The causes of divergence in regional innovation patters - a comparison of two coastal cities in China

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Abbreviations

863	National High-tech R&D Programme
API	Active Pharmaceutical Ingredients
CAE	Chinese Academy of Engineering
CAS	Chinese Academy of Sciences
CIT	Corporate Income Tax
CCP	Chinese Communist Party
CPPCC	Chinese Communist Party Central Committee
ETDZ	Economic and Technology Development Zone
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GOP	Gross Ocean Product (Marine GDP)
HTIDZ	High-Tech Industrial Development Zone
IP	Intellectual Property
MBPF	Marine Biotech and Pharmaceutical Firm
MEF	Marine Equipment Manufacturing Firm
MIIT	Ministry of Industry and Information Technology
MLP	National Medium and Long-term Plan for S&T Development (2006-2020)
MNC	Multinational Corporation
MNR	Ministry of Natural Resources
MOE	Ministry of Education
MOF	Ministry of Finance
MOST	Ministry of Science and Technology
NDRC	National Development and Reform Commission
PRD	Pearl River Delta
P-SOE	Previously State-owned Enterprise
OECD	Organisation for Economic Co-operation and Development
PRI	Public Research Institute
R&D	Research and Development
R&E	Research and Education
RIS	Regional Innovation System
RMB	Ren Min Bi
SEZ	Special Economic Zone
SME	Small and Medium Enterprise
SOA	State Ocean Administration
SOE	State-owned Enterprise
S&T	Science and Technology
TIM	Territorial Innovation Model
TVE	Township and Village Enterprises
UPRI	University and Public Research Institute
VoC	Varieties of Capitalism

Abstract

Ranging from “systems of innovation” to “varieties of capitalism” (VoC), a broad body of literature explores regional innovation following the institutional approach and attributes the divergent patterns of innovation to institutions (Hall and Soskice, 2001). However, this approach is criticised for being overly deterministic and treating firms as homogeneous recipients of institutional influences. Whilst acknowledging the role of institutions, a firm-oriented approach is needed for conceptualising regional innovation (Iammarino, 2005; Uyarra, 2010). Recognising the importance of innovation networks, this study operationalises the networking concept and elaborates regional firms’ innovation relational patterns. With interests in understanding the wide regional disparities across China’s regions despite the high centralisation and the context of China’s pursuit to become a country strong in marine economy and innovation, this thesis uses the multiple-case study method and concentrates the empirical focus on two regional coastal cases in China - Qingdao and Ningbo. Despite superficial similarities in a number of aspects, the study shows differences in marine innovation performance between the two regions and explores the causes of these divergent patterns of innovation.

By selecting firms from two representative sub-marine-sectors, this thesis presents four key findings: (1) it characterises that marine firms’ innovation performances are influenced by the combinations of firm-level factors, especially the relational networks with vertical and horizontal actors, (2) it identifies two different patterns of marine firm innovation on the regional level, labelled as the *regionally coordinated* pattern and the *firm-oriented* pattern; (3) it demonstrates that the *regionally coordinated* model generates more advantages to facilitate the marine firm innovation and regional innovation than the *firm-oriented* one and explains why, (4) by recognising the firm-level diversity, it demonstrates the mediated institutional impacts and explores the importance of regional institutions in explaining the regional disparities of innovation by structuring the dominant patterns of firm behaviours.

This thesis contributes to regional innovation studies by offering a framework to explore the causes of regional differences in innovation, reconciling the conflicts between the institutional explanations and the intra-regional heterogeneity across firms, and uncovering China’s regional innovation and the important but under-researched marine industry, through which deepens our understanding on China’s innovation and contributes to the literature on marine clusters. Policy implications include the need for policymakers to differentiate the regional focus and emphasise institutional building, and more general implications highlighting the importance of facilitating firm-centred innovation development and supporting innovation collaboration.

Declaration

No portion of the work referred to in the thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

Copyright Statement

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Chapter 1. Introduction

Regionalisation has long been recognised as one important aspect of the globalisation and has attracted the focus of policymakers and researchers (Isaksen, 2001). The stories like the “Third Italy”, Baden-Württemberg, and Silicon Valley have provided plentiful spaces for the empirical investigation of the regional success and raised the interest to explore the reasons leading to the prosperity in some regions while not in most others. In the past decades, the world has witnessed China’s high-speed economic growth. “China is not one place” (Rithmire, 2014). The increasing openness of this country enables the transition of studies on China from a single national case to the subnational-level analysis. The rapid surge of China and its regionalisms have increasingly become topical, which offers a new empirical lens differentiating from the Western models to understand the regional disparities.

1.1 Motivations

1.1.1 The rise of China and the importance of the marine economy

China’s economic miracle embarks on the implementation of the Reform and Open-up Policy. Since the late 1970s, China started the transformation from a centrally planned economy to a more market-oriented economy which has given rise to the entrepreneurship and business autonomy, from the homogenisation claim during the Maoist period to the broad heterogeneity, decentralisation and regionalisation, and from the late industrialisation relying on heavy industry towards a more balanced model of industrial development with increasing technological upgrading.

Over the past decades, China, as a rising power from the emerging markets, has experienced the growth in high speed and is playing an increasingly important role in the world economy. Joining the World Trade Organisation for over 20 years, the exports of China have experienced around tenfold growth with manufacturing as the primary driving force. China, as the “world factory”, has become a major producer of products for the global market. “Made in China” products are popular around the world. In 2010, China overtook Japan and became the world’s second-largest economy after the United States (US) (Financial Times, 2011).

Behind China's economic growth, the marine economy has been an important engine. China is not the first country to implement the marine strategy. The marine industry has been recognised as important in Western economies like the US, Canada, and France (National Ocean Council, 2012; Fisheries and Oceans Canada, 2002a; Kalaydjian, 2008). China is a large marine country endowed with rich marine resources and vast sea waters. Besides the reasons of the increasing depletion of land resources, the dependence on trade, and the concerns about the national security, China treats the marine economy as a new source of economic growth (Conathan and Moore, 2015). In the recent two decades, the marine industry has maintained around 10% contribution to the national gross domestic product (GDP).

1.1.2 Marine strategy in China's innovation transformation

Nowadays, China still maintains the high growth speed, while its economic growth has been decelerating. Whether the popularisation of "Made in China" products has not led this country onto the "competence upgrading track" and whether the Foreign Direct Investment (FDI) is the channel for transferring advanced foreign technology to developing countries dominate the debate about China's development (Gu and Lundvall, 2006). Besides, the traditional development model brings a series of environmental and social problems urgently to be solved.

In such context, *innovation* has become a hot topic in China and is treated as the solution to sustain China's economic development. Innovation has long been recognised as a major driving force of economic growth (Schumpeter, 1934). Marked by the launch of "National Medium and Long-term Plan for Science and Technology (S&T) Development (2006 - 2020)" (MLP), China's technological innovation starts the paradigm shift from prioritising the technological spillovers of multinational corporations (MNCs) and depending on the labour-, investment-, energy-, and resource-intensive model to the development relying on "indigenous innovation" (*zizhu chuangxin* in Chinese) (State Council, 2006; Cao and Suttmeier, 2017).

Numerous data have illustrated China's progress in innovation. China has intensified its innovation investment and overtook Germany and Japan separately in the total R&D expenditure in 2005 and 2009 (OECD, 2022). Since the late 2000s, China shows a large growing momentum in the number of patents belonging to the Triadic Patent

Families, which is in significant contrast to the steady growth in other leading countries. According to the World Intellectual Property Organisation Global Innovation Index, the ranking of China increased from the 29th in 2010 to the 12th in 2021. This East Asian country was the top among the upper-middle-income group of countries and demonstrated a comparable innovation capability to the high-income economies (Dutta et al., 2021).

China's pursuit of the marine economy is situated in its transition towards indigenous innovation and technological upgrading. Marine innovation is important to the continuous growth of blue economy - a critical driving force of China's economic growth and a significant means to realise the sustainable management and development of marine resources, the protection of the environmental ecosystem, and the national security. In the global context, marine technology has been increasingly viewed as one of the solutions to deal with climate change considering the importance of the oceans' health to the global climate. Strengthening marine innovation is one important step to realise goals set by the "2030 Agenda for Sustainable Development" and the "United Nations Decade of Ocean Science for Sustainable Development (2021-2030)".

1.1.3 China's coastal regions and the regional disparities

Despite some marine economic activities have increasingly broken the geographical limitations, inherent to the marine sector is the physical stickiness to the coastal areas. The regional scale is the most direct manifestation of marine industrial development. Studies on the marine economy, like the literature on marine clusters, are often closely related to the regional economy that has been bounded to the ocean in both geographical and economic terms (Colgan, 2003; Monteiro et al., 2013; Doloreux, 2017). In China, marine industrial activities concentrate in the coastal regions which have played important leading essential roles in leading China's development.

Since the late 1970s, coastal cities have been at the forefront of the economic reform experiments and have undertaken the important task to link China with the rest of the world (Han and Yan, 1999). Regional models like the successful Pearl River Delta (PRD) emerged in this background. The selective and gradual openness started from the coastal regions intensified the coastal-interior divide in China (Yeung and Li, 1999).

Despite the efforts of the central government to develop interior China through national policies and programmes like the Great Western Development Strategy, the coastal-interior gap has not seen an obvious reduction (Wei, 2007).

Besides the coastal-interior inequality as the most basic form of the uneven landscapes of China's regional development, regional inequality is widespread on the inter-regional, inter-provincial, and intra-provincial scales in China. Coastal regions cannot be immune from this common feature. Different regional models for example the PRD model and the Wenzhou co-exist in coastal China. The coastal regional economy and the marine economic and innovative activities taking place in these areas also exist large differences[1].

Considering the importance of China's marine sector and the coastal regions, the increasing emphasis on innovation, while the widespread regional disparities and decentralisation, understanding why regional marine innovation in the same country has been different is an interesting question. The lessons drawn from the empirical experiences of regional marine innovation can shed light on China's marine ambition and regional development aiming to reduce the regional contrasts and generate implications for the marine cluster development in other marine economies. Moreover, because of the importance of China to the world economy and the global ocean governance, the innovative transition and the marine strategy in this country will continue to attract the attention of worldwide scholars and policymakers and shed light on other emerging countries.

1.2 Gaps, objectives, and research questions

This research belongs to the general realm of regional innovation research. The objectives that this thesis aims to achieve are linked to the major gaps in understanding the regional innovation and the empirical contexts of China.

Firstly, a significant gap in explaining the regional innovation is that the firm-level factors and the intra-regional diversity of firms have been poorly dealt with. There have been a number of studies seeking to understand the innovation on the regional

[1] This will be discussed in detail in section 2.3.

scale and to explain the regional differences in innovation. Central to the explanations are the institutional impacts that a well-developed region in a specific innovation or industry is because of the supporting institutional arrangements with complementarities between institutions (Hall and Soskice, 2001) or the networking effects and the important mechanisms like the proximity that structure the interactive learning within a region, and thereby influencing the success and efficiency of regional innovation (Dolorexu, 2022). However, the institutional determinism and the dominant assumption of the homogeneous firms fail to characterise the reality of the heterogeneous micro-level entities and their initiatives and capabilities in defining regional innovation. Hence, the first objective of this study is to characterise the firm-level behaviours giving rise to the regional patterns of innovation.

To address the first gap, this research requires a micro-approach starting from the firm-level analysis. This points to the second gap. Previous research has recognised the social embeddedness of firms, networks as the sources of firm-level diversity, and the importance to build connections with different actors. However, prior literature either adopts the network as a holistic concept to explore the differences across networks (e.g., Burt, 1992; Gulati et al., 2000) or focuses on the relationships between firms and a particular kind of collaborators, for example, suppliers (Dyer, 1996). Regional studies highlight the networks but focus on the regional-based agglomeration and stresses the physical proximity, while increasing evidence has illustrated the importance of extra-regional resources and connections (Uyarra, 2010). There is a lack of operationalised ways to understand a firm's network as the combination of the vertical and horizontal relationships with different actors from different sources - how the networks have linked to the locality and how the networks influence the innovation of firms in different regions. Hence, the second objective of this study is to explore the relational networking of firms and how the relational networking influences firms' innovation.

Based upon the above gaps and objectives, a conceptual approach to link the micro-level firms and the regional-level innovation is needed. However, such integration is lacking in regional innovation research. Therefore, the third gap this research is built on has been the missing linkages between the top-down approach and the bottom-up approach to explore regional innovation and between the firm-level factors and regional-level factors to explain regional innovation. There is a lack of a framework to conceptualise the regional innovation disparities without ignoring the heterogeneity of firms. This thus leads to the third objective of this research to develop a framework to address the conflicts and generalise the regional innovation research and the explanation of the causality.

The fourth gap derives from the regional background of China. Most of the empirical studies on regional innovation tend to focus on the Western economies, especially the European regions (Doloreux and Gomez, 2017). Though increasing focus has been shifted to Chinese regions, the non-first-tier coastal cities have been barely touched. Besides, literature about the marine industry or the regional development of marine industry in the marine clusters focuses on the Western contexts. Little is researched on China's marine development in the regional scope, nor the innovation of Chinese marine firms. There is a lack of knowledge and in-depth understanding of regional marine innovation in China, which is obviously important to the Chinese economy and innovative transition. The fourth objective of this study is to investigate China's regional marine innovation.

Driven by the objectives, the general research question that this thesis seeks to explain is why there exist regional differences in innovation among different regions in the same national economy. Specifically, this study attempts to explore and explain the regional differences in marine innovation in China. This central research question that this study aims to answer is:

> **"How can the regional differences of marine innovation be explained in the context of China?"**

Built upon the research gaps, this thesis will divide the above central research question into several sub-research questions that will be articulated in Section 4.2.

1.3 Research contributions

By addressing the above gaps, this research will make several contributions from the following perspectives.

Theoretically, this thesis will add to the regional innovation literature. Specifically, it will improve the theoretical framework to conceptualise and explain the regional disparities of innovation. Rather than focusing only on the institutional explanations by directly associating the regional institutions and the regional innovation performance, this research follows the bottom-up approach starting from the analysis of individual firms. It will illustrate how the relationships either regional or non-regional-based have been established, illustrate how firm-level factors - specifically the relational networking behaviours influences the firms' innovation and explain the regional innovation, and how the regional institutions shape the regionally dominant patterns of the firm behaviours through which influence the regional innovation. In this way, this research enriches the understanding of regional innovation and explains the regional innovation disparities in a comprehensive way.

In addition, this thesis proposes a conceptual framework to explore and explain regional innovation disparities. By integrating the bottom-up analysis based on firms and the institutional analysis, this research mitigates the conflicts between the institutional impacts and the firm-level diversity. The framework is applied to the empirical analysis in this thesis. By generalising the causalities, the framework proposed by this research can be applicable to the regional innovation research in different contexts.

Furthermore, considering the fact that China's regional marine development has rarely been explored in prior research, this research will be one of the first regional studies on China's marine innovation. Through the in-depth investigation of marine innovation in two marine cities, this research will enhance the understanding of the regional conditions of marine industrial and innovative development in China. This will generate new insights into the understanding of China's regional development, marine strategy, and innovative transformation. It will also generate implications for the innovation development in emerging economies and the marine clustering development in other marine economies.

Moreover, this research will methodologically contribute to the comparative case study. Different from the single case study, involving two cases yields more robust results. Unlike the holistic case study that focuses on one unit of analysis, this research will contribute to the analysis based on the embedded multiple case design by involving both firms and regions as the unit of analysis. This will generate implications for future discussion on the multi-level phenomenon.

Lastly, this research will provide practical implications for policymakers and firm managers. By exploring the networking behaviours in firm innovation, this research will propose managerial implications to managers to pursue innovation. By exploring regional development and the marine industry, this research will generate valuable insights for policymakers on the central and regional levels in formulating industrial policies and innovation programmes to support regional development, marine clusters formation, and innovation development of firms.

1.4 Research scope and methods in brief

China is the largest developing country with a large number of coastal cities. The territorial broadness makes it essential to demarcate the geographical scope. This study focuses on two city-level coastal regions - Qingdao and Ningbo, located in China's economically developed eastern areas. The two cases are superficially homogeneous in their historical, economic, administrative, and demographical perspectives but have performed differently in marine development. This enables a deeper look into the factors that influence and explain the regional differences in marine innovation. Because this research aims to characterise the firm-level factors, diverse firms were selected for the data collection. Besides, considering the complexity of the marine sector covering a vast range of sub-sectors and activities, this research focuses on two marine sub-sectors, namely the marine biotech and pharmaceutical industry and the marine equipment manufacturing industry, as typical examples of the emerging and traditional marine sectors that can represent China's marine development.

The exploration of this research started from the literature in both English and Chinese languages to understand the existing explanations of regional differences in innovation, firm-level diversities, and regional marine development, by which to build the conceptual framework. An *embedded multiple-case strategy* is adopted as the primary research method (i.e., regions are the cases, while firms are the units of analysis and data collection). Through semi-structured interviews with the managers in marine firms and informants such as government officials, researchers, and financiers in Qingdao and Ningbo, this research thoroughly analyses how relational networking influences the innovation of marine firms and how the firm-level factors and institutional factors combine to explain the regional differences of marine innovation in the two Chinese coastal cities.

1.5 Thesis structure

The rest of this thesis is organised as follows:

Chapter 2 outlines the research context of marine development in China. Specifically, this chapter demonstrates the Chinese narratives of the marine industry and marine economy, the rationales of develop the marine economy, and summarises the main characteristics of China's economic and innovation development in the past decades. Based upon the understanding of the national context, the regional disparities across Chinese coastal areas are illustrated by presenting facts and evidence.

Chapter 3 thoroughly reviews the literature on regional innovation systems, varieties of capitalism, relational networking theories, and marine clusters. Discussion on the paths of China's regional development is presented by reviewing relevant literature. These strands of literature justify the importance of studying the research question from the theoretical perspective as well as build the foundation for the conceptual framework to answer the research question and address the gap in the comparative analysis of regional innovation.

Chapter 4 builds the conceptual framework and structures the central research question into several sub-questions. Besides, this chapter discusses the philosophical stance and research strategies adopted by this study. The multiple-case study method is employed in this research. The ways to operationalise the research, including case selection, data collection, and data analysis, are demonstrated, followed by clarifying the validity issues and the limitations.

Chapter 5 and **Chapter 6** present the findings of two regional cases based on the empirical evidence from firm-level interviews. Specifically, Chapter 5 elaborates on the regional case of Qingdao by exploring the regional institutions and the regional patterns of marine firm innovation in terms of innovation commitment and relational networking. Chapter 6 explores the regional case of Ningbo. Both chapters identify the regional patterns and characterise the firm-level heterogeneity within each case. By covering a diversity of marine firms within each region, the two chapters obtain the dominant regional patterns of marine innovation and demonstrate that the firm-level differences in business and innovative performance can be attributed to the different combinations of firm-level factors, especially the relational networking.

Chapter 7 makes a comparative analysis of the two regions and synthesises the analysis of causalities. Specifically, this chapter explores the causal paths through which the firm-level factors (i.e., the two kinds of regional marine innovation patterns) contribute to the explanation of the two regions' disparities in marine innovation and economy, and how the regional patterns of marine firm innovation have been structured by the regional institutional factors.

Chapter 8 concludes this research by summarising the key findings, discussing the contributions to knowledge and the implications on policy and management, and outlining the limitations of this research, which is followed by the potential research directions for future work.

Chapter 2. China's Marine Development

China, as a rising power, its transition has captured the world's attention. Driven by different reasons, increasing attention has been shifted to the land-ocean-coordinated development by deepening the exploration and exploitation of the ocean, especially since the 2000s. The marine industry has become an important engine fuelling the fascinating economic growth in China. However, in academic research, insufficient attention has been attached to the marine industry considering the large contribution it has made to China's development. There is a lack of empirical knowledge about why the marine sector is important to China, how it is defined in the Chinese context, as well as how and why China pursues the innovation-driven marine development. More significantly, the marine industry as a sector geographically bounded to the ocean, its development on the regional scale in China is barely touched.

Driven by these questions, this chapter seeks to build the empirical knowledge foundation about China's transition, marine economy, innovation, as well as the regional development in the Chinese context. Section 2.1 elaborates on the rationale, definitions and development, and limitations of China's marine economy. Initiated by the state, Chinese marine innovation is analysed in Section 2.2 by unravelling the authorities involved in marine innovation, the historical path, and the current situations. Moreover, based on the public though scarce regional data, Section 2.3 detects the regional differences in China's marine innovation. Section 2.4 summarises this chapter and briefly discusses the empirical differences between China and major marine economies in other geographical contexts.

2.1 The state of China’s marine economy

2.1.1 China and the oceans: the growing dependence

With a coastline of over 32,000 kilometres, approximate 11,000 islands (Gov.cn, 2018), and sovereign jurisdiction over a large area of continental shelves and exclusive economic zones totalling around 3 million square kilometres, China is a marine power in geographic terms. It enjoys access to rich natural marine resources. There are around 24 billion tons of marine oil reserves and 14 trillion cubic meters of natural gas reserves, 3.1 billion tons of coastal placer reserves, and more than 20,000 kinds of marine life in China (Ce.cn, 2009). However, traditionally, China is a country significantly relying on land resources with an enrooted culture of the agricultural civilisation. Marine resources, especially deep-sea resources, are far from being well explored and utilised.

(a) The global trend of exploring marine resources

Since the exploitation of land resources is increasingly reaching the limit, the under-explored ocean and the vast number of marine resources attract the attention of China and many other countries. A number of policies and programmes targeting the effective management and sustainable utilisation of marine resources have been proposed by coastal economies. For example, the Australian Marine Industries and Sciences Council launched the “Marine Industry Development Strategy” in 1997, which proposes an integrated ocean strategy to develop and manage Australia’s marine resources. In 2002, the Canadian government issued “Canada’s Ocean Strategy - Our Oceans, Our Future”, which establishes the operational framework for the integrated management of oceans in Canada and aims to achieve the sustainable development of marine resources (Fisheries and Oceans Canada, 2002a). In July 2010, the US launched the “National Policy for the Stewardship of the Ocean, Our Coasts, and the Great Lakes” (i.e., “National Ocean Policy”) by Executive Order 13547. The National Ocean Policy aims to coordinate the Federal agencies to achieve the sound management of the ocean, coastal, and Great Lakes ecosystems and resources and ensure that the resources continue to provide the wealth of benefits in a sustainable way (National Ocean Council, 2012). In this global context, China also seeks to achieve a land-ocean-coordinated development and to leash the potential of the ocean.

(b) Ocean and the trade

Besides, since the implementation of the reform and opening-up policy in the late 1970s, and especially after joining the WTO in the early 2000s, Chinese economic growth has been significantly dependent upon the exports-driven development. At the same time, China relies on import trade for the supply of raw materials. For instance, in 2020, over 73.5% of China's oil consumption relied on imports (Ministry of Commerce, 2021). Middle East countries, such as Saudi Arabia, Iraq, Oman, and the United Arab Emirates constituted the major sources of China's oil imports (Liu, 2021). The majority of oil from these countries is transported by the maritime shipping using oil tankers. When trade is essential to sustain China's economic growth, seaborne commerce is critical to Chinese trade. According to the official data from the Ministry of Commerce, in 2020, approximately 95% of China's international trade moves by sea lanes, which accounts for 30% of the global seaborne trade volume (Economic Daily, 2021). The heavy reliance on the ocean to sustain economic growth also determines the ocean's strategic value to China.

(c) National security and maritime claims

Moreover, China's emphasise on the marine development is out of its security interests and resolution to assert the maritime claims. Among China's maritime waters, only the Bohai Sea belongs to China's inland sea. The Yellow Sea, the East China Sea, and the South China Sea are involved in complicated demarcation conflicts and territory disputes (China Science Daily, 2012). The first island chain has traditionally acted as not only a shield but also an obstruction restricting China's navy and merchants to reach the open sea in wartime, which may restrain the navy's project power and shackle the Chinese economy (Cheng, 2011). Aiming to protect its maritime interests, China will have to (i) control its littoral waters up to the "first island chain", which reflects the concerns with defending its sovereignty and territorial integrity as the ocean is seen as the extension of the land borders, and (ii) extend the protection to the network of global waterways beyond China's near seas, which is crucial to conduct power projection and participate in the global governance and communication (ibid.). Safeguarding the security and much general maritime interests require China to strengthen its maritime power from various perspectives, such as enhancing its naval forces and expanding significant marine industries like shipbuilding.

The above dimensions highlight China's increasing dependence on the ocean and the rationale of its marine development. It was generally acknowledged that China entirely revamped the sea governance since the early 2000s following the release of the "Law on the Administration of Sea Area Use" in 2001 and the "Marine Functional Zoning Plan" in 2002 (Conathan and Moore, 2015; Choi, 2017, Song et al., 2013). This was in reaction to the global trend of claiming sovereign sea space based upon the "United Nations Convention on the Law of the Sea"[1] and sought to institutionalise the integrated coastal management under the global agenda of sustainable development (Choi, 2007). From then on, a comprehensive sea governance system has gradually been established in China. The marine economy became a new agenda for China's economic development.

2.1.2 China's blue economy and the marine industry

Marine economy and the scope of marine industry are defined differently in various countries and contexts. This section primarily focuses on the Chinese definitions. In 2003, the State Council launched the "Outline of the National Marine Economic Development Plan". For the first time, China officially characterised the national strategic importance of developing the marine economy and establishing marine industries in China during the 2000s (State Council, 2003). Subsequently, marine economy took off and become an important engine of Chinese economic growth.

Define "marine economy" and "marine industry"

Marine economy, also often referred to as "blue economy" or "ocean economy", is not a new concept. Nevertheless, there is no uniform definition of marine economy and marine industry across marine economies. Over the past several decades, China has made efforts to identify marine economic activities and define the marine industry, based upon which specifying and quantifying the Chinese marine economy become achievable. As is shown in Figure 2.1, before the 1990s, marine industrial data were only available in three traditional sectors and were managed by dispersed authorities and organisations (Song et al., 2013).

[1] China signed the Convention in 1982 and ratified it in 1996.

