Urban Studies* 48 (13):2749-69. doi: https://doi.org/10.1177/0042098010391294

———. 2011b. "The location and global network structure of maritime advanced producer services." *Urban Studies* 48 (13). doi: https://doi.org/10.1177/0042098010391294

Kapila, Subhash. 2012. "The global power shift to Asia: Geostrategic and geopolitical implications." *Al Jazeera Centre for Studies*.

Kogut, Bruce, and Harbir Singh. 1988. "The effect of national culture on the choice of entry mode." *Journal of international business studies* 19 (3):411-32.

Koliousis, Ioannis G, Stratos Papadimitriou, Elena Riza, Peter J Stavroulakis, and Vangelis Tsioumas. 2019. "Strategic correlations for maritime clusters." *Transportation Research Part A: Policy and Practice* 120:43-57. doi: https://doi.org/10.1016/j.tra.2018.12.012

Koliousis, Ioannis G., Stratos Papadimitriou, Elena Riza, Peter J. Stavroulakis, and Vangelis Tsioumas. 2018. "Scarcity theory and maritime clusters: From paradox to modelling." *Marine Policy* 93:40-6. doi: https://doi.org/10.1016/j.marpol.2018.03.029

Kronenberg, Kristin. 2013. "Firm relocations in the Netherlands: Why do firms move, and where do they go?" *Papers in Regional science* 92 (4):691-713.

Kwak, Seung-Jun, Seung-Hoon Yoo, and Jeong-In Chang. 2005. "The role of the maritime industry in the Korean national economy: an input–output analysis." *Marine Policy* 29 (4):371-83. doi: http://dx.doi.org/10.1016/j.marpol.2004.06.004

Lee, Brian HY, and Paul Waddell. 2010. "Residential mobility and location choice: a nested logit model with sampling of alternatives." *Transportation* 37 (4):587-601.

Lee, Choong Bae, Junbin Wan, Wenming Shi, and Kevin Li. 2014. "A cross-country study of competitiveness of the shipping industry." *Transport Policy* 35:366-76. doi: https://doi.org/10.1016/j.tranpol.2014.04.010

Leitham, Scott, Ronald W McQuaid, and John D Nelson. 2000. "The influence of transport on industrial location choice: a stated preference experiment." *Transportation Research Part A: Policy and Practice* 34 (7):515-35.

Li, Mengchi, and Meifeng Luo. 2020. "Review of existing studies on maritime clusters." *Maritime Policy & Management*:1-16. doi: 10.1080/03088839.2020.1802786. https://www.tandfonline.com/doi/abs/10.1080/03088839.2020.1802786

Louviere, Jordan J, David A Hensher, and Joffre D Swait. 2000. *Stated choice methods: analysis and applications*: Cambridge university press

Luo, Meifeng, Liming Liu, and Fei Gao. 2012. "Post-entry container port capacity expansion." *Transportation Research Part B: Methodological* 46 (1):120-38.

Ma, Shuo. 2011. "What kind of International Maritime Center should Shanghai become?" *Pearl River Water Transport* (1):97-9. http://www.cqvip.com/qk/98467x/201101/37448876.html.in Chinese

MacCarthy, Bart L, and Walailak Atthirawong. 2003. "Factors affecting location decisions in international operations–a Delphi study." *International Journal of Operations & Production Management* 23 (7):794-818.

Makkonen, Teemu, Tommi Inkinen, and Jouni Saarni. 2013. "Innovation types in the Finnish maritime cluster." *WMU Journal of Maritime Affairs* 12 (1):1-15. doi: https://doi.org/10.1007/s13437-013-0039-4

Maritime by Holland. 2018. "The Dutch Maritime Cluster." Maritime by Holland. https://www.maritimebyholland.com/download-link.php?file=wp-content/uploads/2018/01/10536-171117-NML-Vierluik-Monitor-2017-EN_LR_pages.pdf.

"Maritime Policy Green Paper." 2006. European Commission. http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=LEGISSUM:l66029&from=EN.

Maritime UK. 2019. "State of the maritime nation." Maritime UK. https://www.maritimeuk.org/documents/429/Maritime_UK_-_state_of_the_maritime_nation_report_2019_D17mVSQ.pdf.

Maskell, Peter, and Leïla Kebir. 2006. "What qualifies as a cluster theory." *Clusters and regional development: Critical reflections and explorations*:30-49. https://hal.archives-ouvertes.fr/hal-01675959

McFadden, Daniel. 1974. "Conditional logit analysis of qualitative choice behavior."