Before 1990s	1990 - 2001	2001 - 2006	2006 - present
- Marine fishery - Coastal ports and marine transportation industry - Offshore oil and natural gas industry	- Marine aquaculture industry - Marine transportation and ports industry → Marine communication and transportation industry - Sea salt industry - Offshore oil and natural gas industry - Beach placer industry - Coastal international tourism - Marine shipbuilding industry (added in 1994)	- Marine aquaculture industry - Marine communication and transportation industry - Offshore oil and natural gas industry - Sea salt industry - Beach placer industry - Coastal tourism - Marine shipbuilding industry - Marine chemical industry - Marine biomedicine and health products industry - Marine electric power and seawater utilisation industry - Marine engineering construction industry - Marine information consultation service industry	• Major ocean industries: 12 sub-sectors • Ocean scientific research, education, management and service industry: 10 sub-sectors • Ocean-related industries: 6 sub-sectors

Figure 2.1. The scope of China's marine sub-sectors - the development track

Source: adapted from Song et al. (2013), p.122.

Since the 1990s, the State Oceanic Administration (SOA) started to collaborate with other governmental departments, for example, the National Bureau of Statistics, to obtain and compile marine industrial data and publish marine statistical documents in the form of reports, yearbooks, and bulletins. The coverage of industrial categories was increasingly enriched. Traditionally sectors associated with marine economic activities, such as fishery, oil and gas, and marine transportation, were joined by emerging industries like marine biotech and pharmaceutical sector, sea water utilisation sector, and marine tourism. In 2006, SOA issued the "Industrial Classification for Ocean Industries and Their Related Activities (GB/T 20794-2006)", which becomes the first formal statistical standard for marine industrial classification guiding the marine economic data collection and measurement of marine economy.

According to the latest industrial classification, the *marine economy* is characterised by economic activities in two aspects - *ocean industries* and *ocean-related industries*. Hereafter, this thesis uses the term "marine industry" or "marine sector" to refer to the "total of the two parts"). The former refers to industrial sectors directly involved in the activities for developing, utilising and protecting the ocean, which includes 12 major industries and ocean scientific research, education, and management services providing support to the major industries (see Figure 2.2 for details). Ocean-related industries refer to activities having technical and economic links with major marine industries (ibid.). Therefore, in China, the marine economy is defined as "the summation of various types of industrial activities for developing, utilising and protecting the ocean as well as the associated activities" (SOA, 2007a). As Figure 2.3 shows, the Chinese marine economy characterises the economic activities of ocean industries and ocean-related industries.

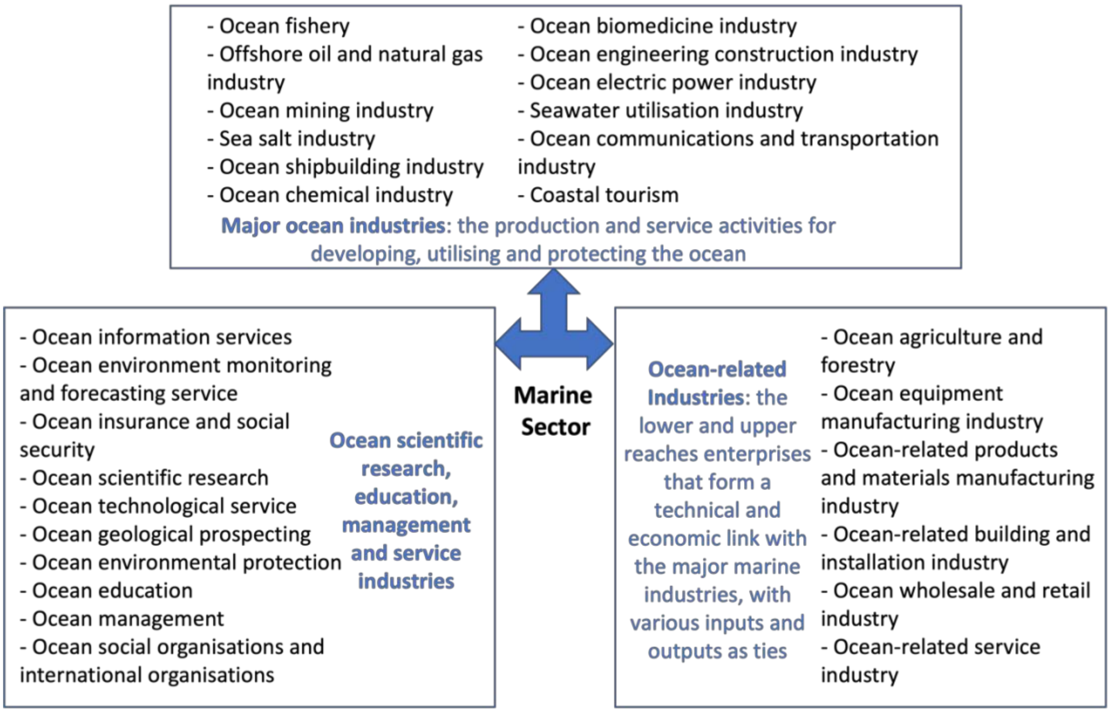

Figure 2.2. The sub-sectoral components of China's marine sector

Sources: summarised from General Administration of Quality Supervision, Inspection and Quarantine of China, and the Standardisation Administration of China (2006).

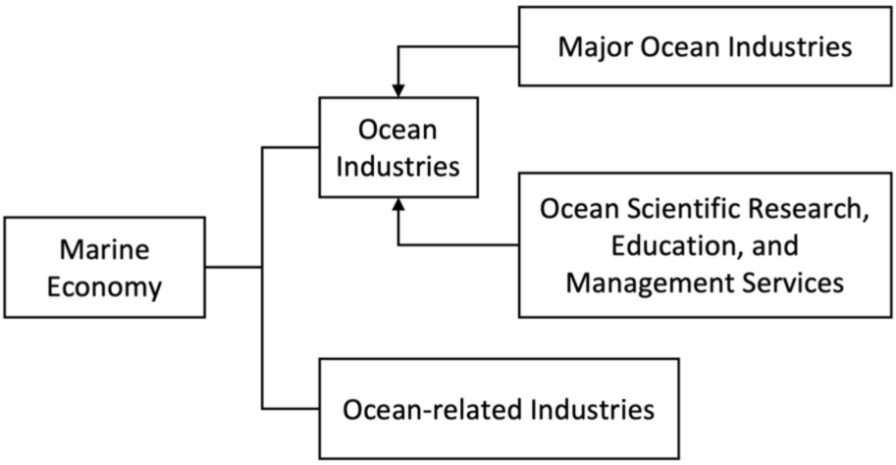

Figure 2.3. China's marine economy

Source: adapted from SOA (2007a).

The value of marine industry to China's economy

Marine GDP or *gross value added (GVA)* of the marine industry is the most widely used market indicator[1] of the marine economy in many coastal countries, such as Canada, France, and the United Kingdom (Kildow and Mcllgorm, 2010). Since 2006, China has adopted Gross Ocean Product (GOP) (i.e., marine GDP) as the main indicator of the marine economy, which measures the finished marine economic activities produced in the coastal region within a specific period of time calculated at the market price (MNR, 2020a). It is mostly made up of the GVA of the ocean industries and the ocean-related industries.

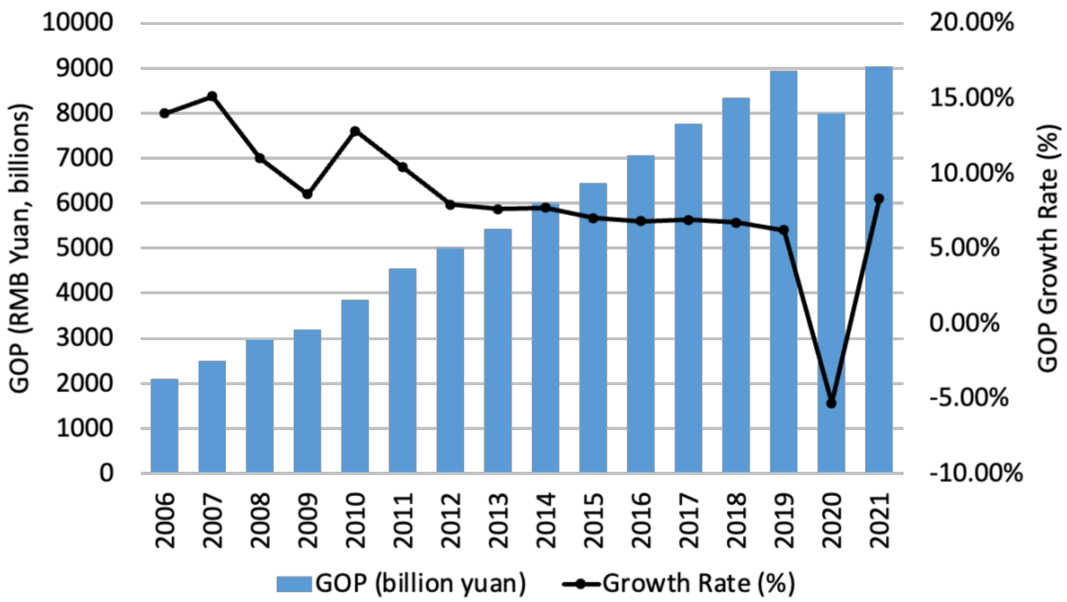

Figure 2.4. China's GOP and GOP growth rate from 2006 to 2021

Sources: MNR (2019, 2020b, 2021, 2022) and SOA (2007a to 2018).

Entering the 2000s, China's ocean economy has been growing rapidly. Except for the fall in 2020 due to the global pandemic, the marine economy in China maintained a high-speed growth. Recovering from the global pandemic, the marine economy returns on the growing track in 2021. GOP in China reaches 9038.5billion yuan, accounting for 8.0% of the national GDP this year (MNR, 2022). As Figure 2.4 shows,

[1] Non-market indicators are generally under-developed. China has established accounts characterising the non-market aspects of marine economy, while they are in the very early stage of development (Zhao et al., 2014).

the average annual growth rate of GOP from 2006[1] to 2021 was 8.23%, which was higher than the high-speed GDP growth (~7.97%). The marine economy measured by the GOP has made large contributions to broader China's economy. Besides, the marine industry has also provided a large number of jobs. Increasing from 21.1 million in 2001, the number of people employed by the marine sector reached 36.8 million in 2018[2], accounting for 4.7% of the national total (China Daily, 2019).

Structural change of China's marine industry

Along with the marine economic growth, the marine industry in China has also experienced a structural change. Table 2.1 displays and compares the sub-sectoral GVA in 2012 and 2021. The data indicate a lower dependence on labour-intensive primary sectors such as ocean fishery and sea salt industry that grew slowly and even experienced a decline. However, it is worth noting that these primary sectors are still critical in sustaining China's international trade and employment in rural areas, which cannot be underestimated (Zhao et al., 2014). In contrast to the stagnation of primary sectors, in this decade, there was a steady increase in the tertiary sector. Coastal tourism and marine communications and transportation industry have become the pillars of China's marine economy. More importantly, marine emerging industries involving new or high technologies have achieved an annual growth rate of more than 10% (Economic Daily, 2022b).

The growth of marine emerging sectors cannot leave with two important factors. For one thing, the growth has been underpinned by the rapid development of marine technology and increasing innovation. New and high technologies are essential to improve the efficiency of industrial activities and strengthen the industrial competitiveness, which injects new impetus into the growth of these sectors. For another, the development of emerging sectors has been supported by the Chinese government. For example, to promote the bio-industry development, China's State Council released the "12th Five-year Plan for the Bio-industry Development" in 2012. When the ocean is considered as the world's last hope in searching for novel drugs from the nature for curing several diseases like cancer (Ebarvia, 2016), the marine

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[1] China officially started to compile and publish GOP data from 2006. Before 2006, only data of several major marine industries were available.

[2] Marine employment data after the year 2018 are unpublished.

biotech and pharmaceutical industry is seen as an essential field of the bio-industry and has been touched by a number of national policies.

Table 2.1. Gross value added (GVA) by marine subsectors in 2012 and 2021

Marine subsectors	GVA in 2012 (RMB Yuan, billions)	GVA in 2021 (RMB Yuan, billions)
Major ocean industries	2057.5	5948.8
Ocean fishery	365.2	529.7
Offshore oil and natural gas industry	157.0	161.8
Marine mining industry	6.1	18.0
Sea salt industry	7.4	3.4
Ocean chemical industry	78.4	61.7
Ocean marine biotech and pharmaceutical industry	17.2	49.4
Ocean electric power industry	7.0	32.9
Seawater utilisation industry	1.1	2.4
Ocean shipbuilding industry	133.1	126.4
Ocean engineering construction industry	107.5	143.2
Ocean communications and transportation industry	480.0	746.6
Coastal tourism	697.2	1529.7
Ocean scientific research, education, management, and service industries	882.2	2543.8
Ocean-related Industries	2069.0	3089.7

Sources: SOA (2013) and MNR (2022).

Considering the wide coverage of the marine industry, this research decides to focus on two marine sub-sectors. They are the marine biotech and pharmaceutical sector as an emerging marine sub-sector and the marine equipment industry (*Haiyang Zhuangbei Chanye* in Chinese) as a traditional marine sub-sector. Specifically, the former industry refers to the production, processing and manufacturing activities of marine-based medicines and marine health care products by using organisms as raw materials or by extracting useful components therefrom or being used for the ocean. Chinese marine medicine[1] is also included. Besides, the often-used definition of the latter industry incorporates both the manufacture of machinery and equipment used for marine activities and the building of ships and floating structures such as drilling

[1] Chinese medicine is excluded from the manufacture of pharmaceuticals, medicinal chemical and botanical products by United Nations (2008).

platforms. It is a broad definition characterising both the standardised industrial classifications and the practical use in the Chinese context considering the policy documents (referred to in Section 2.1.3) and the media coverage.

2.1.3 Limitations and challenges of China's marine economy

After years of rapid development, the marine industry has become an important source of economic growth for China. However, problems and challenges exist synchronously with opportunities and achievements on China's path of pursuing the ocean-driven development. This section discusses the key limitations and challenges faced in China's marine economic development from three perspectives.

Statistical bias

Statistically, according to Zhao et al. (2014), not all relevant sub-industries can be directly identified within China's statistical databases. Nowadays, official data only cover the GVA data of major ocean industries, while ocean-related industrial data are unavailable in all kinds of formal statistical releases. This leads to the concern of data biases, which can obstruct the development of a much more comprehensive understanding of marine sectors, especially in the case that China involves all kinds of industrial fields in characterising the marine economy while there are blurred sub-sectoral boundaries.

Besides, the practical use of industrial definition in the policy realm is not always the same as in statistical terms. For example, regarding one of the sample marine sub-industries of this research - the marine equipment industry, plenty of policies[1] use the term "marine engineering equipment" to refer to the equipment used to explore, utilise, and protect the ocean, which includes both products belonging to a major ocean industry - "shipbuilding industry" (e.g., drilling platforms and drilling ships) and products labelled as the "marine equipment manufacturing industry" - an ocean-related industry (e.g., seawater desalination equipment, underwater equipment, and deep-sea equipment) (State Council, 2012; MIIT, 2016). Therefore, characterising marine industrial activities is complicatedly and sometimes flexibly contingent upon

[1] Examples include the "Medium and Long-term Development Plan for Marine Engineering Equipment" and the strategy of "Made in China 2025".

the specific contexts.

Environmental problems

In China, marine industrial development has caused severe environmental problems. For example, having the largest fishing industry in the world, China accounted for over 60% of the global aquaculture production and over 18% of the world's marine catch production (Food and Agriculture Organisation, 2016). However, overfishing coupled with industrial pollution destroys the marine ecosystems, harms the habitats of marine life, and causes damage to reduce fishery resources. This pushes China to implement "zero/negative growth" policies, for example, by controlling the marine catch and reducing the fishing capacity, to manage the marine fishery resources and restore the marine ecosystem and marine biodiversity (Xinhua News Agency, 2017; China Ocean Newspaper, 2017).

Besides, human activities in coastal regions, such as discharging pollution into the ocean and land reclamation, especially in the coastal areas, increase the ecological pressures of the ocean, which has led to problems, including seawater eutrophication, seawater backfilling, coastal erosion, the desertification of the seabed, and so on (China Science Daily, 2012; Academy of Ocean of China, 2021). These environmental problems were put in second place in the stage when China eagerly pursues rapid economic growth. However, in the new era seeking economic development in high quality, realising the "green" and sustainable development of the blue industry becomes a major task for China to become a true marine power.

The urgent need for innovation

As discussed at the end of Section 2.1.2, China's marine economy has been experiencing a structural change. In this process, marine emerging sectors have become more important. In general, accelerating the development of emerging sectors is in line with China's targets of industrial transformation, supply-side reform, and configuring indigenous innovation capabilities. Despite their stronger growth momentum, these new industries are in smaller sizes relative to other traditional marine sub-sectors which are characterised by the labour and material-intensive models (e.g., mariculture and seafood processing) or heavily dependent upon foreign technologies. This lack of core technology poses challenges for the traditional marine industry towards knowledge-intensive and higher value-added activities.

Besides the industrial transformation, one of the major driving forces behind China's marine strategy is the quest for new growth opportunities and resources from the oceans to complement the land-based economic activities that are approaching the limits and the depleting land resources. Compared with the land area, the ocean environment is more complex and unknown to human beings. The lack of technological capacities would obstruct the further discovery and development of oceanic resources. Moreover, the demand for environmental protection and sustainable development, as well as the Chinese interests in national security and economic ambition all highlight the significance of self-dependent innovation development. Therefore, innovation and technological upgrading are crucial to China in the long-term perspective. The next section shifts the focus to China's marine innovation.

2.2 China's marine innovation

After decades of development, China has made large progress in marine innovation. In the marine bio-medicine industry, the indigenously developed marine medicines by China have accounted for nearly 30% of the global marketed marine products (Economic Daily, 2022b). The world's largest marine microorganism resource collection was built in China. In the field of marine equipment, China independently developed the Jiaolong deep-sea research submersible that can dive into the deep sea reaching depths of up to 7,062 meters (CGTN, 2017). Ships used for deep-sea and polar region research such as the Xuelong series and the Xiangyanghong series have also been quickly developed and applied in marine scientific research (Chen and Lei, 2019). Development in key equipment for seawater desalination and a number of marine fields are also approaching or have reached the world's leading level.

China's pursuit of the innovation-driven marine development is situated in its transition towards indigenous innovation and technological upgrading, where the state is the key director, planner, governor, and promoter. Therefore, this section illustrates the state-initiated marine innovation in China by first disentangling the governance structure and introducing departments governing marine affairs. Besides, the historical paths of Chinese marine innovation marked by the shifting targets of marine policy in various stages will be reviewed. Based upon this, the last sub-section will introduce the current situation of China's marine innovation.

2.2.1 China's marine innovation: the governance structure

China's marine development has been significantly motivated by the central state, from which the marine innovation strategies and policies are initiated and developed in a historically dynamic process. Before going into the details of marine policy change, this section reviews the governing bodies in Chinese marine innovation. Figure 2.5 shows the simplified governance structure. After decades of reform, China has configured a highly centralised and sophisticated governance structure to direct, supervise and manage the marine innovation development.

The central-level governance authorities

The *de facto* top-level authority of the central government is the State Council (OECD, 2008). Below the State Council are a handful of ministerial-level agencies in charge of affairs in different domains. Key government agencies responsible for marine innovation affairs include the Ministry of Science and Technology (MOST), Ministry of Finance (MOF), National Development and Reform Commission (NDRC), Ministry of Industry and Information Technology (MIIT), and State Oceanic Administration (SOA) (vice-ministry-level) belonging to the Ministry of Natural Resources (MNR). Besides the five agencies (MOST, MOF, SOA, NDRC, and MIIT), other ministries participate more or less in innovation and marine development from different aspects[1].

[1] For example, the Ministry of Education (MOE) supports and manages university-related R&D development; the Chinese Academy of Sciences (CAS) and Chinese Academy of Engineering (CAE) conducts S&T research and contributes to the innovation policy initiatives. These agencies configure the central-level hierarchy in China that govern and lead the national marine and innovation development.

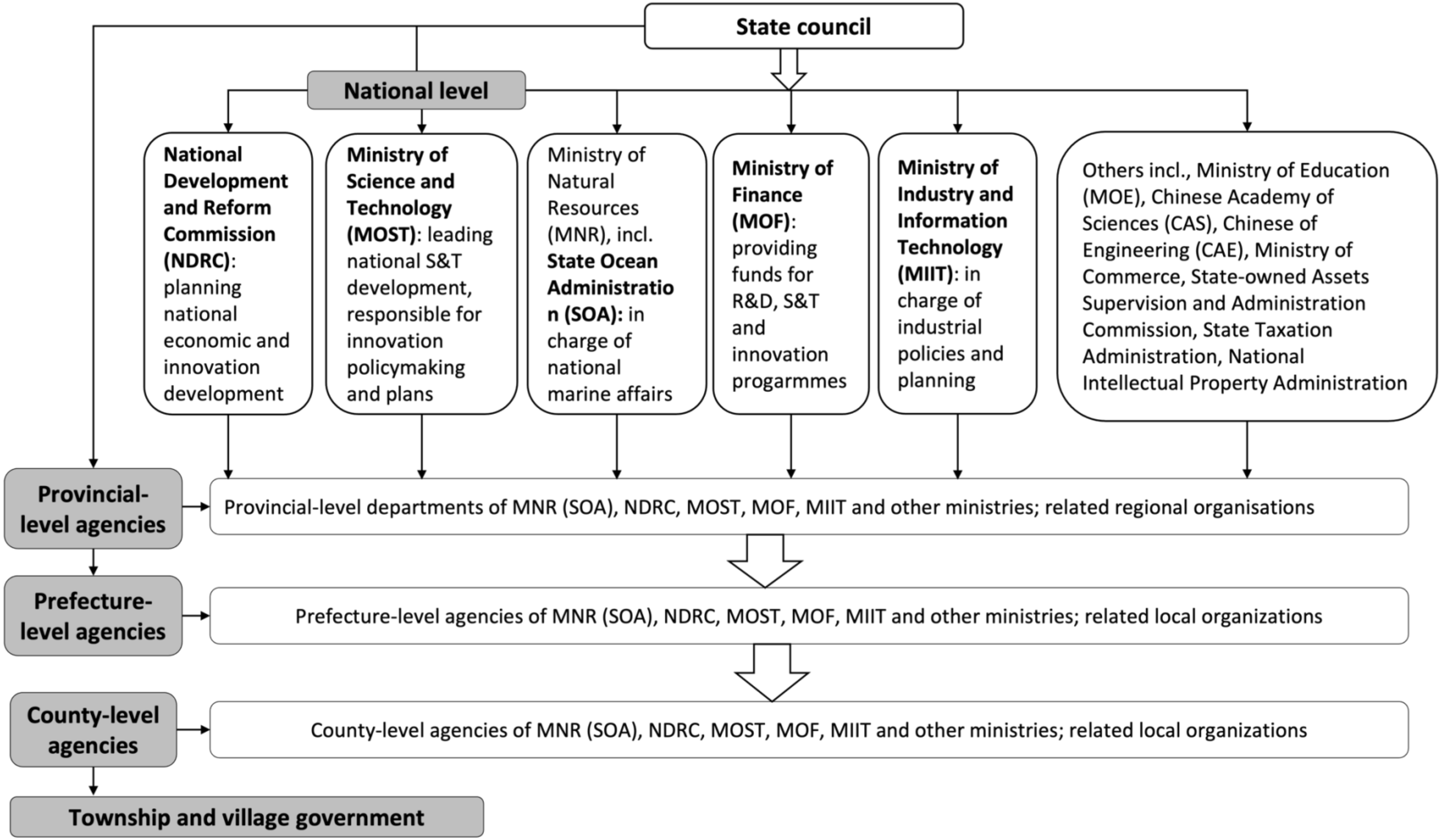

Figure 2.5. The governance system of China's government

Source: developed from OECD (2005).

MOST is almost the most important government agency lead the S&T and innovation plan and policymaking, especially in the early years of China's S&T reform. With continuous efforts of institutional restructuring, more departments are involved in innovation policymaking and management, which demands increasing cooperation and joint decision-making between different agencies[1] (OECD, 2008).

SOA oversees the planning, legislation, and management of marine resources[2]. Though SOA dominates the marine policymaking and management of marine issues, its capability in cross-agency coordination and mobilising resources as a vice-ministerial agency is relatively weak. In the context of increasing coordination between ministries, horizontal-coordinated policies usually enjoy higher authority than those issued by a single government agency[3] (Liu et al., 2011). Since the State Council has been involved in directing, organising, and coordinating marine policymaking, the significance of marine innovation development has been primarily enhanced (Qiao et al., 2011).

MIIT leads the formulation and implementation of industrial policies and supervises the high-tech sectors, such as the biotech and pharmaceutical industry and the information and communication technology industry (MITT, 2015). With the increasing overlap between the industrial and innovation policies, MIIT which masters vast resources for industrial R&D and innovation has become more important. In the marine field, MIIT is heavily involved in industrial development, especially the development of the marine equipment industry.

NDRC oversees a wide range of macro-economic and socio-economic development and reform issues. NDRC has been heavily involved in innovation policymaking through

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[1] For example, while MOST still obtained most S&T spending, its role in managing S&T budgeting is diminished, and it has to go through the budgeting process and obtain appropriations from MOF (Sun and Cao, 2014). MOST's emphasis was also concentrated more on the particular areas of innovation and their execution (Liu et al., 2011). MOF, which dominates the financial system and determines the funds for R&D, embarks on "omnipresent" participation in innovation policies.

[2] It used to be managed by the State Scientific and Technological Commission - the predecessor of MOST (between 1993 and 1998), the Ministry of Land and Resources (between 1998 and 2018) and its successor MNR (since 2018).

[3] In other words, the impact of policies issued only by SOA is limited and mainly restricted to the vertical oceanic bureaus at the provincial and prefecture levels.

economic regulations and strategic distribution of resources under its discretion (Sun and Cao, 2014). Regarding the marine policy, NDRC formulates the five-year plans for marine economic development, leads the establishment of marine economic development zones, and directs and coordinates the significant marine sub-sectors such as marine equipment and seawater desalination, which requires cross-domain collaboration between different government agencies.

The vertical-horizontal ("tiao / kuai") governance structure

In Figure 2.5, there are four levels of regional government and agencies below the central-level ministries, including the provincial or municipal level, the prefecture level, the county level, and the township and village level. Except for the bottom village-level government, the administrative set-ups of regional governments on different levels follow a similar structure to the top-level government. Structurally, this constitutes the vertical (*tiao* in Chinese) relationships between central and sub-national governments in the professional domains (Mertha, 2005). On each regional level, the relationships between different government agencies on the same administrative level constitute the horizontal (*kuai* in Chinese) relationships (Shirk, 1993). The *kuai*-based structure grants the local government independence to manage and coordinate regional affairs (Chen, 2018; Mertha, 2005). The vertical-horizontal (tiao-kuai) structure constitute the important governing basis for China's political economy, which will be illustrated in Section 3.2.4 in detail.

2.2.2 The historical path of China's marine innovation marked by policy changes

In the post-1978 era, China's S&T and innovation system experienced a gradual evolution driven by major policy changes. China's marine innovation has been developed in the background of the reform and transition of the Chinese economic and innovation system. In general, four key stages can be distinguished in China's marine innovation development, including "*initiating*", "*exploratory*", "*constructing*", and "*deepening*" stages, marked by major policy milestones. Figure 2.6 illustrates the evolution of marine policies in China. Beyond the affiliations to the national S&T policies, the marine sector has increasingly developed into an independent policy realm guiding the marine economic and innovation development in China.

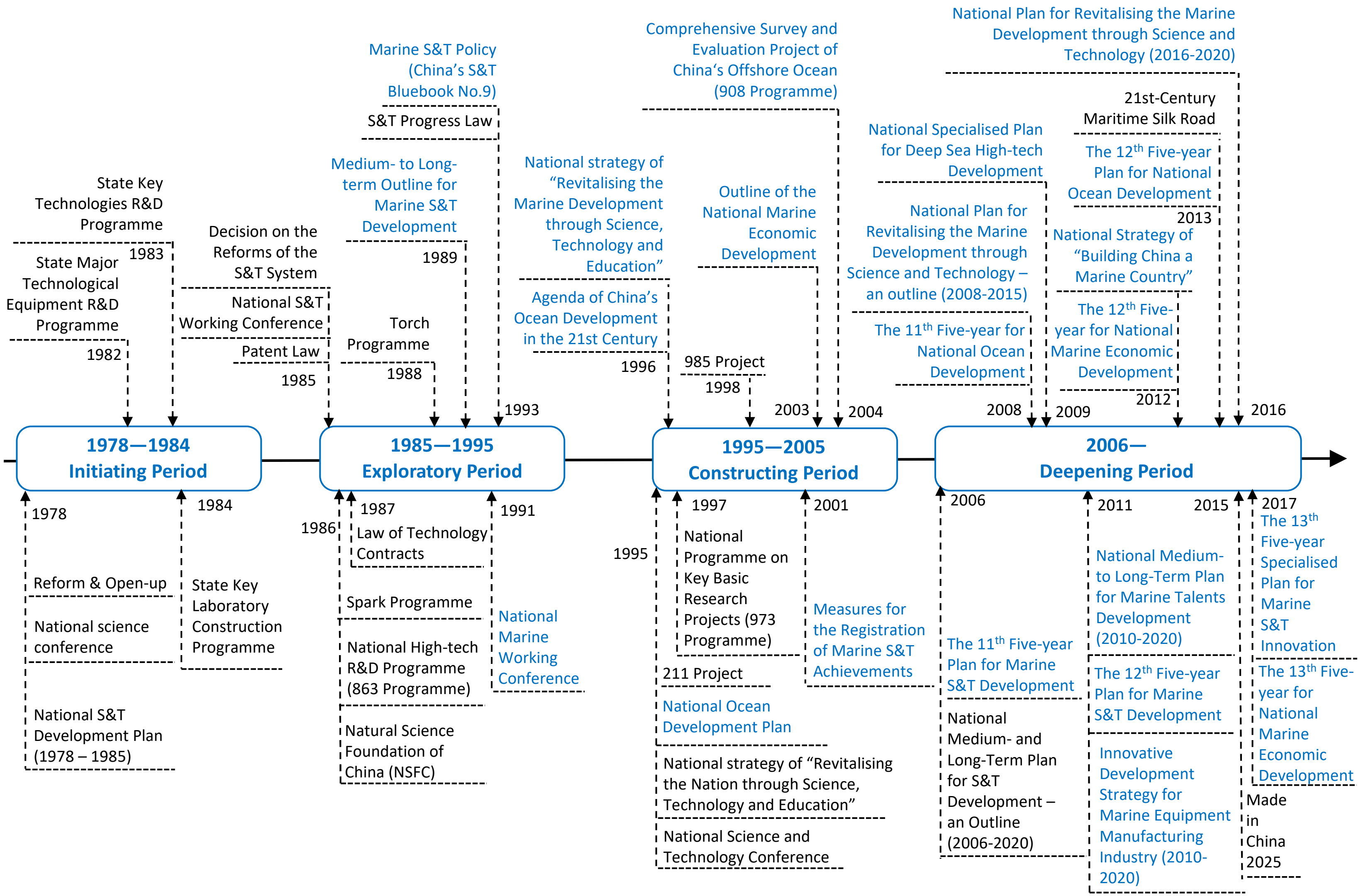

Figure 2.6. Evolution of China's Marine Innovation and Development

Source: author summarised.

Initiating period (1978 - 1985)

In March 1978, the National Science Conference was held in Beijing. Deng Xiaoping made the famous speech that S&T is the productive force, intellectuals belong to the working class, and S&T is key to the "Four Modernisations" (Deng, 1978). In the same year, the "National S&T Development Plan (1978-1985)" was issued, which marked the start of the S&T system reform in China. Several S&T programmes were introduced, such as the "State Key Technologies R&D Programme" started in 1982, the "State Major Technological Equipment R&D Programme" initiated in 1983, and the "State Key Laboratory Construction Program" introduced in 1984.

Marine innovation development entered the initiating period. However, no independent marine policies or programmes were introduced at this stage. Marine innovation was characterised as a small part of the focused S&T development areas. For example, the "National S&T Development Plan (1978-1985)" covered several marine fields, including mariculture, equipment for offshore oil extraction, technologies to build modern ports and large and specialised ships.

Exploratory period (1985 - 1995)

Marked by the National S&T Working Conference in 1985 and the release of the "Decision on the Reforms of the S&T System", China started the structural reform of the national S&T system. The main tasks of this reform were to restructure the operating mechanisms of the S&T work, guide the development of the S&T system towards serving the economy, and integrate the S&T system and economic system (Xinhua News Agency, 2009). Innovation policies in this stage centred on S&T and industrial development. A series of S&T programmes and policy initiatives were launched to facilitate a wide range of S&T and R&D activities, supplemented by the continuous market-oriented economic reform and the enactment of several laws, such as the "Law of Technology Contracts" (1987) and the "S&T Progress Law" (1993) (Liu et al., 2011).

Under such a background, China started to make more attempts in marine innovation development. For one thing, national innovation programmes and S&T policy guidelines[1] increasingly highlighted the significance of marine S&T. A typical example is the 863 Programme, launched in 1986 to master cutting-edge technologies and develop China's high-tech industries (MOST, 2012). Marine technology was listed as one of the critical technical areas in this programme. Other programmes launched in this period such as the Natural Science Foundation of China (NSFC) established in 1986 to support basic research and S&T researchers, the Spark Programmes started in 1986 targeting the rural areas, and the Torch Program launched in 1988 for high-tech industrialisation also involved marine S&T, particularly in the areas of offshore oil and gas, fishery, and marine transportation.

For another, marine-themed S&T policies emerged as independent policies driven by the state efforts despite the restricted number and scope. In 1991, the first National Marine Working Conference was held in Beijing and made the plan for marine policies and industrial development for the 1990s. "Medium- to Long-term Outline for Marine S&T Development" (1989) and "Marine S&T Policy (China's S&T Bluebook No.9)" (1993) were also released as initial but essential attempts of China's marine innovation policies, which highlighted the importance to discover and utilise natural resources from the but underplayed the technical aspects (Gov.cn, 2005; Qiao et al., 2011).

Constructing period (1995 - 2005)

Built upon the proceeding practices of marine S&T development and the urgent need for marine economic development, the significance of marine innovation was levelled up in the stage. High-level government agencies, for example, the State Council, started to participate in coordinating marine affairs and issuing marine policies. Marine-themed policies not only closely followed the transition of the national innovation policies but also became increasingly diversified.

Held in May 1995, the National S&T Conference initiated a new phase of China's innovation development. At this conference, the Chinese Communist Party Central Committee (CPPCC) issued the "Decision on Accelerating the Progress of Science and Technology" and proposed the national strategy of "Revitalising the Nation through

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[1] Key national S&T policies in this period include the "Science and Technology Development Plan (1986 - 2000)", the "National Medium- to Long-term Programme of S&T Development" issued in 1992, and the "Ten-Year Plan for S&T Development and Outline of the Eighth Five-Year Plan (1991-2000)".

Science, Technology and Education" (*kejiao xingguo* in Chinese). In the following year, the "Agenda of China's Ocean Development in the 21st Century" was released as the first manifesto of China, clarifying the plan for national marine development. The strategy of "Revitalising the Marine Development through Science, Technology and Education" (*kejiao xinghai* in Chinese) was put forward, which recognises the importance of S&T-driven marine development (SOA, 1996). Besides, Section 2.1.2 mentioned that the State Council issued the "Outline of the National Marine Economic Development Plan" in 2003, which for the first time recognises the importance of developing the marine economy. This plan also highlights the significance to enhance the marine innovation capabilities in order to better facilitate marine industrial development (State Council, 2003).

Following the new national strategy to support the education and S&T-driven economic development, many policies and programme initiatives were introduced. For example, to strengthen basic research and its capabilities in facilitating economic and social tasks, China launched the National Programme on Key Basic Research Projects (973 Programme) in 1997, which involved a number of marine projects (MOST, 2006). Also, institutional reforms were conducted to condense the public education and research system and encourage public research institutes (PRIs) to participate in economic activities. A large number of state-owned PRIs were transformed into technology-based firms or internal R&D groups of firms (Liu et al., 2011). Furthermore, in 1998, the Knowledge Innovation Programme was initiated to revitalise and restructure the PRIs of the CAS (OECD, 2008). Two education programmes, Project 211 and Project 985, were launched by the Ministry of Education. In such context, the number of marine R&D professionals reduced from 12,587 in 1996 to 9,875 in 2005. However, China did not cut the number of marine PRIs and kept around 110 marine R&D organisations (SOA, 1997; SOA, 2006; Gov.cn, 2006).

During this period, China's innovation policies started to recognise the importance of private enterprises' innovation[1] and shift more attention to the transfer and industrialisation of S&T achievements (OECD, 2008). Beyond traditional S&T and industrial policies, supplementary financial, tax, and fiscal policies were issued to

[1] Examples include the policy of "Opinions on Promoting the Development of Private S&T Enterprises" issued in 1996, the Innovation Fund for Technology-based SMEs (Innofund) established in 1999, and the continuous expansion of new and high-tech industrial parks.

support innovation from multiple aspects (Liu et al., 2011). Marine innovation policies, for example, the "Measures for the Registration of Marine S&T Achievements" issued in 2001 for accelerating the utilisation and conversion of the S&T achievements, also reflect this national trend.

Deepening period (2006 - now)

In the mid-2000s, "indigenous innovation" (*zizhu chuangxin* in Chinese) has become the main topic of China's innovation development marked by the launch of the MLP at the National Science and Innovation Conference in 2006 (State Council, 2006). It established the long-term goal of building China as "an innovative country" by 2020 and a world S&T leader by 2050, proposed to construct the innovation system with Chinese characteristics, and highlighted the importance of replacing the government-led innovation model with the firm-centred one (OECD, 2008). A series of policies have been introduced following the launch of MLP, such as the S&T human resources (e.g., "National Medium- to Long-Term S&T Talents Development Plan" (2011)), the popularisation of education and science (e.g., the strategy of "Mass Entrepreneurship and Innovation"), and the industrial upgrading (e.g., Made in China 2025).

Alongside the transition of national innovation policies, the development of marine innovation also embarked on a new era with several new features. Firstly, the strategic position of marine-oriented development has been further enhanced and consolidated by the CPPCC. In 2007, the 17th National Congress of CCP proposed to strengthen China's marine economic development. In 2012, the 18th National Congress of CCP further emphasised the importance of marine development and proposed the national strategy of "Building China a Marine Power" (*Haiyang Qiangguo* in Chinese). Developing the blue economy became a national strategy in China. Marine policies have become more comprehensive and systematic. Since the start of the 11th five-year plan in 2011, five-year plans for marine economic development and S&T development have been launched by the central-level authorities (e.g., the State Council, NDRC, and MOST). Led by the key policies, various policies (e.g., marine S&T talents cultivation) and pilot programmes (e.g., the construction of demonstration zones for marine economic and innovation development targeting regional development) have been introduced.

More innovation policies have been released targeting marine sub-sectors, especially the emerging industries perceived to be critical by the government. The data of structural reform of the marine industry at the end of Section 2.1.2 have partly reflected the effectiveness of these policies. Besides the marine bio-medicine industry discussed before, other key marine fields have been highlighted with innovation as the most critical driving forces of industrial development. For example, the "Specialised Plan for Marine Desalination S&T Development in the 12^{th} Five-year Period" was issued in 2012 to guide and support the seawater utilisation sector. The "Innovative Development Strategy for Marine Equipment Manufacturing Industry (2010-2020)" was launched in 2011 to strengthen innovation and industrial upgrading of the marine equipment industry. Policies targeting specific industrial fields would continuously be the main measures of the state to guide industrial development.

2.2.3 The state of China's marine innovation

One important and integrated indicator of China's marine innovation is the *national marine innovation index*, which has been compiled and published by the First Institute of Oceanography of SOA-led Chinese authorities. This innovation index illustrates the historical trend of China's marine innovation development from multiple aspects. Figure 2.7 shows the National Marine Innovation Index from 2002 to 2016 from the "National Marine Innovation Index Report 2017-2018". Generally, an upward trend can be clearly identified, despite the fluctuations in certain years. This index reached 307 in 2016 from the basic level of 100 in 2002, which demonstrates the increasing input and the enhancing capabilities and performance of China's marine innovation.

Sub-indices and data

Four perspectives of marine innovation have been manifested by this composite innovation index, including (i) marine innovation resources, (ii) marine knowledge creation, (iii) marine innovation achievements and (iv) marine innovation environments, which was integrated from the data of 20 indicators[1].

[1] The definitions and calibrated data of sub-indices and indicators are listed in Appendix A.

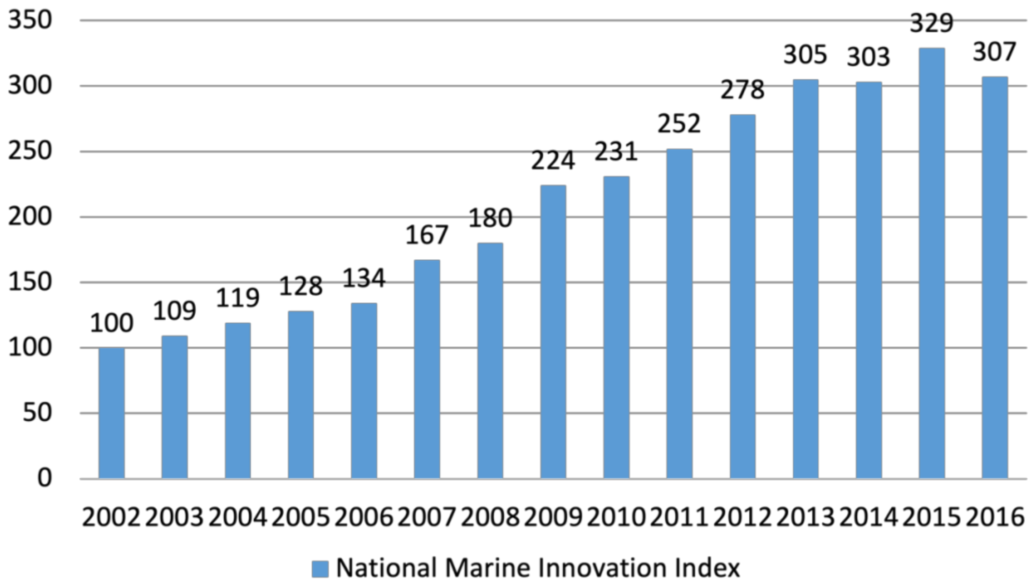


Figure 2.7. Growth of Marine innovation index in China from 2002 to 2016

Source: Liu and He (2019, p.24).

Specifically, the *marine innovation resources* index characterises the "input" intensity of marine innovation mainly indicated by R&D expenditure and personnel. From 2002 to 2016, the annual growth rate of marine R&D expenditure was 23.72% on average. R&D personnel also grew steadily. Besides, the *marine knowledge creation* index measures the marine innovation "output" based on the data of patents, academic papers, and published work. For instance, between 2001 and 2016, the number of marine patent applications in China increased with an average annual growth rate of 23.90% (Liu and He, 2019). The number of patent applications was over 4000 pieces each year since 2012. A total of 9,923 pieces of papers were published in SCI-indexed journals in this period of time. This perspective has achieved the most rapid growth and contributed the most to Chinese marine innovation.

Thirdly, the *marine innovation achievements* index concerns the effects and impacts of marine innovation activities. It measures the contribution of marine innovation to economic development. For example, in the one decade since 2006, 65.9% of Chinese GOP growth came from the contribution of marine S&T progress. The contribution rate of marine S&T progress to the marine economy increased from 54.4% in the 11th five-year plan period from 2006 to 2010 to 64.2% in the 12th five-year plan from 2011 to 2015 (Liu and He, 2019). Lastly, the *marine innovation environments* index shows the environments where marine innovation is situated in from the aspects of GOP per capita, the proportion of marine R&D expenses on equipment, the contribution of governmental funding in marine R&D expenses, and the number of graduates in marine subjects. For example, the data in 2016 showed that the proportion of governmental funding had been decreased, while there was still 80.69% of the marine R&D expense came from the government. This further reflected the role of the state as the key promoter of Chinese marine innovation.

Limitations of the National Marine Innovation Index

Even though the innovation index data measures China's marine innovation in a multiplex way, it has several limitations. The primary limitation of the marine indicators is the overemphasis on quantity over quality. For example, in measuring the marine innovation output, the patent data only characterises the patent counts, whereas there are consensuses on the limitations of using patents to assess innovation that will be further illustrated in Section 2.3.2. Indicators like patent citations that can measure the value of innovation and knowledge flows were not captured by the innovation index.

Furthermore, the marine innovation index overemphasises S&T innovation but overlooks non-R&D innovation. Data on marine R&D expenditure[1] and R&D staff have illustrated the vast scale of China's investment in human and pecuniary resources to support marine innovation. The contribution rate of marine S&T progress to the marine economy and the rate of marine S&T transfer have also demonstrated that S&T innovation is an important driving force to economic growth. However, non-R&D innovation, in the form of organisational innovation, business innovation, institutional innovation and so on, is also critical source of economic development, which has not been reflected in the index. Related to this limitation, the innovation data is mainly obtained from marine scientific research organisations such as universities, PRIs, and key labs and engineering centres. This underestimates the roles of firms in contributing to marine S&T input and output. Moreover, firms' innovation in business models, organisational structures, and management strategies has been overlooked. These

[1] According to Liu and He (2019), the sources of R&D expenditure indicate the strong position of government funds (~80.69%) and an increasing proportion of enterprise funds (~9.11%) to marine UPRIs. No official data regarding the sources of China's marine R&D spending has been provided. Only demonstrating the data regarding UPRIs is likely to cause an overemphasise on the government's role.

limitations have obstructed a much more comprehensive understanding of China's marine innovation.

In fact, before 2016, the *marine firm innovation* index was also an essential perspective to characterise China's marine innovation. It measured the innovation of Chinese marine firm in several aspects, including the rate of S&T self-dependency[1], enterprise R&D staff and expense, and granted invention patents. As Figure 2.8 demonstrates, between 2009 to 2015, the value and average growth speed of the marine firm innovation index were apparently higher than the other sub-indices (The First Institute of Oceanography, 2018). Nevertheless, due to the restricted access to marine firm data, this firm innovation was excluded since 2016. All in all, China's growing dependence on firm innovation and the historically recorded importance of marine firm innovation co-exist with the lack of corporate innovation data and insufficient understanding of marine firm innovation in China. This empirical gap calls for more research to explore China's marine innovation at the firm level.

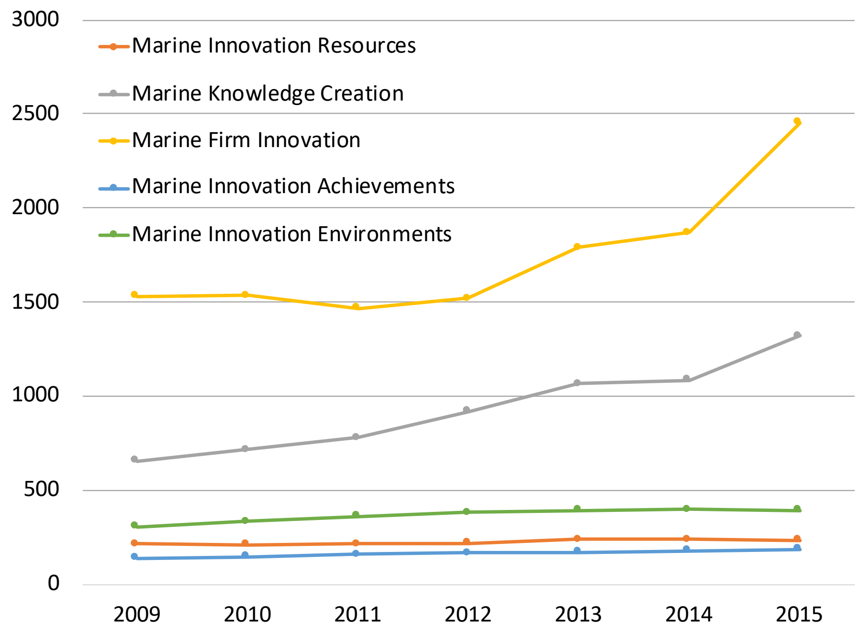


Figure 2.8. Sub-indices of the national marine innovation index from 2009 to 2015

Source: The First Institute of Oceanography (2018).

This section shows the state-led evolution of Chinese marine development by demonstrating the governing bodies of China's state involved in marine affairs,

[1] It characterises the capability of indigenously marine innovation.

reviewing the development path of Chinese marine innovation, and displaying statistical data about the situations of China's marine innovation. Combined with Section 2.1, they demonstrate China's marine economy and innovation from an integrated and national perspective. However, China as a large economy, its economy and development levels demonstrate a regionally unbalanced feature. There exist widespread differences across regions. And the marine sector is not an exception. Therefore, the next section shifts attention to the empirical focus of this research - the regional differences in China's coastal areas.

2.3 Regional differences in China's marine development

According to Colgan (2003), defining the marine economy seems to be a problem of defining the economic value of natural resources, while in fact, it is a problem of defining the characteristics of a regional economy whose boundaries are linked to the ocean. Exploring the marine economy is better considered as a regional question. And the coastal regions are the places where the available data come from. In China, the eastern coastal regions are the most developed areas. Their development started earlier than the central and western regions and has significantly contributed to the Chinese economic miracle in the post-1978 era. Nevertheless, these coastal regions are different in various aspects such as regional histories, local endowments, industrial structures and focuses. Their economic and innovation development has also been different. Focusing on the marine industry, the main aim of this section is to illustrate the regional differences in marine development through statistical data.

2.3.1 China's coastal regions and their marine economy

Defining the regional scale is a complicated issue. In the mainland China, there are 11 provincial-level coastal areas, which are composed of 55 cities and 226 coastal counties (i.e., countries, county-level cities, and districts). The 11 provincial-level coastal regions include eight provinces (i.e., Liaoning, Hebei, Shandong, Jiangsu, Zhejiang, Fujian, Guangdong, and Hainan), one autonomous region (i.e., Guangxi) and two centrally administrated municipalities (i.e., Shanghai and Tianjin). The two regional cases of this study - Qingdao and Ningbo, are situated in Shandong Province and Zhejiang Province respectively.

Figure 2.9. Three marine economic circles in China

As Figure 2.9 shows, the 11 provinces are further classified into three marine economic circles, which reflects China's supra-regional economic planning strategy for managing economic development (will be illustrated in Section 3.1.4) and the efforts to improve industrial diversification and specialisation by adjusting the layout of regional marine economy. The strategic positions of the three economic circles are distinguished according to regional contexts, such as the natural endowments, geographic locations, historical conditions, and development potentials. Different development goals have been set for the three super-regional circles (State Council and SOA, 2017).

Specially, the northern circle has a strong industrial basis and advantages in marine S&T education. It has been positioned as the important area to develop advanced manufacturing base, service base, and S&T innovation and R&D base. The economy of the eastern circle is with high external dependence. The ports and shipping infrastructure are well-developed, which is crucial for China's connection with the external world. Also, this region is a critical area to develop advanced manufacturing and service bases. The southern zone is endowed with rich natural resources. Besides developing the industrial bases, embracing the South China Sea also determines its significance to China's national defence and security. Within each circle, provinces and key marine cities have also been assigned development tasks with highlighted key industries, resources, and ecological problems. For instance, Shanghai, the economic centre of China, is positioned as the internationally financial, commercial, shipping and S&T innovation centre. Industries surrounding shipping, such as shipping information, financial and legal services, ship design, and cruise tourism are listed as key areas.

In recent years, while all three supra-regional marine economic areas have been growing, the southern circle shows the strongest growth momentum. In the decade from 2012 to 2021, its contribution to the national GOP raised from 20% to around 40%. The proportion of the norther and eastern circles declined, especially the former. This is caused by the stagnated growth in certain provinces compared with their counterparts in other supra-regions. In China, the provincial statistical data of the marine economy clearly indicates the cross-regional differences.

As Figure 2.10 shows, in 2019[1], the GOP of Guangdong Province was 1858.82 billion yuan, and the GOP of Shandong Province was 1550.21 billion yuan (MNR, 2021). The two provinces have demonstrated absolute predominance in marine economic development in terms of the provincial GOP, accounting for nearly 40% of the national total. They are followed by Fujian Province, Shanghai, Zhejiang Province, and Jiangsu Province in the second tier. However, the gap between the top two and other regions was large. The provincial GOP of Guangdong and Shandong exceeded 1000 billion yuan in 2012 and 2013 respectively. However, Fujian Province which has been in the third place constantly for many years attained this number only until the year 2018.