McFadden, Daniel, and Kenneth Train. 2000. "Mixed MNL models for discrete response." *Journal of applied Econometrics* 15 (5):447-70.

Morrissey, Karyn. 2014. "Using secondary data to examine economic trends in a subset of sectors in the English marine economy: 2003–2011." *Marine Policy* 50:135-41. doi: https://doi.org/10.1016/j.marpol.2014.05.018

Morrissey, Karyn, and Valerie Cummins. 2016. "Measuring relatedness in a multisectoral cluster: an input–output approach." *European Planning Studies* 24 (4):629-44. doi: https://doi.org/10.1080/09654313.2015.1127898

Ortega, Cristina, C Nogueira, and H Pinto. 2014. "Sea and littoral localities' economy: Exploring potentialities for a maritime cluster-An integrated analysis of Huelva, Spain and Algarve, Portugal." *Journal of Maritime Research* 10 (2):35-42. http://www.jmr.unican.es/index.php/jmr/article/view/254

Othman, Mohamad Rosni, George James Bruce, and Saharuddin Abdul Hamid. 2011. "The strength of Malaysian maritime cluster: The development of maritime policy." *Ocean & coastal management* 54 (8):557-68. doi: http://dx.doi.org/10.1016/j.ocecoaman.2011.02.004. http://www.sciencedirect.com/science/article/pii/S0964569111000287

Pagano, Anthony, Grace Wang, Onésimo Sánchez, Ricardo Ungo, and Eddie Tapiero. 2016. "The impact of the Panama Canal expansion on Panama's maritime cluster." *Maritime Policy & Management* 43 (2):164-78. doi: https://doi.org/10.1080/03088839.2016.1140241

Pinto, Hugo, and Ana Rita Cruz. 2012. "Structuring a knowledge-based maritime cluster: contributions of network analysis in a tourism region." *Revista de Estudios Regionales* (95). https://www.redalyc.org/pdf/755/75525394003.pdf

Pinto, Hugo, Ana Rita Cruz, and Colin Combe. 2015. "Cooperation and the emergence of maritime clusters in the Atlantic: Analysis and implications of innovation and human capital for blue growth." *Marine Policy* 57:167-77. doi: https://doi.org/10.1016/j.marpol.2015.03.029

Port of London Authority. 2020. "History of the Port of London pre 1908." Accessed 29 April. http://www.pla.co.uk/Port-Trade/History-of-the-Port-of-London-pre-1908#13.

Rashidi, Taha Hossein, Joshua Auld, and Abolfazl Kouros Mohammadian. 2012. "A behavioral housing search model: Two-stage hazard-based and multinomial logit approach to choice-set formation and location selection." *Transportation Research Part A: Policy and Practice* 46 (7):1097-107.

Ren, Shengce, and Bingliang Song. 2009. "Concept of the high-end maritime services and its development implication." *China Water Transport*:pp. 93-5.in Chinese

Rietveld, Piet. 1994. "Spatial economic impacts of transport infrastructure supply." *Transportation Research Part A: Policy and Practice* 28 (4):329-41.

Rose, John M, and Michiel CJ Bliemer. 2009. "Constructing efficient stated choice experimental designs." *Transport Reviews* 29 (5):587-617.

Salvador, Regina, Abel Simões, and C Guedes Soares. 2016. "The economic features, internal structure and strategy of the emerging Portuguese maritime cluster." *Ocean &*

coastal management 129:25-35. doi: https://doi.org/10.1016/j.ocecoaman.2016.04.012

Shi, Xin, Haizhou Jiang, Huan Li, and Dong Xu. 2020. "Maritime cluster research: Evolutionary classification and future development." *Transportation Research Part A: Policy and Practice* 133:237-54. doi: https://doi.org/10.1016/j.tra.2020.01.015

Shinohara, Masato. 2010. "Maritime cluster of Japan: implications for the cluster formation policies." *Marit. Pol. Mgmt.* 37 (4):377-99. doi: https://doi.org/10.1080/03088839.2010.486648

Shipping and Freight Resource. 2020. "Difference between Maritime, Shipping, Freight, Logistics and Supply Chain." Accessed 27 Sep. https://www.shippingandfreightresource.com/difference-maritime-shipping-freight-logistics-supply-chain/.

Singapore, Inland Revenue Authority of "Corporate Tax Rates." https://www.iras.gov.sg/irashome/Quick-Links/Tax-Rates/Corporate-Tax-Rates/.

Stavroulakis, Peter J, and Stratos Papadimitriou. 2016. "The strategic factors shaping competitiveness for maritime clusters." *Research in Transportation Business & Management* 19:34-41. doi: https://doi.org/10.1016/j.rtbm.2016.03.004

———. 2017. "Situation analysis forecasting: the case of European maritime clusters." *Maritime Policy & Management*:1-11. doi: https://doi.org/10.1080/03088839.2017.1330560

THB. 2018. "Study on the Economic Contribution of Maritime and Port Industry in 2016." Transport and Housing Bureau. https://www.hkmpb.gov.hk/document/Study_on_Economic_Contribution_of_Maritime_and_Por.pdf.

Train, Kenneth E. 2009. *Discrete choice methods with simulation*: Cambridge university press

TuscorLloyds. 2020. "World's leading shipping centres." TuscorLloyds. https://www.tuscorlloyds.com/top-worlds-leading-shipping-centres/.

University Grants Committee. 2020. "General Research Fund (GRF)." Accessed 4 April. http://www.ugc.edu.hk/eng/rgc/funded_research/funding_results/grf/grf.html.

Viederyte, Rasa. 2016. "Preconditions evaluation in Maritime Clustering research." *Procedia Economics and Finance* 39:365-72. doi: https://doi.org/10.1016/s2212-5671(16)30337-9

Viederytė, Rasa. 2014. "Lithuanian Maritime Sector's Clustering Economic Impact Evaluation." *Procedia - Social and Behavioral Sciences* 156:292-7. doi: https://doi.org/10.1016/j.sbspro.2014.11.191

Wang, Liehui, and Yuemin Ning. 2010. "Trend of development of the high-end maritime services and strategies of Ningbo." *Economic geography* 30(2):pp. 268-72. In Chinese

Xiong, Xiaoliang. 2010. "Maritime Cluster and Construction of Wuhan International Maritime Center." *China Collective Economy*. http://www.cqvip.com/qk/81762x/201104s/690748471201110087.html. In Chinese

Zhang, Wei, and Jasmine Siu Lee Lam. 2017. "An empirical analysis of maritime cluster evolution from the port development perspective – Cases of London and Hong Kong." *Transportation Research Part A: Policy and Practice*. doi: http://dx.doi.org/10.1016/j.tra.2017.05.015

Zhou, Xin. 2015. "Competition or cooperation: a simulation of the price strategy of ports." *International Journal of Simulation Modelling* 14 (3):463-74.

Appendices

Appendix A. Definition of terms

There are many similar terms related to the maritime industry mentioned in this thesis. In order that these terms are understood correctly, this section clarifies their definition.

Maritime industry: Anything related to the ocean, sea, ships, navigation of ships from point A to point B, seafarers, ship owning and other related activities (Shipping and Freight Resource, 2020).

Maritime cluster: Generally, a maritime cluster refers to a geographic concentration of firms in maritime sectors, of research and education organizations which are active in related fields, and of public support mechanisms operated by the government and regional stakeholders (Doloreux et al., 2016).

Sectors in the maritime industry: In this study, we distribute the maritime industry into the following five sectors,

a) Marine biological resources: Industries such as fishery and aquaculture (Fernández-Macho, Murillas, Ansuategi, Escapa, Gallastegui, González, Prellezo, and Virto, 2015; Morrissey, 2014);
b) Physical maritime transportation activity: Port and shipping activities such as port logistics and liner shipping industries (Shinohara, 2010; Othman, Bruce, and Hamid, 2011; Makkonen, Inkinen, and Saarni,

2013);

c) Maritime services: Sectors that serve the transportation of goods, which can be divided into traditional maritime services (e.g. freight forwarder) and high-end maritime services (e.g. legal services and maritime education) (Morrissey and Cummins, 2016; Benito, Berger, De la Forest, and Shum, 2003);

d) Maritime technologies: Shipbuilding and ship repair (Shinohara, 2010; Salvador, Simões, and Soares, 2016; Pagano, Wang, Sánchez, Ungo, and Tapiero, 2016);

e) Others: Off-shore activity/navy/sea-related recreation/others (Shinohara, 2010).

Maritime service businesses: Maritime service companies, such as ship brokers, ship management companies, classification societies, marine insurance providers, ship finance companies, legal service providers, maritime-related education and R&D, consultancies included.

Maritime service cluster: A maritime service cluster normally refers to a geographical concentration of maritime service businesses.