Besides the differences in the absolute size of the marine economy, comparing these coastal provinces show the uneven regional development in China. In the six most-developed coastal provincial areas measured by GOP, Guangdong, Shandong, Zhejiang, and Jiangsu are also the nationally most-developed regions in economic development measured by GDP, ranking the top four among provincial regions in China mainland (National Bureau of Statistics, 2019). Together their GDP was over one-third of the national GDP in 2019. However, marine provinces like Hainan Province and Tianjin only ranked the last third in China's provinces in 2019 by GDP.

[1] Provincial GOP is only available until 2019.

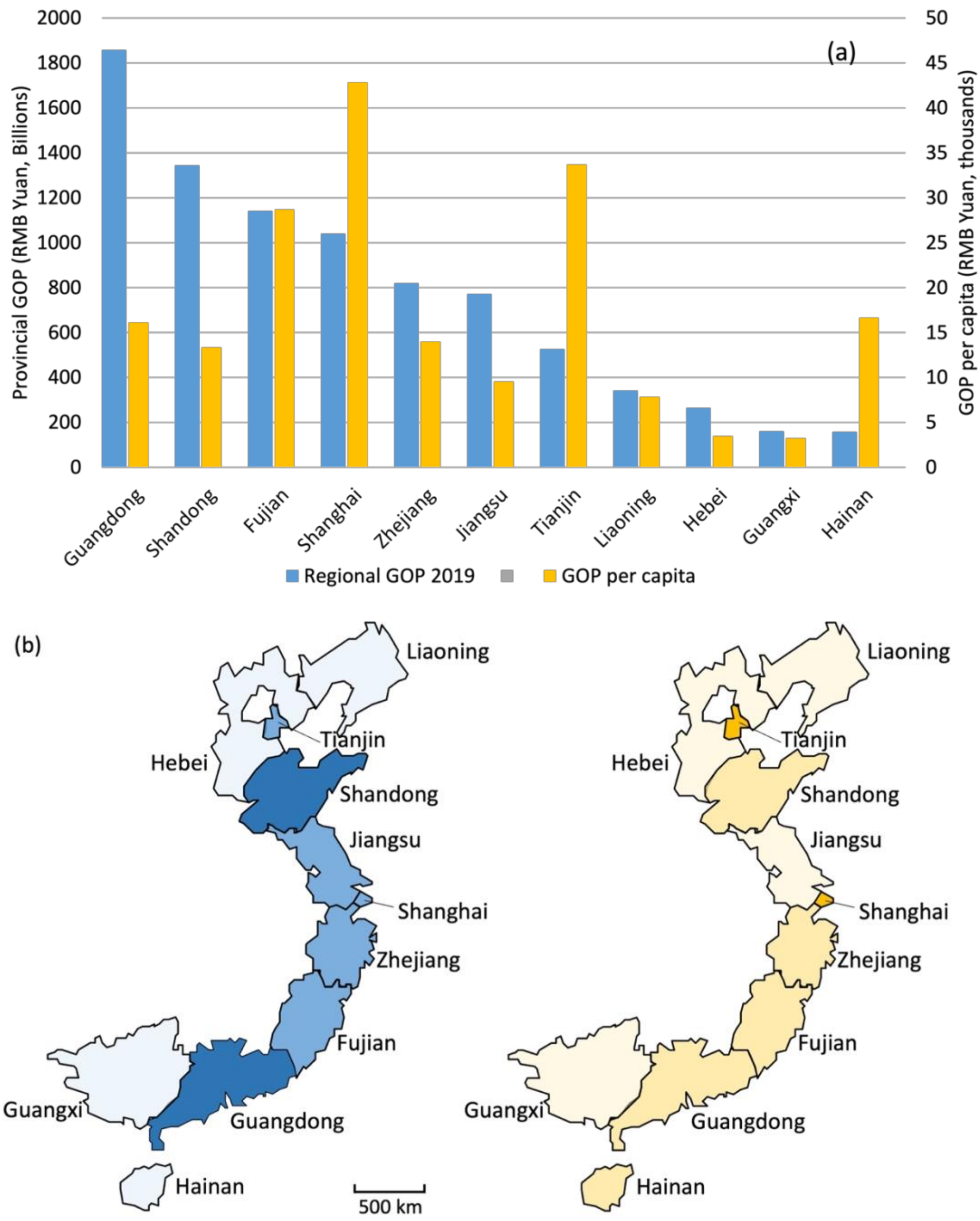


Figure 2.10. China's regional differences of marine economic development in 2019

Source: MNR (2021).

Furthermore, measuring the marine economy by the GOP per capita shows a different picture. Shanghai and Tianjin, two provincial-level cities, demonstrated absolute advantages by this measurement in 2019. Fujian Province and Hainan Province also performed well. However, Guangdong Province and Shandong Province, the leader in marine economic size, only ranked the 6th and the 8th separately on a per capita regional GOP basis. These two provinces are large in the absolute economic size as well as in the size of the population.

However, measuring GOP per capita using the total number of provincial populations has severe limitations. The marine economy has evident geographical feature by concentrating around the coastal areas. However, each province differs in the distribution of population and economic activities and inner-coastal areas. For instance, provinces like Shandong and Jiangsu have large inner land areas that are suitable for economic activities, which have gathered most of the people within the provinces. In 2019, populations in the coastal areas within the two provinces only accounted for 35.18% and 24.57% of the provincial total respectively. However, in Hainan Province and Fujian Province, over 72.6% population lived in the coastal areas. Therefore, calculating the GOP per capita using provincial population is close to the actual level of Hainan and Fujian Province but underestimates the levels of marine economic development in provinces such as Shandong and Jiangsu.

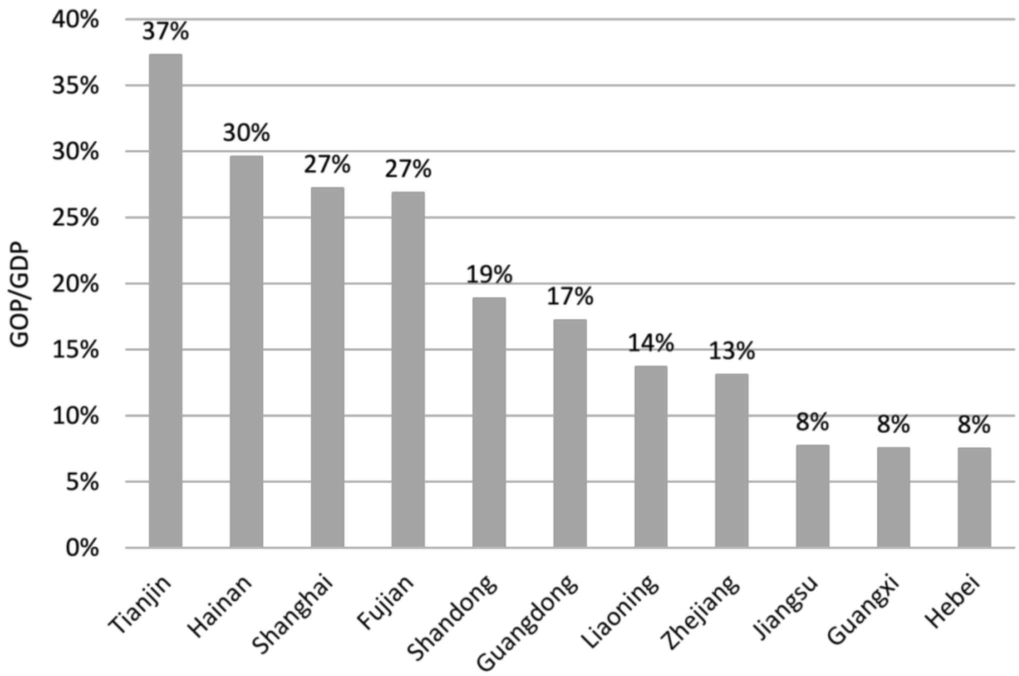


Figure 2.11. Contribution of the marine economy to the coastal regions' GDP (%) in China in 2019

Source: calculated based on the data from MNR (2021).

Besides the differences in GOP and GOP per capita, the reliance on the marine industry to support the regional economy varies across the coastal region. As Figure 2.11 shows, Tianjin is heavily dependent upon the marine industry with 37% of its GDP contributed by the marine industry in 2019. This city is followed by Hainan Province, Shanghai, and

Fujian Province where the marine economy accounts for nearly 30% of their regional GDP. However, for provinces like Jiangsu, Guangxi, and Hebei, the "blue" feature in their economic development is not evident.

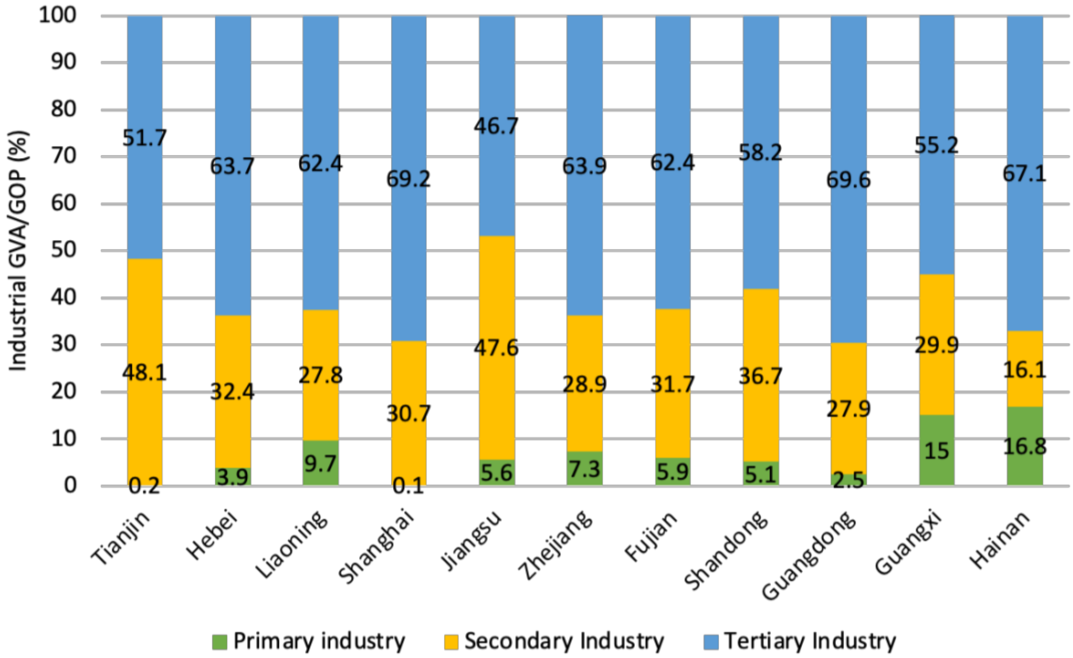


Figure 2.12. Regional disparities of GOP in China in 2019

Source: calculated based on the data from MNR (2021).

Moreover, the marine industrial structure in each province differs. As Figure 2.12 shows, for provinces like Guangxi and Hainan which are located in relatively rural areas of China, their marine economies are not only small in size but also high in the dependence upon the marine primary industry, such as mariculture and sea fishing. This is significantly different from the other regions. For example, in Guangdong Province and Shanghai, the marine service industry has become the mainstay of the provincial marine economy. In Jiangsu Province and Shandong Province, there are notable large secondary marine sectors.

2.3.2 Differences in China's regional marine innovation

The above section shows the regional differences in marine economic development from different perspectives. This section shifts the attention to marine innovation, which is the key research area of this study. Similarly, most regional data illustrate the differences in marine innovation on the provincial level. An important indicator from the official source is the “regional marine innovation index”, which transforms the national marine innovation index demonstrated in Section 2.2.3 to the measurement and calibration of marine innovation on the regional level. Besides the provincial differences, this section also involves city-level data for comparison.

Provincial-level differences

Table 2.2 displays the regional marine innovation indices from 2014 to 2016 aggregated from the four kinds of sub-indices[1] illustrated in Section 2.2.3. Among the provincial regions, Shanghai maintained the predominantly leading position in marine innovation, which was followed by Guangdong Province and Shandong Province. As mentioned in Section 2.3.1, they also represent the most developed level of the marine economy measured by the regional GOP. Tianjin also belongs to the first tier in marine innovation. It was followed by Jiangsu, Fujian, and Liaoning provinces which were above the national average level. Provinces including Zhejiang, Hebei, Hainan, and Guangxi far lagged behind the leading provinces. Marine innovation indices in these places were lower than the average level.

Table 2.2. Comparison of ocean innovation index of major ocean-related cities

Year / Region	Regional Ocean Innovation Index		
	2014	**2015**	**2016**
Shanghai	65.3 (1st)	64.27 (1st)	65.06 (1st)
Guangdong	53.28 (3rd)	52.15 (3rd)	61.51 (2nd)
Shandong	51.92 (2nd)	55.6 (2nd)	56.5 (3rd)
Tianjin	51.05	51.92	54.9
Jiangsu	44.41	45.09	49.83
Fujian	42.56	46.39	46.69
Liaoning	42.45	44.96	44.48
Zhejiang	32.96	35.41	36.33
Hebei	32.74	32.31	30.13
Hainan	26.68	26.94	22.74
Guangxi	16.36	17.14	19.71
Average	36.15	37.52	38.1
Median	42.56	45.09	46.69

Sources: The First Institute of Oceanography of SOA (2017, 2018), Liu and He (2019).

[1] Marine firm innovation index was not included in the regional measurement even before 2016.

Furthermore, Figure 2.13 shows the sub-indices of regional marine innovation in China's coastal provincial areas in 2016. According to this figure, Jiangsu Province had invested the most in marine innovation, while its output in marine innovation and the supporting effects of the regional environments on marine innovation were restrictive. Shandong Province enjoyed the best environments for marine innovation across all coastal provinces. Its marine innovation output and achievement also achieved satisfactory results in 2016. The sub-indices in Shandong were the most balanced among those leading regions in marine innovation. Furthermore, Shanghai and Guangdong achieved fascinating performance in marine innovation-led economic development and R&D output separately. Their investment in the marine innovation and the regional environment was also in the leading positions.

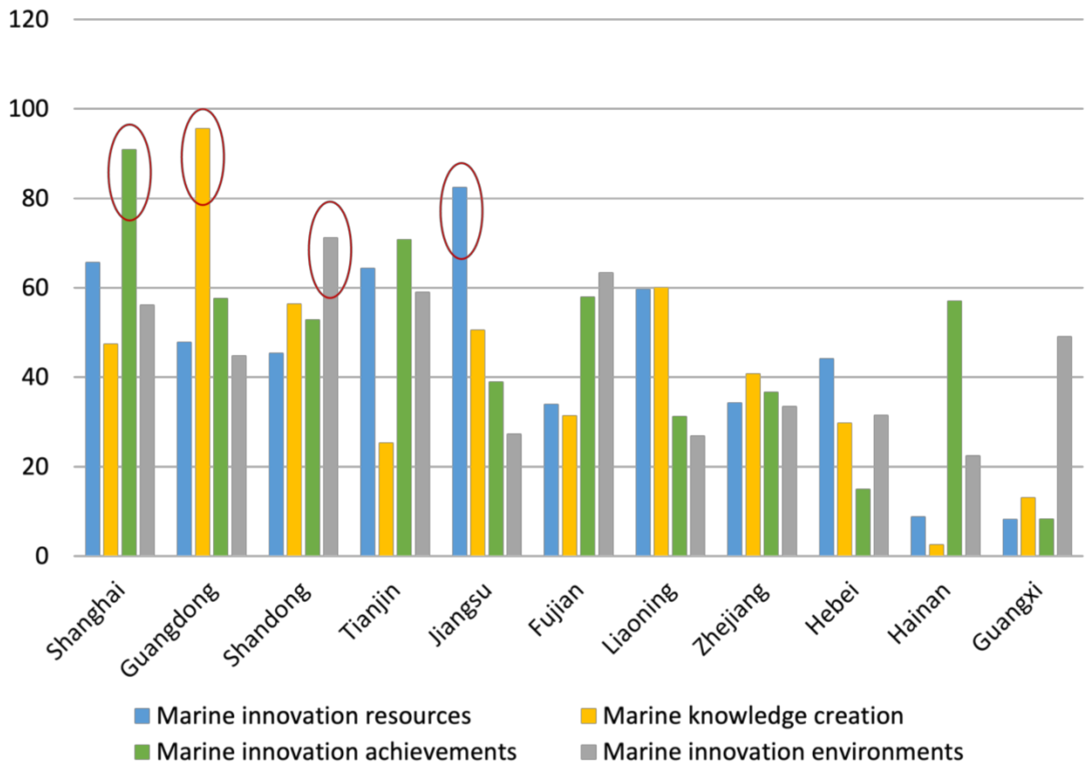


Figure 2.13. Chinese Coastal Provinces' Marine Innovation Sub-Indices in 2016

Source: Liu and He (2019).

However, the regional comparison also implies the complicated situations of the marine innovation process and the different regional contexts. Take Tianjin for example, the resources and environments of this city were better than most other provincial regions, while its marine knowledge creation - the output measure of marine innovation was disappointing. This somewhat indicates the non-linearity of marine innovation. Furthermore, as mentioned in Section 2.2.3, the marine innovation achievements index measures the contribution of marine innovation to regional economic development. The resources, environment, and output of marine innovation in Hainan Province fell behind most other regions. Nevertheless, the limited marine innovation generated amplifying effects on the regional economy.

Moreover, in the "National Marine Innovation Index Report of China 2017 - 2018", Liu and He (2019) explored the relationships between the regional marine innovation index and the regional economy measured by GDP per capita, and how regional innovation interacted with the regional marine economy as measured by GOP per capita. In general, it was found that economically developed areas usually achieved higher value of marine innovation and vice versa, except Zhejiang. Also, regions with strong marine economies were also relatively stronger in marine innovation and vice versa, except Zhejiang and Hainan. The positive relationships are explainable because the economically developed areas tend to have stronger capabilities, more resources and opportunities to pursue innovation. In the Chinese context of seeking the indigenous innovation-driven development, it is widely acknowledged that innovation can in turn inject persistent power to sustain economic development in the long-term, and thereby becomes the common pursuit of those regions with a degree of economic advantages.

This case of Zhejiang is contradictory to the national trend, which implies that its flourishing economic development has neither been transformed to the advantages of marine innovation nor been attributed to the support of marine innovation. This further leads to the question of why marine innovation can be well developed in some regions (e.g., Guangdong and Shandong) but not in others (e.g., Zhejiang), despite they all have developed economy and marine economy. However, Figure 2.13 and the analysis based upon it only show the situations in one year. Longitudinal data would help to generate a more comprehensive analysis of the advantages and disadvantages of marine innovation in various regions. Moreover, the regional marine innovation data cannot escape from the limitations relevant to the marine innovation index as discussed in Section 2.2.3.

City-level differences

China is a country with a vast territorial size. Some provinces in China are larger than many countries in the world. As Section 2.3.1 specifies, the distribution of population in each province and the dependence on the marine economy differ across coastal provinces. Within each coastal province, the area, the number of marine cities, and the area distribution of the coastal and inland regions of each coastal province are also different. Not to mention there are two provincial-level coastal cities - Shanghai and Tianjin. Even though city-level innovation data are even scarcer than provincial data, narrowing the focus to the city-level regions can characterise the situations of China's regional marine innovation in a more accurate way. This section attempts to explore the regional differences in marine innovation from the city perspective.

(a) Marine S&T input-output efficiency

In the "National Marine Innovation Index Report of China 2016", the First Institute of Oceanography (2018) compared the inputs of marine S&T resources across cities with different administrative positions. It was found that most S&T resources had been gathered in cities with high administrative positions, including the Municipalities directly under the Central Government (*Zhixia Shi* in Chinese), the Municipalities with Independent Planning Status under the National Social and Economic Development (*Jihua Danlie Shi* in Chinese), and provincial capital cities. In 2015, 90.27% of the national marine S&T investment and 89.33% of the national marine S&T staff were concentrated in these cities.

Also, major ocean-related cities were compared in terms of the marine S&T input-output efficiency using the Data Development Analysis (DEA) method. *Technical efficiency* measures the extent to which marine S&T resources are effectively utilised by a city. *Scale efficiency* measures the gap between the optimum scale of S&T resource input and the actual input of a city. 80% was set as the boundary between efficient and inefficient cities. As Table 2.3 shows, Qingdao and Nanjing represent highly efficient cities. They enjoy advantages in administrative and geographic positions, policies, and marine S&T foundations. On the one hand, they can effectively manage and utilise marine S&T capital and labour resources and transfer the resources into S&T output which is measured by the number of granted patents, published papers, and academic works. On the other hand, the scale of marine S&T input has reached the stage of constant returns to scale.

Table 2.3. Comparison of marine S&T input-output efficiency in major marine cities

Types of cities	Criteria	Representative cities
Highly efficient	Technical efficiency > 0.8, scale efficiency > 0.8.	Qingdao, Nanjing
Technically efficient	Technical efficiency > 0.8, scale efficiency < 0.8.	Beijing, Shanghai, Guangzhou, Shenzhen, Zhuhai
Scale efficient	Technical efficiency < 0.8, scale efficiency > 0.8.	Tianjin, Dalian, Xiamen, Zhoushan, Hangzhou, Nantong
Inefficient	Technical efficiency < 0.8, scale efficiency < 0.8.	Ningbo, Zhanjiang

Source: adapted from the First Institute of Oceanography (2018, p.99).

Compared with Qingdao and Nanjing, the "technically efficient cities" have advantages in technological capabilities. However, there exist gaps between the scales of their marine S&T resources input and the optimal level. For cities such as Beijing[1], Shanghai and Guangzhou that had enjoyed large administrative and geographical advantages, marine S&T inputs were redundant. For emerging marine cities like Shenzhen and Zhuhai, their marine S&T inputs were limited. Besides, the "scale efficient cities", such as Tianjin, Dalian and Xiamen reached the optimum scale of marine S&T resources. However, the input has not been effectively utilised and managed. Furthermore, in inefficient cities, exemplified by Ningbo and Zhanjiang, neither the scale of marine S&T input nor the utilisation capabilities were well-developed. Without technical advantages, making up for the deficiency in the input of resources would be the priority for them.

As a quantitative method, the S&T input-output efficiency is a useful and valuable indicator to capture the cross-city differences of Chinese coastal and ocean-related regions in marine S&T development that explicitly show the advantages and disadvantages. However, this measurement suffers from several drawbacks. Firstly, the input and output indicators involved in the analysis only measure the S&T aspect. And

[1] Beijing is not a coastal city. However, marine innovation is conducted in this city, especially by the universities and public research institutes doing marine research. As is shown in the sub-section on marine patents, inland cities conducting marine innovation is a usual phenomenon in China.

the diversity and coverage of indicators are restrictive. For instance, marine S&T input can not only generate S&T achievements. Economic output is an important perspective to evaluate the value of S&T input, which is overlooked. Furthermore, different variables are treated as the same without considering the relative weight of their importance to marine innovation.

(b) Marine patent counts

The number of patents, as an often-used indicator of innovation, also characterises the difference across Chinese cities in marine innovation. According to OECD (2009), patent data have advantages in the easy accessibility for a long time series and containing information such as the patented invention (and innovation), the name and location of the assignees, references to prior knowledge and so on. One of the major advantages of patents to facilitate regional comparison is that patent data can indicate geographical locations (Ejermo, 2009). Patent data also cover a wide scope of technologies that may lack data from other sources. A number of studies have investigated the relationships between patent counts and innovation performance (e.g., De Rassenfosse et al., 2013; Dechezleprêtre et al, 2017; Hoogland, et al., 2021). Assuming patents can reflect the inventive output, the patent count is considered as a good proxy of innovation of countries, regions, firms and other organisations, and individuals. More patents thus indicate more inventions.

Figure 2.14 shows the number of marine patent applications in 15 major Chinese cities between 2001 and 2016[1]. The data were retrieved from the Derwent Innovations Index (DII) database. Marine patents are identified based on the International Patent Classification classifications. As this figure shows, Qingdao achieved the best performance with around 4000 pieces of patents applied during this period, which was closely followed by Beijing and Shanghai. However, there are large gaps between the first-tire three cities and the other cities. Traditional coastal cities such as Xiamen, Shenzhen, and Ningbo only ranked in the last one-third.

[1] The specific ways in which marine patents had been identified were not given. However, as this report was written by the central governmental departments of China to characterise the marine innovation context, the data provided are considered to be credible.

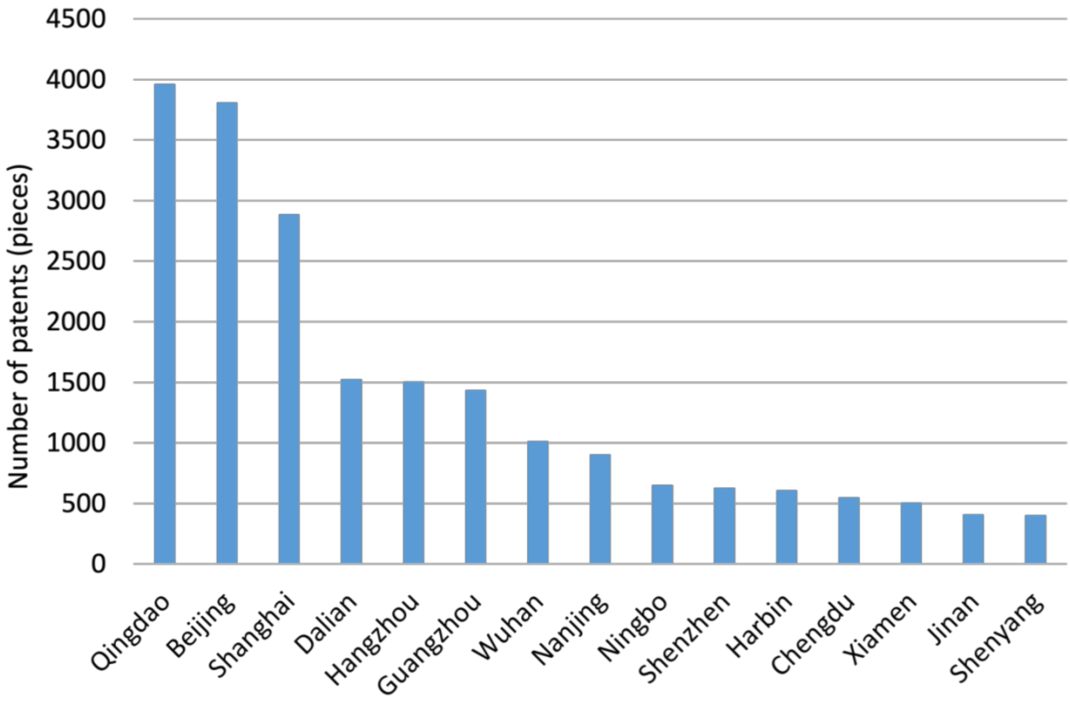


Figure 2.14. The number of marine patents applications of major Chinese ocean-related cities between 2001 and 2016

Source: Liu and He (2019, p.17).

Figure 2.15 compares the number of granted patents in major Chinese cities. The data sources and the coverage of marine fields and cities are different from the last figure. Based on the patent data from the Orbit patent database, Qingdao Research Institute of S&T Information analysed the marine patents granted between 2009 and 2019[1] of Chinese cities in seven key marine technical fields that are treated to be important in China's marine innovation. These fields include underwater vehicle, oceanic monitoring, marine bio-resources development, marine oil, gas and mineral resources development, seawater utilisation, marine renewable energy, and marine environment protection. The comparison indicates the cross-regional differences in terms of the granted marine patents, while Beijing, Qingdao, and Shanghai maintain the top three positions among major Chinese cities.

However, measuring the regional innovation performance using the patent counts exists biases. Firstly, the patent data was not normalised by population. This could mislead the understanding of the regional disparities because cities are in different

[1] Data in 2019 does not cover the whole year.

sizes, especially when the comparison covers many large metropolitans, such as Beijing, Shanghai, Guangzhou and Shenzhen with large sizes of population. Furthermore, some regions, such as Qingdao and Beijing, have gathered plenty of marine research organisations, some of which are national-level ones like the institutes of the CAS that produced many academic patents. However, there are no such clustering effects of research organisations in other cities like Wuxi. This also explains the inclusion of many inland cities in the sample, such as Wuhan, Harbin, and Xi'an, where marine research organisations and surrounding companies are important applicants for marine patents. More important, this phenomenon also indicates that marine innovation activities are no longer dominated by coastal cities only but can break the geographic constraints and extend to non-coastal areas.

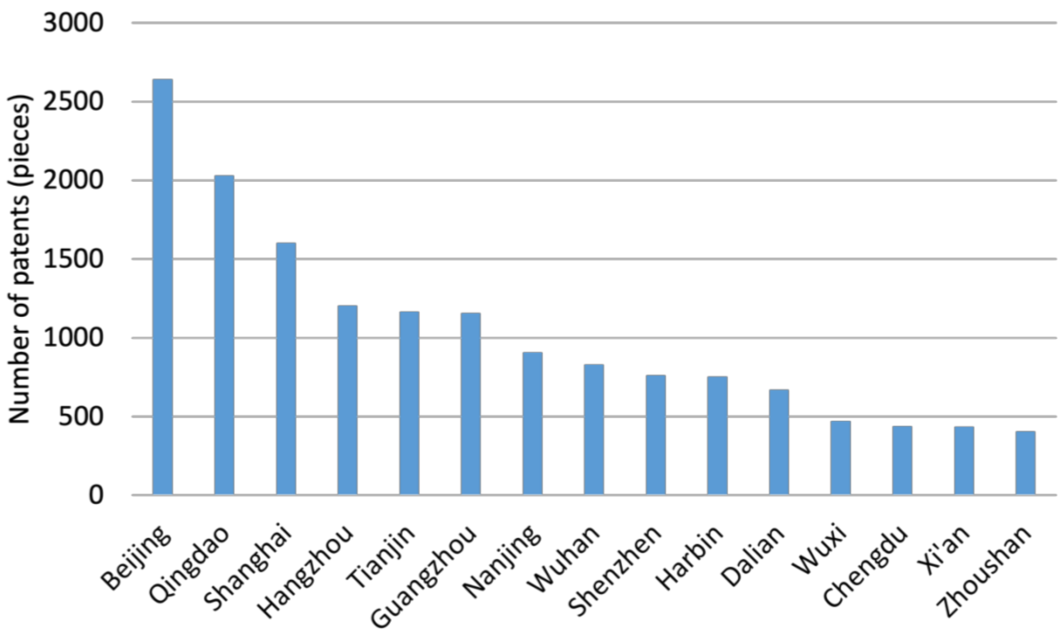


Figure 2.15. The number of granted marine patents in major marine fields of major ocean-related cities in China between 2009 and 2019

Source: Qingdao Research Institute of S&T Information (2019).

Recognising the unbalanced distribution of marine research organisations, breaking down the data in Figure 2.15 by organisations (Appendix B) further demonstrates the regional disparities. Although Qingdao ranked the second, most of the marine patents were contributed by universities and public research institutes. The number of granted patents from companies only accounts for 30.1% of the total. The dependence on research organisations was much heavier in Harbin and Zhoushan. In contrast, cities such as Beijing, Shanghai, Tianjin, Shenzhen, and Wuxi relied significantly on firm innovation. Comparing regions in terms of the enterprise patent counts, Beijing has predominant advantages for it gathered many central state-owned enterprises (SOEs) like China National Offshore Oil Corporation that are the global leading marine patent applicants in the focused marine fields. Shanghai, Tianjin, Qingdao, and Shenzhen also ranked high, while the inter-regional differences were not large.

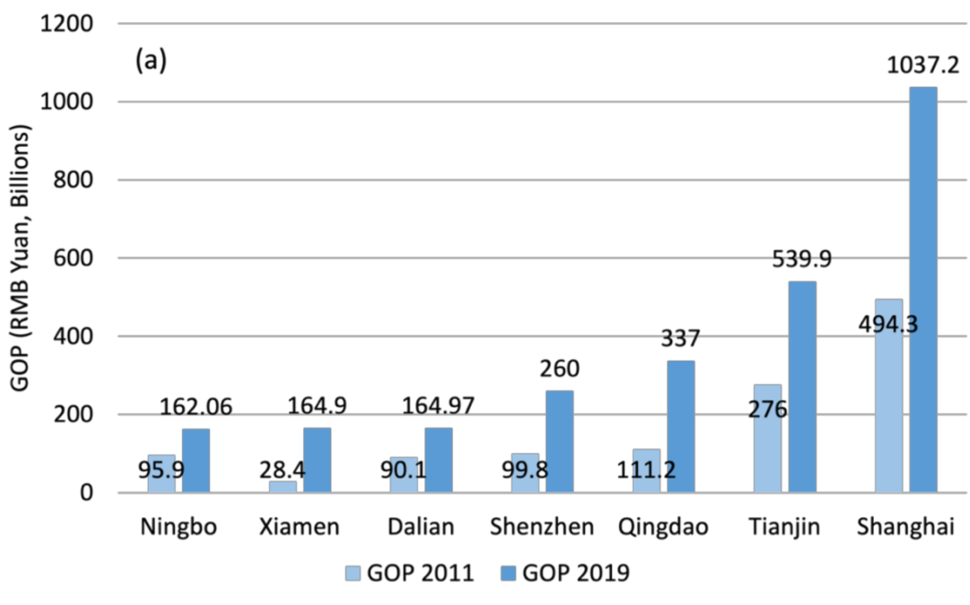
Moreover, another important bias relating to the patent counts lies in the differences across countries in the economic costs and benefits of patenting activities (Pavitt, 1988). This also applies to regional differences. Specific to the Chinese conditions, recent studies indicate that the patenting propensity in China has been boosted as much as 160% by the patenting promotion policies and the patent subsidies have increased the patent counts by over 20% (Li, 2012; Dang and Motohashi, 2015). However, the patent subsidy programmes are mainly initiated at the local government level to stimulate patent applications. Therefore, barely relying on the patent counts as the innovation indicators of the regional differences could be misleading.

Besides the bias of using the number of patents in regional comparison, patent counts as innovation indicators have some commonly recognised drawbacks. Firstly, many inventions are not patentable or necessarily patented when other means of protection against imitation (e.g., trade secrecy, lead time on the market or reputation) are more useful (De Rassenfosse et al., 2013). Besides, the patenting propensity differs across technical fields (Breschi et al., 2000). Patents are widely used in fields such as chemicals, drugs, and electronics, while not in many other fields (Mohnen, 2019). As a result of the heterogeneity, some technical fields have more patents than others. Furthermore, the value distribution of patents is highly skewed, and many patents do not have industrial applications and have little economical values, while a few have high values (Griliches, 1990). Therefore, interpreting innovation using patent counts should be cautious. Quality-adjustment through citations is frequently used, which is combined with other measures in terms of the renewal of patents, generality, and originality (Trajtenberg; 1990; Ejermo, 2009).

(c) Regional marine economic development

Moreover, treating innovation as the means to realise economic development, the disparities in the marine economy can to some extent imply the differences in marine innovation and generate different economic foundations for the marine economic development. In China, several major marine cities have stated that they would build themselves into a "global marine centre", which implies their determination to pursue marine development. Figure 2.16 compares these "leading" marine cities in marine GDP. Besides Shanghai and Tianjin, the rest five cities are "coastal open cities" - the bridgeheads of China's opening-up, vice-provincial-level cities, and Municipalities with Independent Planning Status under the National Social and Economic Development. However, large differences exist in their marine economic development.

Except for Xiamen, the marine industrial foundations of the four cities were similar in 2011. After nearly one decade, Ningbo (in Zhejiang Province) and Dalian (in Liaoning Province) were left far behind by Qingdao (in Shandong Province) and Shenzhen (in Guangdong Province). Although the GOP of Xiamen (in Fujian Province) was still lower than other cities, its marine economic growth realised the fastest speed. Xiamen's GOP in 2019 was nearly six times than the data in 2011. In obvious contrast, the marine economy in Ningbo and Dalian grew slowly. A similar trend can be identified in the GOP per capita[1].



[1] The growth speed of GOP per capita in Shenzhen was lower than its GOP is mainly because of the large size of immigration into this city. Its rapid development attracted lots of people to this city, which would not be extended here.

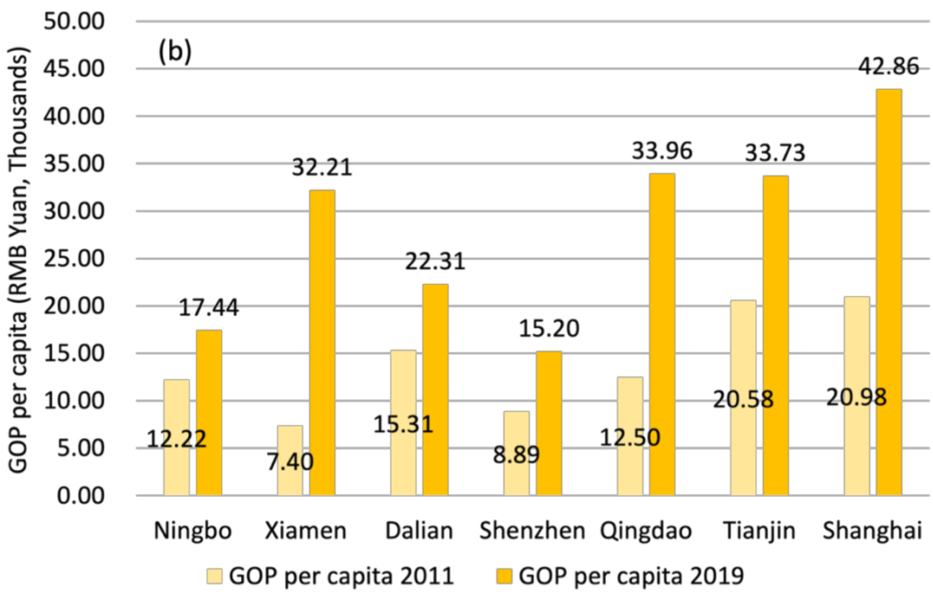


Figure 2.16. Marine GOP and GOP per capita of major China's marine cities (including provincial cities) in 2011 and 2019

Sources: calculated based on data from CEIdata (2022).

The provincial-level analysis in the last sub-section concludes that the generally positive relationships between the marine economic development in GOP per capita and marine innovation. Marine economy and innovation in China have usually been coupling developed. Therefore, based on the regional data of GOP per capita, it can assume that entering the 2010s, these first-tire marine cities diverging in the marine economy would also be increasingly divergent in marine innovation. Cities like Dalian and Ningbo, with the marine economy in small size and weak growth momentum, are expected to be decoupling from the group of marine cities strong in marine innovation. However, this prediction requires more rigorous tests or evidence support, especially in qualitative forms.

2.4 Summary

This chapter reviews the definitions, rationales, characteristics, and situations of marine economic and innovative development in China. By displaying evidence from policy shifts and industrial data, the contents of this chapter illustrate the state-led marine development in China even in the post-reform era and the wide range of regional disparities in marine economy and innovation. However, when firms have become increasingly important in China and marketisation is more developed, the understanding of how China's regions have been different and how firms have structured the regional marine development is still insufficient.

Besides, looking into the Chinese definitions, the term "marine economy" in the Chinese context is used as the new source of economic growth, which covers almost all economic fields. This perspective stresses the integrated development of coastal and marine resources by treating "oceans as natural capital" (Silver et al., 2015) and views the marine economy as a complex governmental project opening new governable spaces and rationalising particular ways of governance (Conathan and Moore, 2015; Choi, 2017). Nevertheless, beyond the Chinese conception, there exist diverse practical and academic conceptualisations of the marine industry and marine economy, which will be illustrated in Section 3.4.1.

Compared with the major marine economies, China's all-round definition of the marine economy makes this sector extremely important to the national economy as indicated by the proportion to GDP. Nearly the 2010s, when China's marine economy accounted for around 10% of the national GDP, while in the same period, the value added by the ocean-based activities in major Western marine countries was no more than 5% of the GDP. In Canada, the US, and France, it was less than 2% (Zhao et al., 2014). Further, the labour productivity in China is obviously lower than other leading countries in North America and Europe. When a large number of individuals in China are employed in the labour-intensive primary sub-sectors like the fishery industry, employment in the Western marine countries is concentrated more on the higher value-added marine sub-sectors.

Apparently, despite the large contribution of China's marine industry to either the national GDP or employment, industrial transformation and technological upgrading are urgent issues in this country. Besides formulating marine S&T strategies, implementing marine policies, and directing attention to marine innovation from offshore areas to deep sea that have been done in China's practice by relying more on the state power, the experience of Western countries such as establishing Ocean Trust Fund in the US and encouraging the integration and collaboration between the research, the industry, and the policymaker in the European Union provides valuable insights for China.

Furthermore, the marine discovery and development of China started later than Western countries. For example, when the UK began its marine exploration as early as the colonial period, China was performing the sea ban (*haijin* in Chinese) strategy by implementing a series of policies restricting the marine trade. Though China realised the importance of marine development, especially in the 21st century, and has achieved large progress, there exists a large distance from the leading marine economies. In the new era, the world's marine governance system built upon the Western countries' experiences and narratives demands more say and participation from China and developing marine countries.

Moreover, entering the 2000s, the environmental protection has become increasingly important. China can draw lessons from the large marine economies like US and Australia which have formulated the ocean governance system with protecting the marine ecosystem and biological diversity as the primary aims, or Japan that commits to ocean protection by improving public awareness through activities like science popularisation education (Yu, 2013). Nevertheless, the balance between the marine economic development and the control of marine environmental damage poses more challenges to the late development of China.

Chapter 3. Literature Review

This research reviews four main streams of literature. These strands of theories are selected because these are dominant, popular, and well-developed theories that have been widely applied in the research to explore regional innovation and marine industry, explain the different innovation patterns or industrial specialisations in various contexts, and conceptualise firm-level differences. As the often-used frameworks for analytical and normative aims, the chosen theories have been highly influencing academics and policymakers. The different streams of theories lay theoretical foundations for analysing and comparing regional innovation patterns from different perspectives. The aim of this chapter is to review the central arguments, ongoing debates, and criticisms and problems associated with the mainstream theories, which pave the way for constructing the conceptual framework of this study in Chapter 4.

As will be shown in this chapter, theories to explain regional differences in innovation, represented by the regional innovation system (Section 3.1) and the varieties of capitalism (Section 3.2), focus on the regional factors like institutions in structuring the innovation patterns in different regional economies. Inferring the interactive importance from regional innovation studies, the relational networking perspective provides an analytical lens to explain and conceptualise the inter-firm differences (Section 3.3). However, these theories with distinctive focuses and logics of causality are independent from each other. When the regional-based marine activities become increasingly important to regional and national economies (Section 3.4), there is a lack of exploration and explanation of the causes of different regional patterns of marine innovation reconciling the conflicts between the institutional impacts and the diverse firms within a region. The context of transitional China further complicates the case.

Therefore, drawing upon the theoretical works, the research question is cast on the causes of regional disparities in marine innovation in China, and more fundamentally, how comparative patterns of China's regional marine innovation are conceptualised in a framework which is shaped by the regional institutions and the relational networks of firms in innovation.

3.1 Regional Innovation System

Over the past three decades, regional innovation system (hereafter RIS) has been widely used as an analytical framework for understanding innovation on the sub-national levels. The RIS approach attracts the attention from economic geographers and innovation scholars who are interested in the debate about the uneven geographical development of innovation - being the main driver of regional economic development, and the factors influencing the different regional innovation capacities of regions, which generates important empirical implications for policymakers (Asheim et al., 2016). This section elaborates this framework.

3.1.1 Theoretical foundations of the RIS

Emerging the 1990s, the RIS concept has been built upon two main bodies of research - the system of innovation and regional science dominated by various kinds of territorial models of innovation (hereafter TIMs).

Innovation System

Early interests on the effects of "innovation" can be traced back to Joseph Schumpeter, who views innovation as a "*combination of existing resources, materials, or means of production*" that is reproducible, can be carried out in practice, brings profits to entrepreneurs and developers and promotes the development of the whole economy (Schumpeter, 1934). Over several decades, the conceptualisations of the innovation process have evolved from the early technology-push or market-pull *linear* model of innovation dominated in the 1950s and 1960s towards the *chain-linked* model since the 1980s and the recent *cyclic* innovation model (Kline and Rosenberg, 1986; Berkhout et al., 2007). The innovation system concept emerged in the 1980s and has become a prevailing framework in innovation research to understand the innovation patterns and different innovation performances in different economies. Transcending the linear view of technical change, this approach perceives innovation as being interactive, evolutionary, and institutional.

(a) Interactive approach

The innovation system adopts a firm-centric view that firms are the fundamental units of innovation (Lundvall, 2007; Nelson and Rosenberg, 1993; Metcalfe and Ramlogan, 2008). Nevertheless, by highlighting interactive learning, proponents of the innovation system argue that the differences in innovation efficiency and performance across national or regional systems cannot be explained by the firms' innovation strategy and performance alone. All kinds of innovation system place "interactive learning" at the centre. As Lundvall (1992) argues, knowledge is the most fundamental resource in the modern economy and learning[1] is the most important process. Through interactive learning, actors combine different pieces of knowledge in new ways or generate new knowledge, and lead to new products or processes (Edquist and Johnson, 1997). The central argument is that the innovation performance of a system depends not only on the innovation capacities of firms but also on their interaction with each other and various organisations such as government, universities, public and private research organisations (Freeman, 1995; Etzkowitz and Leydesdorff, 2000).

Interactive learning compensates for the knowledge that the firm itself may lack, lowers the fixed cost in procurement and distribution with increasing speed of technological change, and reduces the uncertainties of technological innovation (Doloreux, 2002). Therefore, interactive learning influences the innovative performance of a system by affects the process of knowledge creation, development, and diffusion. The technological capacity of an innovation system originates from the interactive learning, and the interactivity underlies the "systemic" approach (Cooke et al., 1997; Edquist, 1997).

(b) Evolutionary approach

Inspired by the Schumpeterian view of capitalism that economic change can never be stationary, one of the key features of the innovation system is the acknowledged influence of evolutionary approaches. Following the evolutionary view, a focus on the dynamics of innovation is present in which technological change is regarded as an open-ended and path-dependent process, where the innovators only seek "relative" technical advances, not in an absolute or optimal sense (Nelson, 1987; Edquist, 1997). Learning, as the important mechanisms through which diversity is generated, is the key mechanism in the evolutionary process (Edquist 1997). In the evolutionary terms,

[1] Learning occurs in the mode of formal science and technology or by doing, using and interacting.

the system never reaches a state of equilibrium, which contrasts with the assumptions advocated by neoclassical economists[1] (Cooke et al., 1997).

(c) Contextual and institutional approach

In contrast to the neoclassical models in which institutions play no role or in a loose and implicit way, one of the key assumptions of the innovation system is that the differences in innovation performances across systems depend on the varying institutional specificities (Freeman, 1995, OECD, 1999; Edquist, 2005). There are different ways of conceptualising institutions that involve some levels of ambiguity. One of the most widely adopted definitions is by North that institutions are

> *"… the humanly devised constraints that structure political, economic and social interaction. They consist of both informal constraints[2] (sanctions, taboos, customs, traditions, and codes of conduct), and formal rules (constitutions, laws, property rights) (North, 1991, p.97)."*

In innovation, institutions play basic functions in reducing uncertainty and generating stability, managing conflicts and cooperation, providing incentives, and channelling resources to innovation activities (Edquist and Johnson, 1997). Therefore, institutions and their competencies influence the mechanisms of innovation, the amount of resource allocated to innovation, and thereby the rate and direction of learning and

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[1] In neoclassical economics, the economy is seen as an equilibrium system, in which (i) the disequilibrium tendency caused by deviant firm behaviours is regarded as "noise" rather than as the driving force underlying the economic development in the evolutionary models, and (ii) the erosion of profits with price competition is the primary dynamic leading to the convergence towards equilibrium rather than moving away from equilibrium in the evolutionary approach that adopts Schumpeterian competition pursuing supra-normal profits through innovation (Boschma and Frenken, 2006). Furthermore, the neoclassical view sees technological change as an exogenous factor, which contrasts with the interactive and evolutionary innovation system approach where technological change is endogenous to the economic growth (Equist, 1997; Carlsson, 1995). The key assumption of neoclassical framework lies in the utility-maximising individual and a given market structure. However, in real world, on cannot assume "God-like actors" that behave in the uniform rationality (Dosi, 1984, p. 107), but have to rely on the "bounded rationality" built upon the micro-level routines and macro-level institutions.

[2] Formal institutions are not always in place or effective, especially in developing countries. Informal institutions can play complementary, competing, and accommodating roles when formal ones are absent (Helmke and Levitsky, 2004).

the innovation performance of a system (Patel and Pavitt, 1994). When the institutional change lags behind the technological change, innovation can be hindered. Recognising the institutional differences as the key explanatory factors of varying innovation performance[1], the innovation system is widely applied to the comparative analysis in order to identify institutions that can lead to more successful outcomes than the others and realise absolute advantages[2] (Edquist, 1997; Benner, 2020).

Initially, the innovation system framework was applied to the national-level analysis. However, there have been increasing concerns on the appropriateness of the national level as the starting point for innovation analysis, especially with the sub-national success in Italian agglomerated clusters, the European political initiatives towards regions, and the failure to generate successful technopoles in larger countries like the UK and France, which refutes the unimportance of regional level of governance (Asheim and Isaksen, 1997; Cooke et el., 1997) [3]. Almost simultaneously to the emergence of the innovation system approach, territorial models of innovation emerged (or re-emerged) to explain the successful transition to the post-Fordist model in some regions than the others (Asheim et al., 2016). This relates to the second body of literature that significantly influences the RIS concept.

Territorial models of innovation

The TIMs was firstly introduced by Moulaert and Sekia (2003) to describe the various models that see the "region" as the locus of innovation[4]. These TIMs highlight the socio-institutional factors specific to the regions where the innovation emerges, and

[1] The innovation system theory is often criticised for involving too many institutions and institutional combinations in analysis, which causes a lack of "parsimony" (Taylor, 2016; Radosevic, 1998).

[2] This means to identify institutions, more of which will improve the innovation performance of the economy (Benner, 2020). Rejecting the notion of absolute advantages, the Varieties of Capitalism perspective deal with the comparative institutional advantages (see Section 3.2).

[3] Another stream of the innovation system highlights the sectoral characteristics (i.e., the sectoral innovation system). It conceptualises the industrial patterns of innovation from the underlying technological regimes (Breschi and Marlerba, 1997). It suggests that technological regimes vary in innovation opportunities, appropriability conditions, cumulativeness and knowledge base, thereby affecting the innovation patterns (Malerba and Orsenigo, 1996; Winter, 1987). This approach recognises the influence of national or regional institutions that often favour some sectors over the others by fitting better in with the sectoral specificities (Malerba, 2002).

[4] The RIS is regarded as a kind of the TIMs.

characterise the localised, not placeless, learning process (Uyarra, 2010; Doloreux and Parto, 2005).

(a) Industrial district

Most of the research on TIMs has been inspired by the pioneering work of Alfred Marshall's account of the "industrial district" that explain regions' innovation capacity and competitiveness from the spatial perspectives (Doloreux et al., 2019; Isaksen et al., 2018). The rationale of Marshallian industrial districts lies in the "external economies of scale" as the competitive advantages over the "internal economies of scale" of large firms (Asheim, 1996). Therefore, the growth of industrial districts stems from the "economies of localisation" achieved by the extensive labour division and the strong specialisation of firms in the same industry in the territorial agglomerations. More significantly, the Marshallian approach deviates from the pure economic mechanisms of agglomeration by integrating the socio-cultural factors that highlight the "mutual knowledge and trust" and "industrial atmosphere" (ibid.).

In the 1970s, this approach is re-boosted by the Italian responding to the decline of the Fordist production model (Ortega-Colomer et al., 2016). Drawing on the empirical work on the spatially concentrated small and medium enterprises (SMEs) in Italy, the (new) "industrial district" stresses the natural environments, the socio-institutional factors, in particular the local community structured by trust, mutual dependence and shared local rules, as well as the historical evolution as being critical to the success of a district (see Becattini 2017 and Brusco 1982).

(b) Milieux Innovateur

Similar to the industrial districts, the "milieux innovateur" developed by French scholars (Aydalot, 1986; Camagni, 1991) underlines that firms as the key regional players, their relationships with other agents in the same milieu facilitated by the geographical proximity can reduce the uncertainty intrinsic in innovation, thereby is central to the innovation development. One of the most important lessons from this model is that it emphasises that the "support space" constituted by the relationships beyond the production- or market-based ones determines the corporate innovation and spatial development (Moulaert and Sekia, 2003). This model is increasingly converging towards the model of "learning region" which stresses the networking and the "institutional thickness" (Amin and Thrift, 1994) that contribute to innovation by facilitating the sharing of tacit knowledge and the emergence of collective learning (Asheim, 1996; Moulaert and Sekia, 2003).

(c) Cluster

The North American school mainly centres on the "cluster" concept, which is defined as "*a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities*" (Porter 2000, p.16). Firms gain competitive advantages from the concentration of industrial activity in a region because of the easier access to employees, suppliers and the specialised information accumulated within a cluster, and the local rivalry in the forms of competitive pressure, peer pressure and constant comparison that motivates them to innovation to maintain competitive globally (Porter, 1998). Therefore, different from those approaches stressing networking and cooperation, this approach emphasises more on market and competition as the sources of success, though the willingness to cooperate is an important source of competitive advantages (ibid.) However, Porter's methodology underlines globally excellent clusters and his emphasis is upon national competitiveness rather than regional economies (Cooke et al., 1997).

(d) Technopole

Attracted by the success of Silicon Valley since the 1970s, many national and regional governments aimed to imitate the model of high-tech innovation development in Silicon Valley by co-locating the research institutes and innovative firms in selected geographical spaces. The concept of "technopole" was introduced by the Technopolis programmes in France and Japan, which is a kind of growth pole driven by the planned development of high-tech industries, aiming to encourage the technology transfer by reducing transaction costs through close proximity, and thereby the development of profitable innovation (Wang et al., 1998; Doloreux, 2002). However, not many of the attempts of the planned technopoles have been successful in generating synergetic surplus for innovation (Malecki, 1991; Cooke, 2001). Distinct from the cluster that is organically evolved and network stimulated, the technopole is hierarchically planned based on the linear model of innovation, from which the agglomeration is induced.

Cooke (2001) argued that technopoles can only be saved by absorbing the interactive process of innovation facilitated by networking and social capital.

There are several studies comparing the similarities and differences of TIMs (e.g., Moulaert and Sekia, 2003; Olsen, 2012; Dotti, 2014). Although we accept these models are different, the way to theorise them and differentiate one from another is "vague" and "fuzzy" (Doloreux et al., 2019). Furthermore, these concepts are largely built upon a few successful regions, which derives a series of ideal conditions to promote the regional development. However, as exemplified by the difficulty to promote technopoles in less favoured regions in Europe, these ingredients are not always transferable to other places. The TIMs can hardly be used as generic frameworks for prescribing policy intervention than to understand the policies and the social contexts in the specific cases (Laranja et al., 2008). Despite that many questions remain unanswered, these TIMs suggests that the regional competitiveness originates from the localised learning and knowledge accumulation and the economic externalities driven by co-location, which sheds light on the conceptualisation of the RIS (Doloreux and Parto, 2005).

3.1.2 The RIS: components, mechanisms, and typologies

Built upon the innovation system research and regional studies, the RIS approach conceptualises "regions" as meaningful spaces. This term "region" can be applied to a diversity of territories and jurisdictions, including countries, provinces, cities, and industrial districts (Doloreux and Parto, 2005). Concerning the regional evolution, Cooke et al. (1997) distinguish two kinds of regions - (i) the administrative regions such as states in the US and provinces in Canada, and (ii) the cultural regions where people share a common culture but have not developed into or states (e.g., the Basque area) or forfeited that status (e.g., Scotland). The latter usually has no determinate sizes but a degree of internal cohesion and homogenous criteria (Cooke and Schienstock, 2000). Therefore, regions, are defined as the territories that are smaller than their state and possess supra-local governance capacity (e.g., to develop innovation supporting policies and organisations) and cohesiveness, which differentiates them from their state and other regions (Cooke et al., 1997). A RIS refers to,

> *"… a geographically defined, administratively supported arrangement of*

innovative networks and institutions that interact regularly and strongly to enhance the innovative outputs of firms in the region" (Cooke and Schienstock 2000, p.273).

Components

The RIS consists of four basic elements, including firms, institutions, knowledge infrastructures, and innovative policy addressing the regional development (Doloreux, 2002). They are structured into the production structure (i.e., the techno-economic structures) and the institutional infrastructure (i.e., the political-institutional structures) (Asheim and Isaksen, 1997). Capturing the main components and structural configurations, Figure 3.1 provides an illustration of the RIS, which incorporates two major sub-systems - (i) the knowledge application and exploitation sub-system and (ii) the knowledge generation and diffusion sub-system.

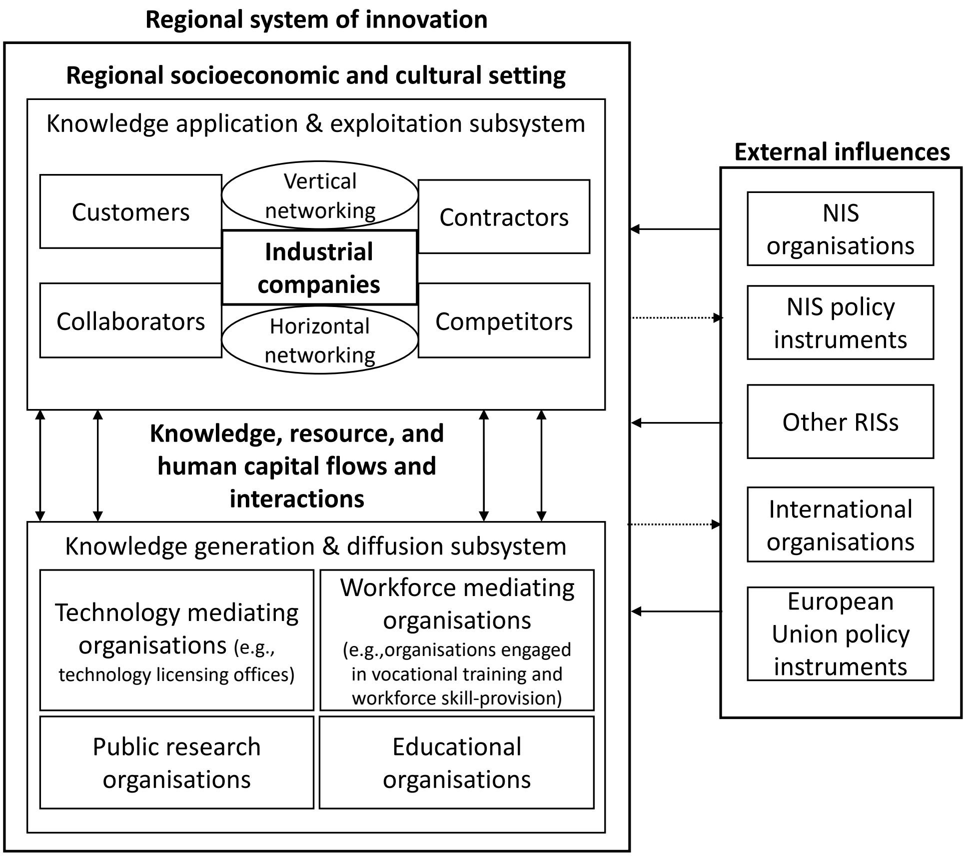

Figure 3.1. The RIS framework

Sources: adapted from Tödtling and Trippl (2005), p.1206, and Cooke (2002).

Specifically, the first building block is constructed around industrial firms that have built vertical and horizontal network linkages with other firms or organisations. The second sub-system represents the supportive regional organisations engaged in the generation and diffusion of knowledge. These two sub-subsystems are embedded in a common regional socioeconomic and cultural environment (Tödtling and Trippl, 2005). The interactive relationships across organisations within and between the two subsystems facilitate the exchange of the flow of knowledge and resources. And the innovative performance of a region is expected to be improved when firms are motivated to become better innovators through interacting with organisations and firms in their region (Dolorexu, 2002).

Internal mechanisms

Several internal mechanisms are critical to the efficiency and success of the RIS. Besides interactive learning (discussed in Section 3.1.1) as the centre of the RIS framework, shared knowledge is an important perspective of the RIS, which increases the interactive learning capabilities (Doloreux, 2002). Especially, unlike codified knowledge that can easily be exchanged, RIS highlights tacit knowledge that is socially embedded and context-dependent, which makes it much "stickier" and geographically immobile (Uyarra, 2010). Drawing upon the importance of interactive learning and knowledge production, *proximity*[1] matters to the RIS (Boschma, 2005). The spatial agglomeration associated with the geographical proximity provides firms a critical mass of inputs and outputs to use and interact with and the geographical proximity reduces the transaction costs (Doloreux, 2002). Face-to-face and interpersonal contacts based on trust and common cultural and social understanding facilitate the relationships between regional actors, and thus support the sharing of tacit knowledge (Morgan 1997; Maskell and Malmberg, 1999).

In addition to the proximity, "institutional thickness" developed by Amin and Thrift in 1995 refers to a large number of organisations in a region with a high level of mutual connectedness and low degree of conflict is the prerequisite for nurturing the mutual consciousness and cooperation, and therefore the collective learning and the regional economic growth and development (Barnes, 1999; Martin, 2005). Moreover, many scholars argue to develop the regional-specific assets or regional core competence and capabilities, which stimulates the knowledge transfer and determines the ability of

[1] More discussion on proximity will be shown in Section 3.3.1.

regions to compete (Storper, 1997; Lawson, 1999; Cooke, 2005). Storper (1997) refers to the concept of "untraded interdependencies", in the form of conventions, informal rules, cultural values, and various kinds of resources for knowledge exchange and production, coordinate economic actors and "tie" firms and other organisations to specific areas.

Typology

In the RIS literature, there is a longstanding debate on whether the RIS is scarce or ubiquitous. There is a lack of clarity about how a specific region can be seen as a RIS - how we know a RIS when we see one, which makes the operationalisation of the RIS concept difficult (Doloreux and Parto, 2005). According to Cooke (2001), the existence of a RIS is a rare event. A strict reading of the early RIS literature suggests that only three regions can be labelled as true RISs, including Silicon Valley, Emilia-Romagna, and Baden-Württemberg (Doloreux and Parto, 2005). This implies that not all regions can work effectively as an ideal RIS and it would be risky to replicate an ideal RIS (Cooke, 2001; Iammarino, 2005). In other views, the RIS is present in all regions that are different from each other in numerous aspects such as size, firm density, industrial specialised patters, governance structures and so force (Zukauskaite, 2018). The empiricity involve great varieties and complexities, from which many studies have attempted to draw on the empirical evidence to construct the RIS typologies[1].

Following different approaches, the typologies highlight distinct institutional features in various kinds of RISs that shape the regional innovation[2]. According to Zukauskaite

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[1] There are several popular typologies made by regional scientists. Asheim and Isaksen (2002) distinguish three types of RISs characterised by the nature of the relationships between the production structure and the institutional set-ups in a region, which matches Cooke's (2004) classification. This typology highlights three distinguishing features, including actor constellations (small or large firms), innovation processes (experience-based or scienced-based) and collaboration patterns (within or outside the region). Cooke (2004) further identifies two types of RISs - institutional RISs (IRISs) and entrepreneurial RISs (ERISs) defined by their capability to support different kinds of industries, which to some extent reflects the VoC's dichotomy (elaborated in Section 3.2). Different from these approaches, Tödtling and Trippl (2005) differentiate three RIS by identifying the main deficiencies in the RIS.

[2] Asheim and Coenen's (2005) typology highlights the relative importance of institutions on different geographical levels. The typology of IRISs and ERISs defined by Cooke (2004) pays more attention to the institutions that influence the industrial development. Tödtling and Trippl (2005) focus on institutions that lead to or help solve the deficiency.

(2018), the presence of different kinds of institutions and their characteristics and interrelationships in the form of reinforcing, complementary, or contradictory are explanatory to the differentiated innovation capabilities of different regions, and thus explain the regional innovation performances. Institutional constraints such as the poorly developed institutions, inappropriate institutions, or contradictory institutional arrangements are the key bottlenecks to regional innovation.

3.1.3 Debates in the RIS literature

Based on the conceptualisation of the RIS framework, there are several ongoing debates in the RIS literature, which generates important insights to this thesis.

Closed system versus open system

The RIS approach sees that innovation is spatially constructed emerging from the regionally embedded, institutionally supported, networks of actors, whereby knowledge is transferred through intra-regional connections (Uyarra, 2010). It assumes that the necessary resources, capacity, and levers are available at the regional level in practice (Uyarra and Flanagan, 2016). This view is criticised for implying that regions are considered as complete and closed systems. Instead, regions are not "isolated islands" but closely linked to the networks at other spatial levels (Staber, 1996). Scholars advocate to place the analytic attention on the structure and composition of these network and adopts a "relational" rather than a "containerised" use of the term region (Frenken et al. 2007; Cooke and Morgan 1998).

RISs are not sufficient on their own to remain competitiveness in the globalised economy (Asheim and Gertler, 2005). Many scholars have argued that the extra-regional linkages are critical sources of novelty and diversity or the solutions for system dysfunctions and lock-in problems (Laranja et al., 2008; Coenen et al. 2017). For example, Bathelt et al. (2004) find that the co-existence of high levels of "dubbed buzz" - the learning processes among actors embedded in the local community and "pipelines" - the extra-regional channels of communication can provide advantages to firms located in outward-looking and lively clusters. Acknowledged the importance of extra-regional knowledge, Martin et al. (2018) have explored the different ways in which firms in RISs can access to global knowledge through various channels, including international R&D collaborations, FDI, personal relationships, international mobility of skilled labour, virtual communities and online platforms, and temporary clusters such as fairs, exhibitions, and conferences. The global knowledge can be accessed by firms in both thick and diversified RISs and peripheral regions, and by both multinational companies and SMEs in symbolic industries that are deeply involved in global knowledge sourcing activities.

This open view of RIS challenges the policy emphasising on internal connectivity within an RIS and calls on the regional policies to promote and support external linkages to innovation systems on national, supra-national, and corporate levels to access complementary knowledge and combine with the regionally available assets (Laranja et al., 2008; Boschma and Iammarino, 2008; Uyarra, 2010). As related variety are rarely present at the regional level, policy injecting impulses to exogenous development are particularly important for regional transformation (Isaksen et al., 2018). In this respect, the interplay of institutions and organisations between different scales and the multi-scalar coordination in policymaking raise new research questions to be addressed (Marques and Morgan, 2018).

Top-down versus bottom-up approach

The RIS research is dominated by the top-down, macro-to-micro and "Listian" approaches to analysis (Iammarino, 2005). A list of the top-down characteristics of the RISs were identified, such as the role of the public sector and innovation policy, institutional framework, industrial structure or the intensity and organisation of R&D activities, spatial structure and the degree of openness (Howells, 1999). The top-down approach is useful for the comparative analysis of RISs, while the top-down dominance renders that the explanatory power of the RIS framework mainly rests on the structural elements manifested in the macro institutional configurations, but less on micro firms (Hekkert et al., 2007). Following this approach, all kinds of firms are seen as abstract and homogenous entities as the recipients of institutional influences (Werker and Athreye, 2004). Therefore, there is a longstanding criticism on the RIS analysis for holding an institutional determinism view.

As the fundamental actors of innovation, firms are in diversity and are likely to alter or overthrow the environments around them, which further changes the process of technical change (Hekkert et al., 2007). Therefore, the top-down view of RIS is required to incorporate the bottom-up dimensions of regional innovation such as the localised communication patterns, invention and learning, knowledge sharing, search and scanning, and the network integration (Howells, 1999). Many scholars have argued for adopting the evolutionary approach [1] to integrate the top-down and bottom-up analysis of RIS by adopting networks or sectors as the key units of analysis to explore their characteristics and evolution (e.g., Iammarino, 2005; Laranja et al., 2008; Uyarra, 2010). The evolutionary view highlights the co-evolution of institutional and structural elements, characterises the intra-region diversity, and focuses on the ability to select "good" trajectories and avoids lock-in problems (Laranja et al., 2008).

To some extent, the increasingly trendy "ecosystem" concept tries to tackle the lack of a bottom-up approach by incorporating the social network theory into innovation analysis. Following this approach, an ecosystem is viewed as a complex network within which each actor has specific attributes, decision-making principles and different purposes (Tsujimoto et al., 2018). Analysing the behavioural chain in a longitudinal observation enables us to find the behavioural patterns affecting the whole ecosystem (ibid.). By linking the ecosystem approach and the territorial approaches, Scaringella and Radziwon (2018) argue that the two approaches are in fact two sides of the coin, which share a number of common elements that are unchanged.

3.1.4 RIS and its application to China

Most of the empirical RIS studies tend to focus on the European regions (Doloreux and Gomez, 2017). However, the context in transitional China differs from the Western countries. As one of the key strengths of the RIS framework lies in its comprehensiveness and attention to the regional institutional factors, the concrete explanations of China's RISs have to be dependent upon the specific regional contexts. As Tylecote (2006) argues, transitional countries usually have a dual technology system. One is the innovation system which mimics the developed counterparts focusing on

[1] This is relevant a critique on the innovation system framework to understand technological change. Though this framework is based on evolutionary economics and interactive learning (as demonstrated in Section 3.1.1), the innovation system studies are dominated by quasi-static analyses that focus on the comparison of the social structure of different innovation systems and thereby the different innovation performances rather than on the systemic dynamics (Hekkert et al., 2007).

the development of advanced technology, while the other is rooted in the locally embedded industries, especially in traditional technology fields (Li, 2009). In a country like China with its extraordinary size and diversity, innovation takes place in a number of regions that constitute the RISs, which then contributes towards China becoming a technological superpower (Sigurdson, 2005).

Empirical studies on China's RISs

In recent years, regions in China have increasingly captured the research attention. Appendix C summarises the key studies of Chinese RISs. According to Doloreux and Parto (2005), two sets of studies dominate the RIS empirical research, which can also be illustrated by the studies on the regions in China despite their preference of the quantitative methods.

Specifically, the first set of studies investigate the unique characterises of individual RISs. These RIS works are mainly qualitative studies of single regional case, which investigates the inter-relationships within the RIS, examines the role of specific actors played in the RIS, or focuses on specific sectors (e.g., Chen, 2006; Yang, 2015; Zhang, 2015). These studies tend to focus on well-developed regions such as Beijing by focusing on Zhongguancun Science Park, Shanghai with Zhangjiang High-tech Zone and Shenzhen, but there have been increasingly more studies exploring regions that are not recognised as typical innovative regions (e.g., Heindl, 2020). By highlighting the specificity, the RIS research implies that there is no single model that can generalise the dynamics of successful RISs (Doloreux and Parto, 2005). Factors that have been highlighted by these regional cases include the local state (Zhang, 2015), the systematic functions of universities (Su and Shon, 2012), the MNCs (Chen, 2006), the return migration (Sternberg and Müller, 2005) and so on.

The second stream of studies is mainly comparative analysis of innovation systems in various regions aiming to capture the generalities and particularities of regions, which captures the degree to which a RIS approach is applied and its impact on the industrial development in different regions (ibid.). Some scholars conduct comparative case studies (e.g., Chen and Kenney, 2007; Breznitz and Murphree, 2011), which enables a more thorough investigation into the hidden variables and a deeper contemplation on why the phenomenon in one case might be missing in another (Doloreux and Parto, 2005). However, in China, most of the comparative studies are quantitative, which draws on the pre-defined frameworks and indicators to evaluate the performance of RIS, specifies the effects of different factors in influencing the RIS, and hence explains the regional disparities (e.g., Chen and Guan, 2011; Bai, 2013; Li et al., 2022). The usefulness of these indicators has been derived from the "best practice" of RIS or according to their importance in China from the national perspective. Thus, the analysis tends to ignore the specificities in regional institutional and economic settings and nuances of the ways in which different regions innovate, which simplifies the explanation of regional disparities (Heindl, 2020).

Various regional models conditioning China's RIS development

Empirical studies on the development paths of China's RIS have geographical focus on different spatial levels. It is usually acknowledged that China's transition from the homogenisation during the Maoist period towards regionalism started from the onset of the reform in the late 1970s. Combined with the different resource endowments and constraints inherited from the Maoist period, different post-reform models of regional development have emerged. The most direct associations of China's RIS studies include the SEZs, high-tech zones, industrial clusters, and superclusters (e.g., the traditionally well-known ones include PRD, Yangtze River Delta, Beijing-Tianjin-Hebei (i.e., Jing-Jin-Ji). Different from the Western RISs that are usually characterised by the bottom-up and spontaneous development with restrictive state intervention, RISs in transitional China combine the top-down and bottom-up approach of development and the co-evolution of the high-tech and traditional industries.

(a) SEZs and ETDZs

The creation of SEZs[1] since 1979 is seen as the origin of regional concentration and industrial clustering in China (Jankowiak, 2017). The first bunch of four SEZs were

[1] The five officially recognised SEZs in China are Shenzhen, Zhuhai, Shantou, Xiamen, and Hainan. Chinese definition of SEZ is in more hybrid and integrated terms rather than as areas with the single function such as the Free-Trade Zone, Export Processing Zones, and Bonded Logistics Parks. Therefore, many scholars include the national-level new areas to support the integrated development such as Shanghai Pudong New Area and Tianjin Binhai New Area as SEZs (e.g., Zeng, 2011; Frattini and Prodi, 2012; Sigurdson et al., 2005). There are 19 New Areas in total until mid-2021.

established in Guangdong and Fujian Provinces which are geographically far from Beijing but close to Hong Kong, Macao and Taiwan. They were later joined by Hainan. As the bridgeheads of the opening-up experimentation, these SEZs were established mainly to attract foreign investors and technologies, develop foreign trade, and generate spillovers to the local economy. The first group of SEZs played important roles as the “testing labs” for the market-oriented economy (Zeng, 2012). They have enjoyed benefits in infrastructure and policy. Over the next nearly one decade, China deepened the opening of its economy. Since 1984, another 14 coastal cities were opened up. Meanwhile, Chinese authorities decided to establish national-level economic and technology development zones (ETDZs) - seen as another form of SEZs but on the smaller scale. The first group of 14 ETDZs were built in 12 coastal open cities. Based on these experimentations, an increasing number of ETDZs were approved by the State Council in the 1990s, and the geographical distribution has gradually been expanded.

SEZs and ETDZs in various forms have made great contributions in attracting FDI. And the spatially concentrated foreign investments inflow act as the important channels of international technology transfer, which has further resulted in technological spillovers into the local regions (Kowalski, 2020). Evidence has also shown the SEZs’ contributions to China’s economic and innovation development by creating employment opportunities, upgrading technology, contributing to the national and regional GDP, enhancing the trade efficiency and so on (Zeng, 2011). However, the FDI-dependent strategy has induced limited improvements in the innovation capabilities of domestic companies. The “selective openness” in the early years by concentrating the SEZs and ETDZs mainly in the eastern coastal China has intensified the localisation and local embeddedness of foreign investment in China (Wang and Olivier, 2006; Wei, 2007). Despite the expansion of ETDZs to central and western areas, these regions are less attractive to the FDI. With the shift of the innovation paradigm in the mide-2000s, the policy focus of SEZs has also been adjusted towards encouraging domestic firms and creating spaces for the fair competition between transnational and domestic companies (Zeng, 2011).

(b) High-tech zones

In the 1980s, China started to build science parks and high-tech zones alongside the implementation of the Torch Programme aiming to facilitate high- and new-tech industrial development in selected cities. In May 1988, the first high-tech zone - Zhongguancun Science Park was established in Beijing for experiments. In the early 1990s, the state council approved 51 national-level high-tech zones in other cities (26 in 1991 and 25 in 1992) and issued preferential policies and criteria to delimit high-tech enterprises (State Council, 1991, 1992). Names of the high-tech zones in China include science parks (e.g., Zhongguancun in Beijing), High- and New Technological Industrial Development Zones (HNTIDZs) (e.g., Shanghai Zhangjiang), Torch High-tech Industrial Development Zone (e.g., Xiamen), New-tech Development Zone (e.g., Wuhan Donghu), High-tech Industrial Park (e.g., Dalian) and so on (MOST, 2021). Until mid-2021, the number of high-tech zones in China reached 169.

The Torch Programme follows a very similar rationale to the Technopolis Concept and the establishment of the high-tech zones in China was meant to build Chinese technopoles (Wang et al., 1998; Zhu and Tann, 2005). Similar to the technopoles built upon hierarchical planning, the high-tech clustering initiatives in China were driven by the central government in order to create conditions and incentives FOR the high-tech industrial development (Frattini and Prodi, 2012). It is an important sub-national instrument to implement the state-sponsored innovation model. Also, an important objective of high-tech zones was to reduce the economic gaps that had been widened after the SEZs and ETDZs were established around the coastal areas in the 1980s (Wang et al., 1998). Thus, the high-tech zones have been more geographically distributed from the beginning.

China's regional economic development and technological upgrading have benefited from the establishment of high-tech zones in terms of developing local innovation capabilities, creating jobs for university graduates, and attracting more domestic and foreign companies to the region (Walcott, 2021; Zeng, 2012). However, with the soar in the quantity of high-tech zones since the 2000s, the weakening preferential policies, and the top-down nature of these clustering, more concerns have emerged questioning the effects of high-tech zones in generating clustering benefits for firms in the zone, integrating with the rest of the local economy, and transmitting the spillovers to firms outside the zone due to a lack of embeddedness in the regional industrial agglomeration. (Frattini and Prodi, 2012; Macdonald and Deng, 2004).

SEZs, ETDZs, and high-tech zones are typical top-down approaches to clustering development practices in China, which have been designed and implemented in order to achieve broad development goals (Frattini and Prodi, 2012). Besides the initiatives by the central government, local governments are critical in creating the basic and technological infrastructure and industrial environments, which requires a large amount of governmental investment. For example, in the case of Shanghai, the local state employs land-development mechanisms to develop infrastructure and attract industrial firms, which constitutes an important institutional advantage. In Suzhou Technology Park, the local government provides various kinds of support such as offering seed money, labs and testing centres, and technological trading services for start-ups (Zeng, 2012). The willingness of local government to input in building infrastructures and environments is embedded in the Chinese regionally decentralised political system, which would be discussed in Section 2.2.4.

(c) Industrial clusters

Over decades of development, the industrial specialisation of regions has become an evident characteristic in China. Unlike the centrally driven initiatives with strong government support, most industrial clusters have emerged spontaneously from the bottom-up approaches resulting from the manufacturing specialisation (Kowalski, 2021). These clusters in China comprising a large number of SMEs centre on the low-tech and labour-intensive sectors and receive limited government support. Most of them have been concentrated in the coastal areas, especially provinces of Guangdong and Zhejiang where the specialisation has been rooted in the local history with accumulated tacit knowledge and skills, or the business opportunities provided by the economic reforms and the opening of markets (Zeng, 2011; Sigurdson, 2005). However, because of the rising costs, land limitations, and requirements on environmental protection, many coastal clusters have moved to inland areas, which derives the cluster formation in western and central China (Zeng, 2012).

Though most of the industrial clusters have emerged following the bottom-up process, the role of central and local government is not negligible. Since the 1980s, China's authorities implemented the strategy of "one village, one product", which seeks to develop the local industrial specialisation in production (Jankowiak, 2017). This is different from the SEZs and high-tech zones aiming to attract FDI and build high-tech industries. The cities recognised as specialised would be granted funds by the central government for the further development. In such background, the local government offers preferential policies to attract companies related to the production of a given good to a specific location. For those clusters that have already emerged, their further prosperity and decline, to a large extent, are contingent upon the local state support or intervention. In the geographical transfer of clusters mainly due to the market pressures, governments have also played facilitating roles. China's clustering policies have increasingly shifted focus to the inner areas.

(d) Superclusters

Besides traditional clusters that focus on the relationships within a certain geographical area, the strategy of superclusters (or super-region clusters) is also prevalent in Chinese regional development. Superclusters are defined differently by scholars or in practice such as the connected innovation clusters in geographically close or dispersed regions (Engal and del-Palacio, 2009), high-performing clusters (Gilding et al. 2020) or industrial partnerships on a large scale supported by other innovation ecosystem players (Beaudry and Solar-Pelletier, 2020). They retain the similar idea that individual clusters are embedded in networks beyond their geographical and industries boundaries (Doloreux and Frigon, 2022). China's authorities refer to the supercluster somewhat differently as a group of contiguous regions, each of which usually encompasses at least one megalopolis or even megacity[1], three key large cities and their surrounding small cities and towns (Gov.cn, 2016). By amalgamating cities in a wider region together and using competition and innovation to drive growth, supercluster is seen as the tool to realise a higher level of urbanisation and productivity (China Briefing, 2018; Mawson, 2022). And thanks to their sizes, Chinese superclusters have achieved the levels of productivity that have never been seen in other countries (The Economist, 2018).

In China, there are 19 superclusters highlighted by national policies like the "13th Five-year Plan" and the "14th Five-year Plan and the Long-Range Objectives Through the Year 2035" as the multiple growth poles in China's development. These superclusters are regions with different economic sizes and structures. Their distribution is uneven with the most developed ones located in the eastern coastal areas. Of the 19

[1] With more than 5 million population.

superclusters, five of them[1] are prioritised in the latest policy, including the Yangtze River Delta, Beijing-Tianjin-Hebei region, the PRD also (known as the Greater Bay Area), the Yangtze Mid-River cluster, and the Chengdu-Chongqing cluster (NDRC, 2021). However, many planned superclusters in peripheral areas like the Harbin-Changchun cluster have not formally taken shape. These regions lack the megacity like Beijing and Shanghai to lead the regional development and precedent conditions for their innovation and development because simply population size cannot be directly transferred into productivity. What's more important is the supply side factor, including the mobility of resources, entrepreneurship, business practices aligning interests, and the global perspective and connections (Mawson, 2022).

The above contents review the regional models that have empirically conditioned the development paths of Chinese RISs. As Sigurdson (2005) summarises, the development of China's RIS rests on three key factors. Firstly, the central government has strongly supported regional development by providing resources for various kinds of zones, science parks, and incubators with national S&T programmes involved, which reflects the top-down approach to regional development. Secondly, FDI and cross-national industrial and technological linkages linked some regions to the global markets, and hence support their regional development. Lastly, the directed but often spontaneous development of industrial clusters has offered the basis for further regional development. All in all, the Chinese model of RIS is a hybrid, combining these different approaches, practices, and efforts in developing national strategies and building the local capacities (Isaksen et al., 2018).

3.1.5 Summary

This section reviews the RIS literature in terms of the theoretical origins, the components and internal mechanisms structuring the RIS, the key debates, and the RIS's studies in China. As a "focusing device" (Edquist, 1997), the RIS framework facilitates the description, understanding, and the comparison of innovation activities on the territorial levels. Following this approach, the divergent patterns of regional innovation and the different innovation performance across regions are influenced by

[1] The first three as the world-leading clusters are not only the focal points of many RIS studies, but also seen as the engines of China's innovation-driven growth. The manufacturing functions will increasingly be shifted westwards.

the institutional characteristics of the regions, the knowledge infrastructure and diffusion system, firms' innovative strategies and performance, and most significantly the interactive links between actors within a region and the effectiveness of the internal mechanisms.

As inferred by the above contents, though the RIS framework is built upon the evolutionary and interactive learning theory, existing RIS studies have been dominated by the institutional approach, while the roles of idiosyncratic firms, organisations and their interactive relations, and the technological dimensions have been put in a secondary place. Furthermore, the RIS studies are often too closed to characterise the increasingly important roles of the extra-regional linkages. Moreover, China's RISs have been built on different regional practices, which offer rich empirical contexts for the RIS research. Nonetheless, besides those often-studied "successful" regions, insufficient attention has been put on the regional specificities and the organisation of innovation activities to compare and explain different RISs. Therefore, while the RIS framework provides an important theoretical departure, many questions on both theoretical and empirical aspects remain to be solved.

3.2 Varieties of Capitalism

Similar to the innovation system studies, the VoC approach seeks to explain the different performance between different economies with institutionalism as the core (Werle, 2012). Compared with the innovation system, the VoC framework is mainly situated in national analysis in a more comparative way and focuses more on the politico-economic institutionalism than socio-economic institutions. More significantly, rejecting the notion of absolute advantages adopted by the innovation system and its exploration of institutions and institutional settings in isolation, the VoC perspective deals with the comparative institutional advantages and the institutional structure - the relations between institutions which are seen as the primary factors that influence the national innovative capacity (Hollingsworth, 2000).

With the promise that institutional systems influence national economic performance, early comparative political studies treat the nation-state as the basic analytical unit over the private sectors [1] (Shonfield, 1965). More recently, treating *strategic interaction* as critical to the behaviour of economic actors, and thereby determining the economic and political outcomes, the VoC theory brings firms back to the analytical centre and compares capitalisms from the perspective of the private sector (Hall and Soskice, 2001). Firms are conceptualised from the relational view facing coordination problems. And a political economy is distinguished from the other by the conditioning of the institutional system to facilitate the coordination (ibid.).

This section reviews the VoC theory that assumes the causation of the disparities from the institutional perspective. Although the VoC theory seeks to classify the national economies and its causation suffers a number of critiques, its focus on the innovation and the ways in which it assigns the causality to the institutional set-ups are highly relevant to this research that seeks to explain the different regional patterns of innovation.

3.2.1 Central argument

The VoC framework follows a dualist approach, which aims to classify the developed capitalist economies corresponding to two ideal types of economic coordination (Hall and Soskice, 2001). *Liberal market economies* (hereafter LMEs) rely on the market mechanisms to coordinate economic activities, whereas *coordinated market economies* (hereafter CMEs) are characterised by the high dependency on non-market coordination with "consociational, coalitional, or quasi-corporatist regimes" at its cores where social and political institutions can influence economic activities (Hall and Soskice, 2001). Typical LMEs are Anglo-Saxon countries such as the US, the UK, Australia, and New Zealand, while Germany represents the prototypical CMEs[2].

Hall and Soskice (2001) ascribe the cross-national patterns of specialisation to the institutional differences or similarities in the VoC approach. In doing so, this approach

[1] To understand the capability of industrial intervention, the concepts like the "strong" and "weak" state structures and the "neo-corporatism" were developed, which underlines the ability of a state in a national political system (Katzenstein, 1978, 1985; Schmitter and Lehmbruch 1979; Berger, 1981).

[2] There is a dispute on whether Germany still fits the CME following the establishment of the Hartz Commission - an independent body not bound by tripartite policy negotiations (see Vitols 2004a, 2004b, and other discussions on Germany in issue 4, volume 8, 2004 of *Competition and Change*).

puts forward the essential concept of *comparative institutional advantage* that the institutional systems of a particular economy provide advantages for engaging in specific types of activities. The primary focus centres on innovation since it is determinant to success over a long time. Specifically, innovation is classified into two broad types:

> *"… **radical innovation**, which entails substantial shifts in product lines, the development of entirely new goods, or major changes to the production process, and **incremental innovation**, marked by continuous but small-scale improvements to existing product lines and production processes" (Hall and Soskice, 2001, p.38).*

Drawing upon the empirical patent data from several OECD countries to measure their innovativeness[1], Hall and Soskice (2001) find that innovation in LMEs centres on industries where radical innovation is essential, such as biotechnology, semiconductors, and telecommunications. Innovative industries in CMEs, such as mechanical engineering, consumer durables and machine tools, are dominated by incremental innovation. The sectoral specialisations are due to the different institutional configurations in LMEs and CMEs that generate comparative advantages for radical and incremental innovation.

In LMEs, labour markets are flexible with few restrictions on employment protection. Employees are discouraged from developing firm-specific or industry-specific skills but have more incentives to build widely applicable capabilities. As a result, firms can easily access suitable personnel and radically adapt to new product lines. The financial systems, with extensive and dispersedly held equity markets and venture capital, offer innovators easy access to capital. Also, with market-based inter-firm relations, firms are less-bounded in acquiring new technologies and expertise through mergers and acquisitions, buyouts, personnel poaching, new product licensing and so on. Moreover, hierarchical corporate structures of firms concentrate unilateral power at the top, which allows senior management to make radical changes to the business.

[1] Hall and Soskice (2001) used four-year patent data (1983-84 and 1993-94) from the European Patent Office to measure the degree to which Germany and the US concentrated in thirty technology classes with varying technological progress - featured by radical or incremental innovation. They calculated the patent specialisation index by subtracting a country's fraction of its total patents in a field from the world's fraction of total global patents in this field. Higher score means higher specialisation.

By contrast, the CMEs' institutional systems encourage incremental innovation. Bank-based financial systems provide patient capital. Industrial relations and corporate governance structures characterised by worker representation and consensus-based decision-making guarantee the long-term employment and wage protections, which encourage employees to invest in firm-specific skills and engage in incremental innovation. Dense inter-firm networks inhibit hostile takeovers and foster differentiation-oriented corporate strategies, which promotes incremental innovation over radicality.

The argument of Hall and Soskice (2001) posits strong institutional complementarities that the presence of one institution will improve the efficiency of the others. The higher the institutional complementarities of the economy, the closer institutions can fit together coherently to coordinate the economic activities, and the better the economic performance will be (Hall and Soskice, 2001). It predicts a tendency of "polarisation" that national capitalism will gravitate towards the ideal type of either the LME or CME model where institutional configurations are complementary and efficient (Streeck, 2010; Schneider and Paunescu, 2012).

3.2.2 Beyond the dichotomy

The VoC framework faces critiques in several aspects, including the oversimple relation between the theoretical types and empirical cases (e.g., Crouch, 2005), the assumption of a rigid institutional complementarity and coherence (e.g., Witt and Jackson, 2016), and the simple associations between sectors and innovation types based on patent measures (e.g., Taylor, 2004). Figure 3.2 summarises these critiques in two aspects - the dichotomy of national economies and the dichotomy of innovation patterns. Regarding the first critique, this section will present evidence that the national groups are subject to different classifying criteria and changes. The dichotomous innovation patterns are challenged by the hybrid cases with institutional coherence beyond the strict form of institutional complementarity assumed by the VoC. Based on the studies that have casted doubts on the sectoral proxy of innovation by presenting new methods of innovation calibration and "deviant" empirical evidence, further debates have been stimulated on the VoC's strict institutional causation of national disparities.

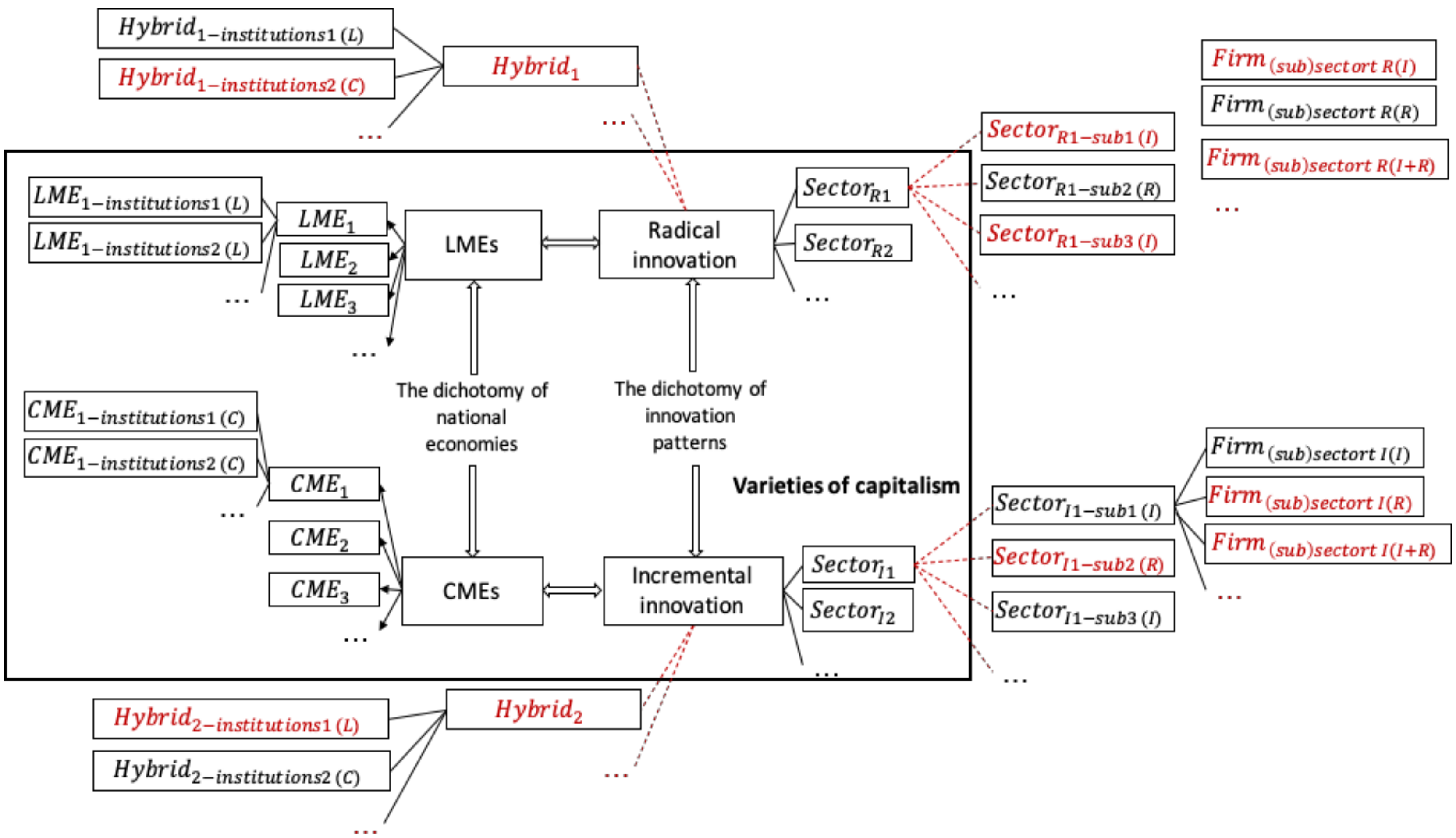

Figure 3.2. Challenges to VoC's dichotomy

Source: author summarised.

The typology

The VoC approach categorises ideal-typical countries by adopting the most parsimonious typology which involves two types of coordination, i.e., either markets or "organised" coordination. However, there is an increasing number of national economies that cannot be categorised into dichotomous types (e.g., the case of China illustrated in Section 3.2.4). Beyond the bipolar distinction between LMEs and CMEs, scholars have identified different ideal types and developed various typologies of national economies (e.g., Whitley, 1999, 2007; Hollingsworth and Boyer, 1997; Amable, 2000, 2003; Boyer, 2004; Tylecote and Visitin, 2007).

A typical attempt to develop a new typology is by Richard Whitley (1999) whose study of the capitalism breaks the tradition of contrasting market-based models in Anglo-Saxon countries with the others and extends the analysis to East Asian economies, such as South Korea and Japan, and identifies six national business systems[1] are identified. Similarly, Amable's (2003) typology also extents the VoC dichotomy to five types including the Asian model. In investigating the Continental European type, Amable finds less cross-country homogeneity in this model than in the others, which raises questions on the "viability" of this model[2] and shifts our attention to hybrid models of coordination and institutional changes.

Hybrid forms of coordination

As the VoC theory claims, the complementarities between institutions lead to higher coherence of economic coordination in the LMEs and CMEs. Nevertheless, the conception of institutional complementarities has been challenged by many empirical

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[1] Whitley (2007) updated this framework by modifying the classification and enlarging the original categorisation into eight ideal types with two new models - the financial conglomerate and integrated conglomerate. The classification of capitalisms is subject to continuous refinement and enrichment. For instance, the post-war South Korea was moved from the *compartmentalised* to *integrated conglomerate* category which also incorporates the France *groupes industriels*.

[2] Since the 1990s, institutions, especially the wage-labour nexus and financial system of the Continental European model, were challenged by market liberalisation and globalisation. The labour market and social protection systems in several countries experienced changes to introduce labour market deregulation. Countries traditionally featured as having "bank-based" financial systems, such as France and Germany, underwent soaring financial markets and changes in the banking industry.

cases with neither "purely" liberal nor coordinated institutional systems have performed well in innovation and economic development. For example, Boyer (2004) explores a range of OECD countries with high-speed growth and finds at least three kinds of institutional configurations being supportive to the technology-led growth regime. In his category, many "social democratic" countries integrate the characteristics of LMEs and CMEs. Similarly, Campbell and Pedersen (2007) interpret that the success of Denmark stems from the interaction of market and non-market institutions. Institutional complementarities in the Danish case are rooted in the hybridisation built on the institutional heterogeneity rather than homogeneity. These contradictory cases cast the debate on how "hybrid" institutional configuration contribute to economic performance and how many classifications should be included in the typology to cover the increasing hybridisation.

In addition to the empirical investigations, scholars have developed many operationalised approaches to measure the institutional coherence and how it defines economic behaviours and generated different conclusions. Hall and Gingerich (2004) identify a positive correlation relationship between the internal institutional consistency and macroeconomic growth, which validates the VoC's assumption. However, using the same method, Kenworthy's (2006) study shows no correlation. Furthermore, many scholars adopt the qualitative comparative analysis (QCA) method and analyse the possible combinations of institutions, which provides little support for the institutional coherence hypothesis claimed by the VoC (e.g., Kogut and Ragin, 2006; Witt and Jackson, 2016). These studies undermine the "tight integration" of institutions as suggested by the VoC and leave alternative path of complementarities in "tension", "loose integration" (Deeg, 2005) or "checks and balances" (Crouch, 2005), which accommodate the empirical plurality.

Moreover, many scholars (e.g., Boyer, 2005; Crouch, 2005; Jackson and Deeg, 2006; Deeg and Jackson, 2007) criticise VoC's conceptualisation of institutional complementarities for its *path-dependent* view. A path-dependent process is characterised by a series of "self-reinforcing" events involving positive feedback. Because of the institutional complementarity, isolated changes in one institution can hardly happen due to the lack of support from other complementary institutions (Jackson and Deeg, 2006). Though changes occur, it is unlikely to transform the whole institutional configuration following the path dependency. Therefore, VoC suggests that actors have little choice to develop alternative strategies but have to follow the dominant path, which offers little room to understand the changes over time and fails to explain the within-model heterogeneity as elaborated in Section 3.2.3.

Sectoral advantages in innovation

Hall and Soskice (2001) associate radical or incremental innovation with sectors in either "new" or "old" types[1], which has been challenged by many studies that have put forward contradictory evidence to VoC's hypothesis of the sector-specific advantages in radical or incremental innovation, hence the categorisation of national economies with assumed advantages in either type of innovation. Criticisms centre on (i) the use of patent counts to measure radicality and (ii) the use of sectors as proxies of different types of innovation.

The VoC's use of patent counts to measure radicality suffers from criticism due to its limited coverage of time span and countries, the failure to determine the degree of innovativeness of each patent, and the lack of other innovation measures (Taylor, 2004). Also, patenting is not always a reflection of actual innovation as in the LMEs where the widespread patenting activities are the legal devices resulting from the common law (Crouch, 2005). Reacting upon these drawbacks, multiplex indicators, such as patents weighted by forwarding citations, scholarly publications (counts and citations-weighted), generality and originality have been involved in to measure radicality (Taylor, 2004; Akkermans et al., 2009). Although these studies have not directly tested an economy's institutional advantages in facilitating innovation[2], their examination of the industrial or technological advantages and findings of heterogeneity across countries have challenged the VoC's propositions.

Besides, VoC's sectoral classification according to the radical and incremental innovation has been in concern. The oversimple linkage between sectors and types of

[1] Radical innovation is often found in "fast-moving technology sectors" or "complex system-based products", while incremental innovation is more important for maintaining the competitiveness of capital goods by sustaining high quality, enhancing customer loyalty, and making continuous improvements.

[2] Hall and Gingerich (2004) examine the VoC's hypothesis of institutional advantages. Witt and Jackson (2016) made a more robust test of both sectoral and institutional comparative advantages.

innovation risks misunderstanding the essence of the innovation per se[1] (Crouch, 2005). Studies have made attempts to avoid the sectoral proxy of innovation types by characterising the sub-sector differences distinguished by the technological properties, the level of technological cumulativeness, and the extent to which knowledge is industry-generic or firm-specific (e.g., Casper and Soskice, 2004; Malerba, 2004). Some challenge the sectoral proxy by investigating the heterogeneity of firms within a sector or a sub-sector in innovation strategies and business models (e.g., Herrmann, 2006; DiVito, 2009). Empirical evidence has been contributed to challenge the VoC's assumptions on national advantages (e.g., Casper and Soskice, 2004; Casper and Whitley, 2004, Divito, 2009).

3.2.3 Beyond the institutional determinism

As Section 3.1 demonstrates, increasing regional models and empirical evidence have unveiled the sub-national varieties in industrial specialisation and innovation performance. "Creative incoherence" where local deviation from the national institutional system has been identified that cause the regional varieties of capitalism (Crouch et al., 2009). The institutional complementarities insisted by the VoC fails to characterise and explain the inter-economy heterogeneity across regions. Nevertheless, following the similar vein of institutionalism, these regional varieties can be explained by the cross-regional institutional differences. In other words, transferring the analytical focus of VoC from the national to regional level following the institutional logic assists in conceptualising regional differences. And those regional models in "creative" balances can be viewed as different kinds of hybridisation. Despite this, the institutional causation is insufficient to explain the firm-level heterogeneity.

Firm-level heterogeneity

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[1] For example, the radical launch of a hydrogen-fuelled motor engine in the motor industry is labelled as incremental according to VoC's sectoral classification. The VoC's associations of CMEs' competitive sectors to the traditional and declining industries while LMEs' advantageous ones to the future-oriented sectors, imply a neo-liberal assumption that only market mechanisms can cope with the future. It fails to explain the innovative German industries like chemicals, machinery, motor vehicles that were historically at the forefront of technological advances.

According to Hall and Soskice (2001), firms within the same economy face isomorphic pressures to adopt strategies parallel to the overarching institutional settings to take advantage of the opportunities offered by the national economy and intensify their distinctiveness. Actors and their strategic preferences in the VoC framework are posited as "endogenous" to the institutional system (Allen, 2004). However, increasing evidence has shown that firm-level behaviours can "deviate" from the national stereotype supported by the national institutional systems.

Some studies focus on the MNCs. Edwards and Ferner (2002) find that MNCs enjoy a high level of freedom to respond to the institutional influences in the host country, and they can successfully transfer the practice from their home country to foreign countries by exploiting the "slack" or "space" within the host country. Some focus on the role of leading firms, such as Ericsson, who helped build the technology hub in Sweden, different from the industrial organisation traditionally facilitated by Swedish institutional frameworks, but more like the Silicon Valley model (Casper and Whitley, 2004). Some focus on how firms develop strategies breaking up the predicted paths of institutional systems. For example, Herrmann (2006) find that many German biotech firms are adopting radical innovation by utilising functional equivalents to compensate for the national institutional insufficiency in supporting radical innovation.

To explain these deviant cases, Streeck and Thelen (2005) stress that imperfect enactment of a social rule leading to the "gap" between the ideal pattern and the real pattern. Deeg and Jackson (2007) refer to the gap resulting from the "ambiguity" and suggest a shift from seeing institutions as "constraints" to "resources" that can be used by actors legitimately to attain their ends. The institutional influences are retained though depends on the degrees of institutionalisation. When national institutions are highly constraining, firms have fewer opportunities to develop strategies along alternative paths, while when institutionalisation is loose, more heterogeneity may exist (ibid.). Characterising actors' initiatives and capabilities[1], these studies suggest a less deterministic view of the relationships between institutions and heterogeneous

[1] Actors can impose changes in institutions. Hall and Thelen (2005) identify three kinds of institutional changes initiated by actors, including (i) actors may defect from behaviours built upon established equilibriums, (ii) actors may reinterpret existing institutions and modify the behaviours associated with the institution without changing the institution itself, and (iii) institutions can be changed in a formal process of the political reform.

firm behaviours.

A broader framework is requested to accommodate the idiosyncratic micro-level behaviours in the national or regional comparative analysis and reconcile the conflicts. Whitley's business systems (1999, 2007) mentioned in Section 3.2.2 generate useful implications by distinguishing institutions, business systems, and firms. He theorises the business system as the "dominant" pattern of firm behaviours in a nation, which explains why particular business system exists in specific institutional environments and retains firms' influence on institutions by changing the features of a business system. Therefore, by coining the "business system" through summarising the dominance, Whitley constructs a conceptual "mediator" bridging the gaps between institutions and idiosyncratic firms. In his own words, the comparative business system framework focuses on

> *"… integrating the macro-institutional level of analysis with more microanalyses of firm governance and behaviour to account for the major variations in postwar patterns of economic organisation" (Whitley, 2007, p.5).*

3.2.4 China: a new variety of "capitalism"?

It is an ongoing debate about Chain's political economy on whether it can be referred as a "capitalist". Chinese party authority strongly rejects the conception of China as a (state) capitalism economy and restates that the contemporary China insists to go on the path of "socialism with Chinese characteristics" (Qiushi, 2018). The disagreement on terming China as a capitalist mainly out of the ideological concern and the continuous roles of the state and SOEs in China (e.g., Deans, 2004; Peck and Zhang; 2014). Here, this thesis would stop the discussion on this dispute but adopt McNally's (2007) view by applying the capitalism lens "*perceived as the underlying socio-economic system shaping our era, which, not unlike feudalism, represents a generic mode of production, not an ideology*" (p.180) to explore the political economy of China where a capitalist transition is certainly going on.

Lots of efforts have been spent on investigating China's political economy. Some directly operationalised the orthodox VoC framework in the case of China, while they drew completely different conclusions. For example, in his working paper, Witt (2010) employed those institutional dimensions of a political economy characterised by the VoC framework and compared China with the two ideal types. He classified China in the LME group. However, using the same VoC framework, Fligstein and Zhang (2011) defined China as a specifical CME. In the study of Peck and Zhang (2013), the Chinese model was positioned in a triangular relationship with the ideal LME or CME model. Increasing studies have highlighted China's odd fit with the VoC framework and these studies coined new terms, such as Sino-capitalism (McNally, 2012), the state-permeated market economies (Nölke and Claar, 2013), the power-elite capitalism (Peck and Zhang, 2013), and authoritarian Capitalism (Witt and Redding, 2013) to define the Chinese variant.

As discussed in Section 3.2.2, the VoC framework was built on the developed countries' experiences with the analytical focus on the institutions of advanced economies in North America and Western Europe. Though Whitley (1999, 2007) and Amble (2003) have incorporated the emerging and East Asian countries into the typology, the focus on Japan and South Korea limits the wider application of their frameworks to a broader scope of developing economies like China where institutions are in continuous transition. Investigating China's political economy and comparing China's institutions with other economies by simply applying the parsimonious VoC framework would be problematic. Nonetheless, the Chinese case creates opportunities to enrich the VoC and the more general comparative capitalism literature.

Besides adding to the criticism of the VoC's dichotomy and the "pure" institutional complementarities, the case of China challenges the methodological nationalist and firm-centred approach of the traditional VoC framework (Peck and Zhang, 2013). On the one hand, the economic and authoritarian decentralisation, the differing regional endowments in the vast territory, as well as the increasing challenges and opportunities imposed by the globalisation have created different kinds of regional varieties within China (McNally, 2007). For example, Zhang and Peck (2016) identify a range of sub-regional models in China, including the Guangdong model, Sunan model, Wenzhou model, Zhongguancun model, and Chongqing model. Breznitz and Murphree (2011) emphasise the notion of "structural uncertainty" leading to various "regional fiefdoms". This reflects the short of VoC's framework in coping with the multiplex varieties of capitalism within one nation. On the other hand, in contrast to the VoC framework that seeks to build the connections between the competitiveness of firms and the comparative national institutional advantages, a large size of studies on China (and developing and emerging countries) highlight the permeated presence of the state in the "capitalism" transition (e.g., Howell, 2006; Naughton, 2008; Kalinowski, 2013; McNally, 2012; Nölke, 2018; Rithmire, 2014).

At the same time, the private sectors have been rising. Therefore, another group of scholars focused on the roles of social-network ties, particularly in the Chinese terms of "*guanxi*" (either between business firms or between business and government officials) and argued that they have played important roles in China's capitalist development, especially in the emerging private sector (Xin and Pearce, 1996; Peng and Luo, 2000; Wank, 1999). Following this stream of literature, the weak legal institutions and property right protections, the imperfect capital-market structures, and the institutional uncertainty not only differ China from those capitalist economies covered in the mainstream VoC framework but also magnify the insecurity of the private sectors (Peck and Zhang, 2013).

Considering the increasing global significance of China and the impressive economic growth it has achieved, the VoC and more general comparative capitalism studies call on more attention to the Chinese case and the unique and hybrid institutional arrangements involving the state guidance, the networks of entrepreneurs, and the global integration that have been shaping China's political economy. Aiming to explore the regional disparities in China, the following contents draw on the core debates in literature about China to elucidate the fundamental institutional arrangements underlying the Chinese variety, especially the variegated regional development.

Another developmental state?

There is a longstanding debate on how to understand the role of China's state in its economic transformation. In the post-war period, the "developmental states" used to play significant roles[1] in the late industrialised economies like South Korea and Taiwan in the East Asia and Ireland of Europe (Wade, 1990). They are different from the regulatory state in from the UK and US that mainly play regulating roles to support the competitive game without influencing the market processes and industrial

[1] Such as guiding the capital investment, managing the licenses of import technology, and regulating competition for industrial purposes.

development (Whitley, 2001).

(a) Comparing China and the developmental states

To a certain degree, the state-led development in China retains and reflects the earlier experiences of its East Asian neighbours relying on the developmental state. The developmental state model characterises the strong (often nationalist) "will to develop" among the political elites. It relies on a small set of powerful, talented, prestige-laden, and development-focused elite bureaucracies[1] mainly in the economic field to plan rationally and carry out industrial policies. Though the intra-bureaucracy conflicts exist, these "pilot agencies" with widely acknowledged leadership ensure the concentration of talent and expertise and the coherence of policies (Johnson, 1982; Evans, 1995).

Similarly, there is a shared will to develop among state elites in China, especially when this country faced the pressures to survive and revive in the late 1970s when modernisation and industrialisation became the most urgent pursuits of the top leaders in China. China closely followed the paths of Japan and South Korea by using the state power to promote economic development, supporting the export-driven industrialisation, and relying on the fixed-asset investment (McNally, 2007). Besides, the Chinese policymaking practice in the strategic and technological industries resembles the East Asian developmental states in many aspects such as the activities of cultivating national champions, building national technological leadership through scientific, technological and engineering projects, and increasingly pursuing indigenous innovation (Peck and Zhang, 2013).

However, China's experience differs from the developmental states in a number of ways. As a big economy, China has large domestic markets, which differentiates it from the East Asian tiger economies with irreplaceable dependence on export (Nölke and Claar, 2013). In the era of globalisation, FDI and trade were welcomed in China adopting more "free-market principles" (McNally, 2012, p.755). In line with the market-oriented strategies introduced in the 1990s, such as the breaking of the "iron rice bowl", the marketisation of labour, the evisceration of social protections, the privatisation of commonly held assets, and the establishment of the capital market,

[1] E.g., the Ministry of International Trade and Industry in Japan and the Economic Planning Board in South Korea.

some "neoliberal" interpretations of China's transition emerged (Harvey, 2005; McNally, 2007). Though many scholars would not term the market reforms as "neoliberalism" (e.g., So, 2009, Nonini, 2008), the hybridisation transcends the traditional developmental states[1].

Moreover, China has not developed "pilot agencies" like in Japan and South Korea and the state bureaucracies have not been planned rationally (Deans, 2004). The local government agencies with great autonomy and multifaced roles in the local affairs further complicated the practical implementation of industrial policies, which has significantly differentiated China from the development states. Situated in this country's vast territory and complex governance structure, scholars focus on the "central-local relationships" as the most basic institutional element to characterise China's political economy and explain the widespread existence of regional disparities (Segal and Thun, 2001; Xu, 2011; Zhou, 2017).

(b) Central-local relationships

In the Chinese system, the logic or coherence lies neither on the national or local level in a singular way but is built "relationally" between them (Zhang and Peck, 2014). The central-local relation represents the basic architecture in which China's regional patterns of development are embedded. Fundamentally, the unique China's political economy is characterised by the "regionally decentralised authoritarian" (RDA) regime, which combines the "economic regionalisation" and the "centralised political governance" (Xu, 2011). In structural terms, the RDA regime is manifested by the administrative structure governed by the *vertical-horizontal* ("*tiao* / "*kuai"*) relations as illustrated by the marine governance system in Section 2.2.1.

The economic decentralisation in China confers greater autonomy and resources in managing regional affairs on regional leaders. In this respect, many scholars highlight the fiscal decentralisation resulting from the two waves of national campaign and the fiscal reform introduced in the 1980s[2] (Montinola et al., 1995; Jin et al., 2005). They

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[1] For example, Liow (2016) refers to the neoliberal transition in this traditionally developmental state as the "neoliberal-developmental state" when investigating the structural changes in Singapore.

[2] Following the fiscal reform, the subnational fiscal revenue to national fiscal revenue ratio kept increasing and reached the peak in 1993 (Xu, 2011).

believe that China's hierarchical governance has been replaced by "*federalism*" dominated by the administrative decentralisation, jurisdictional competition, and central-local bargaining (e.g., Cao et al., 1999). And it is the autonomous and fiscal decentralisation that promotes regional governors to pursue new opportunities for economic growth. However, in obvious contrast with the fiscal federalist countries, China's decentralisation is backed by the political centralisation in which the central state holds *de jure* and *de facto* discretionary power over the regional-level agencies (Xu, 2011). Political control is pervasive where the CCP controls the ideology, the appointment, promotion and removal of the regional governments, and holds the strategic sectors like banking, telecommunication, and energy in hand.

In such background, though economic decentralisation empowers the regional leaders, their career path is subject to the central-level decisions. Regional economic performance becomes the main indicator to evaluate the regional governors. This induces the "tournament" kind of competition, known as the "GDPism" (Peck and Zhang, 2013, p.375), which has been incorporated into China's *nomenklatura* system (Huang, 1996; Li and Zhou, 2005). Besides, the top-down economic reforms, such as the establishment of the SEZs discussed in Section 3.1.4, the land reform, and the state sector reform, rely heavily on the regional experiments (Heilmann, 2008). Motivated by the motto that "development is the absolute principle" (*fazhan caishi yingdaoli* in Chinese), regional experimentation [1] has been encouraged that regional officers would be rewarded if the experiments succeed, but not be punished if experiments fail[2] (Zhou, 2017). Therefore, besides simply responding to the incentives or initiatives of the central government, the local states develop regional wisdom to promote economic development, which contributes regional experiences to the central policymaking through the bottom-up approach (Blanchard and Shleifer, 2001; Thun, 2006; Heilmann, 2008).

This political institutional arrangement combining the inter-regional variations in historical legacies, local endowments and local leadership capabilities, has significantly led to the heterogeneity across regions in aspects such as the local state configurations

[1] Many scholars argued that China's practice highlighting the policymaking through experimentation has its roots in the pre-1949 era of the CCP's revolutionary bases (e.g., Heilmann, 2011; Perry, 1994).

[2] Meanwhile, problems such as the conflicts in regulations, regional protections, industrial overcapacity, and the potential irregularities of the regional governments have also emerged (Xu, 2011; Zhou, 2017).

and coordination, the regional strategies and economic development models, and thereby the economic outcomes (Peck and Zhang, 2013). This in turn influence the bargaining power of the regional states with the central government. Therefore, when top-down, central-state-led development persists in China, the regionalised bottom-up initiatives built upon the regional economic competition and experimentation also play significant role in Chinese development.

Network capitalism - is "guanxi" still important in China?

Besides the state-led development and the underlying political structures, scholars have also termed China's variety as the "network capitalism" (e.g., McNally, 2007, 2012). The network capitalism in China has largely been initiated and influenced by the overseas Chinese. A typical regional example is the PRD model popularising in the early 1980s. Following the establishment of SEZs in southeast coastal areas, Hong Kong capital attracted by the cultural affinity and China's comparative advantage in cheap labour started to be poured into the PRD region (Ye and Wei, 2005; Wei, 2007). Though in a somewhat different way, networks with overseas Chinese have also been important to the development of southern Jiangsu (Sunan). The Sunan model emerged in the 1980s based on the growth of TVEs, which was once characterised as the "local state corporatism" receiving great support from the local governments (Oi, 1995). Entering the 1990s, with the increasing opening-up and privatisation, TVEs declined. Overseas capital from Singapore and Taiwan flowed into this city. Networking connections with the foreign capital enable local firms in these regions to integrate with the global production networks.

Besides the transnational networking, a different model was identified in Wenzhou which is seen as the "quintessential capital of China's network capitalism" (McNally, 2007, p. 191). The blooming Wenzhou model embarking the rise of the Chinese private sector was based on the network of small family-owned businesses (Ye and Wei, 2005). Family enterprises rooted in entrepreneurship and rural markets rely on the social networks to integrate into the local markets and access resources (Wei et al., 2007), which has largely excluded migrants and external collaborators. Furthermore, the Wenzhou model cannot leave with the tolerance of underground economy underlain by the business-state relationships (e.g., local officials' engagement in business by moonlight or "power share"), though they have also led to problems like local protectionism and rent-seeking (ibid.).

The networking capitalism and the different Chinese regional models promote the search for a cultural essence of Chinese capitalism and *guanxi* capitalism became a popular term. Central to the proponents is that, when formal institutions such as the property rights protection system and law systems are insufficient in China, *guanxi* (i.e., interpersonal, reciprocal, utilitarian, contextual, and long-term oriented relationships in China) plays compensating or substituting roles underpinning the networks (Xin and Pearce, 1996; Wank, 1999; Luo, 2007). As exemplified by the Wenzhou model, many scholars have focused on characterising the networks dominated by the reciprocal ties between private firms and state officials, termed “power-elite capitalism” that are pervasive in the post-Mao stage (Peck and Zhang, 2013). Nevertheless, these *guanxi*-based networks of firms can range from government agencies to business partners, and from foreign firms to local ones.

Guanxi, characterised as an important element in China’s political economy, is absent from the classic VoC framework. The complex, multiple, and deeply networked regional models further challenge the VoC’s assumption of the formal institutional logic on the national level. However, when China is gradually moving towards a technological-intensive economy with increasingly developed formal institutions, the emphasis of *guanxi* has been weakened. In fact, as indicated by the early establishment of the Information and Communication Technology industrial cluster in Kunshan City, one important reason behind the Taiwanese investors’ decision to relocate from the PRD region to Sunan was to reduce the use of *guanxi* with local cadres as they did in the PRD region (Yang, 2007; Wei, 2010). The pressures faced by the low-tech and labour-intensive model further push firms to improve R&D capacities and conduct technological upgrading as exemplified by the regional development of Shenzhen in the PRD area and the Sunan model (Wei et al., 2009; Wang and Lin, 2008).

In recent years, the *guanxi*-dominated research on China, despite that whether market-based and power relationships have replaced *guanxi* with business and political rules remain under-explored (Wei, 2007). A recent study of Bologna (2019) investigating *guanxi* and contracting in the current Chinese market finds no clear evidence of the increasing or decreasing use of *guanxi*. Therefore, besides challenging while enriching the VoC and comparative capitalism scholarship, how relationalities and networks are developing in contemporary China's business practices call for more theoretical and empirical debates. And this further shifts the attention of this study to the next theoretical lens - the relational network in Section 2.3.

All in all, the Chinese political economy with rich illustrations of the regionally variegated models adds to the explanation of regional heterogeneity untouched in the VoC approach and challenges VoC's emphasis on the national institutional complementarities from which the national competitiveness emerges. As suggested by Peck and Zhang (2013), the Chinese case is more appropriately characterised as a contradictory but complementary case combining socialism and capitalism and defined from its "paradoxical admixtures" rather than in "purified essence" (p. 370). This kind of "out-of-equilibrium hybrid" has been formed neither in a linear process nor by pre-design, but through an adaptive and gradualist process of upward spiralling virtuous cycles of induced reforms based on the "trial and error" and even sometimes the unintended consequences of initial reforms (So, 2009; Naughton, 1995). With the consensus that China's development path somewhat resembles but to a large extent deviates from the developmental states of other East Asian countries, the widespread existence of networking capitalism either based on *guanxi* or more formal relationships, and the increasing integration with the globalisation, the debate on how to define properly define the twisting state-led and market-led evolution in China will continue.

3.2.5 Summary

Despite the aim to classify capitalist economies into a dichotomy and the nationalist view, the VoC framework highlights the importance of the institutional settings, especially the complementarities of institutions, as the fundamental factors to explain the sectoral specialisation, the innovation patterns and competitiveness advantages of comparative economies. The VoC's assumption of causality by focusing on the comparative institutional advantages has been widely applied to the comparative capitalism research and regional-level studies (though the regional diversity can also be seen as important evidence overturning the national-level institutional complementarities as insisted by the traditional VoC theory).

Nevertheless, the central shortcoming of the VoC also lies in the institutional causation, which fails to explain the within-model heterogeneity and causes a missing link between macro-level institutions and micro-level actors. Besides, increasing empirical cases have presented contradictory evidence that challenges the VoC's typology, the strict form of institutional complementarities, and the association between industries and types of innovation. With a complex historical legacy, large size and various regions, and exposure to the globalisation, China is an evident example of the new variety of "capitalism" that has generated unique institutional arrangements combining the Chinese, East Asian, Western and socialist characteristics (McNally, 2012).

3.3 Relational Networks

The RIS and VoC theories highlight the explanatory power of institutions in contributing to the regional diverse patterns of innovative development. Despite this, the micro-level heterogeneity of firms has been poorly dealt with. However, firms are essential players in regional innovation by taking decisions about what is produced and how to produce and organising the interaction between its individual members and turning the individual knowing into a collective competence (Metcalfe and Ramlogan, 2008). More important, even though other organisations, research parties, or individual inventors can contribute information flow to innovation acting as the "necessary parts of innovation networks", it is only the firm having the capability to combine multiple kinds of knowledge about markets, organisations, and technologies required for innovation (ibid.). Therefore, Nelson and Rosenberg (1993) interpret innovation as the process by which firms master new technologies. And it is generally agreed that the regional innovation performance can be improved when firms are encouraged to be better innovators and interacting with other firms and organisations (Dolorexu and Parto, 2005). This advocates a shift in the analytical focus to the micro-level firms and an alternative approach to characterise the firm-level diversity.

As can been interpreted from Sections 3.1 and 3.2 and will be illustrated in this section, regional innovation studies generate important networking implications by underlining the importance of networks constituted by firm-centred interrelationships in structuring the interactive learning - as the fundamental element of the knowledge production, and thereby affecting the regional innovation and the industrial specialisation of different economies. From the enterprise perspective, the social embeddedness and the popularisation of the open innovation concept highlights the importance of networking behaviours as the resources and strategies in defining firms' innovation capacities and performance. Therefore, this section adopts the "relational network" view and operationalises the network concept in the firm-level analysis from the perspective of interrelationships. The "relational networks" approach offers a new perspective to capture and explain the heterogeneous firms on the one hand and respond to the firm-centric but interactive- and relational-based view of regional innovation on the other.

3.3.1 Regional studies and networking implications

Numerous regional innovation studies have demonstrated the importance of innovation networks. As suggested by the evidence from the European industrial districts, milieux, territorial clusters and RISs, firms are posited in the regional-based networks by interacting with other firms and organisations such as the knowledge bodies in the same region. The networking effects and the localisation of know-how promote the collective learning, and thereby influences the innovative performance of the regions.

Networking implications from regional models of development

Empirical regional cases have highlighted the importance of networks in regional innovative and economic development. For example, Saxenian (1994) compares Silicon Valley and the Route 128 area in Boston and seeks to explain their different performances. By adopting the network approach, Saxenian finds that Silicon Valley has built a regionally network-based system through which firms share information about markets and technologies and learn from each other. In contrast, the Route 128 region represents the firm-based system where firms prefer to internalise production and innovation. Casper (2007) investigates the San Diego biotechnology cluster and explores why only a few biotech clusters have succeeded in the United States. From the network perspective, it has been found that successful clusters with intense networks not only facilitate the sharing of information and ideas, but also reduce the risks of employees to accept a high-risk position in biotech firms.

Moreover, the regional cases of China contribute empirical evidence to the networking importance. Typical examples include the Wenzhou model and the broader scale of industrial clusters concentrated in the Yangtze River Delta and in the PRD region (mentioned in Section 3.1.4) built upon the intense networks within the local close-knit business communities (Berkowitz and Li, 2000; Nee and Opper, 2012). Besides, as discussed in Section 3.2.4, the PRD model and the Sunan model based on the transnational networks are presented. These regional cases underlie the "networking capitalism" in China. Moreover, the non-local based networking also extends the traditional regional-constrained focus of networks to the extra-regional ones.

The importance of proximity

Focusing on the innovation practices in the regional scope, the "spatial proximity" is one of the most evident characteristics. As mentioned in Section 3.2.1, by highlighting the importance of innovation networks, regional scientists and economic geographers stress the proximity as important mechanism structuring regional innovation by enabling frequent face-to-face communications and promoting tacit knowledge transfer. Marshall's "industrial atmosphere" and its modern version as "local broadcasting" (Owen-Smith and Powell, 2002) or "buzz" (Storper and Venables, 2002) highlight the benefits of geographical propinquity that the co-presence and co-location of people or firms in the same area unintentionally facilitate the diffusion of information (Bathelt et al., 2004).

However, increasing evidence has illustrated that firms in highly innovative regions rely on non-local sources of knowledge (McKelvey et al., 2003; Audretsch and Lehmann, 2006). Even though spatial proximity is important, not all competencies, knowledge and resources are available in a regional innovation cluster (Bullinger et al., 2004). Beyond the regional scope, scholars have defined other types of proximity, including the "cognitive proximity" referring to the cognitive bases of actors and the absorptive capacity of new ideas, the "technological proximity" highlighting the interdependency between various actors, "what" they exchange and the potential value of these exchanges, the "organisational proximity", "institutional proximity", and the "social proximity" (Boschma, 2005; Kirat and Lung, 1999; Knoben and Oerlemans, 2006).

These dimensions characterise that the regional innovation depends on the relational networks beyond the geographical closeness as the only underlying basis. For example, Boschma (2005) treats the cognitive proximity as a prerequisite for interactive learning, while other dimensions are only complementary mechanisms that may be able to bring actors together. However, the emphasis of Knoben and Oerlemans (2006) has been put on the technological and organisational proximity that firms proximate in these two dimensions can substitute geographical proximity and overcome the large spatial distances. These studies generate important implications for understanding the different networks across regions and the elements influencing the relationships between firms and other organisations constituting the networks.

3.3.2 Networks and firm-level heterogeneity

Besides being important to regional innovation, the networks approach offers an important perspective for observing, conceptualising, and explaining firm-level differences in innovation performance. Early attempts have tried to explain why firms are different in economic performance and innovation from different perspectives, such as the resource-based view assuming that the enduring competitive advantages mainly come from the valuable and imitable resources internal to a firm (Barney, 1991), or much from the imperfections in factor markets or luck (Barney, 1986). Nevertheless, increasing studies have refuted the "atomistic" view of firms by emphasising the *embeddedness* that firms as embedded in the network of relationships.

The social embeddedness and implications

The notion of "social embeddedness" stresses that economic actions in modern industrial society are closely embedded in networks of ongoing social relations (Granovetter, 1985). Granovetter (1985) criticises the economic view [1] for being under-socialised, discouraging the in-depth analysis of the broader systems of social

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[1] In classical and neo-classical economics, atomistic actors and rational, self-interested, goal-driven behaviours are assumed, while social relations are "frictional drags" that hinder market competition (Granovetter, 1985). A slight move to the sociological end was made by new institutional economists such as Oliver Williamson by adding some institutional and transactional considerations in his argument of organisational efficiencies of *market* versus *hierarchy*. Williamson (1975, 1979, 1985) argued that transaction costs are inherent in every exchange relation. Even though Williamson (1979) noted that transactions are not immune to social structural influences such as repeated personal contacts across organisational boundaries, norms of trustworthy behaviours and the history of prior relations (Gulati, 1995), these factors were treated as occasional and non-important.

relations and also disagrees with the over-socialised extreme[1] that actors "*adhere slavishly to a script written for them by the particular intersection of social categories that they happen to occupy*" (p.487). According to him, these two strands of views - the under- and over-socialised views merge in sharing the view of the atomisation of actors from immediate social contexts.

While social embeddedness is a meaningful attribute, it is highly conceptual and vague. Therefore, most studies shift focus to the physical existent of networks. A firm's embeddedness in social networks is important, which promotes trust by enabling each partner to know about the other's resources and capabilities, reducing informational asymmetries, and thereby mitigates the transactional costs (Gulati et al., 2000; Granovetter, 2005). Besides, social networks, by themselves, are critical sources of reward and punishment. Acting opportunistically will damage one's reputation and influence the current or potential alliances (Gulati, 1995, Gulati et al., 2000). Moreover, social networks can promote the value creation of networks by improving the coordination between firms (Gulati et al., 2000). The existence of trust further increases the actors' willingness to share knowledge and risks.

In the literature about firm innovation, the networking implications have been increasingly highlighted as exemplified by the prevalent adoption of the *open innovation* strategy. Based on the assumptions that the useful knowledge is widely distributed, "open innovation" suggests the significance the external knowledge sources to innovation and further paths to the market and stresses the purposive "inflows" and "outflows" of knowledge (Chesbrough, 2003). Initially adopted by large MNCs, this strategy has become a widespread trend across firms in different sizes (e.g., Kim et al., 2016; Van de Vrande et al., 2009). Besides, the openness is less determined by the industry. Going beyond the high-tech industries such as software, telecom, and pharmaceutical sectors[2] (Chesbrough, 2003), open innovation is penetrating into the

[1] This view sees that actors are overwhelmingly sensitive to others, are obedient to the norms and values developed based on consensus, and display behavioural patterns internalised through socialisation. In this sense, "social influences" are described as "processes in which actors acquire customs, habits, or norms that are followed mechanically and automatically, irrespective of their bearing on rational choice" (Granovetter, 1985, p.485).

[2] Take the biopharmaceutical industry as an example, the increased intensity of technology, the complexity of innovation, the distribution of competencies required, and the pressure on cutting costs make this industry a fertile ground for open innovation (Schuhmacher et al., 2013; Bianchi et al., 2011).

innovation process of the mature, asset-intensive and lower-tech sectors (e.g., Van de Vrande et al., 2009; Chiaroni et al.; 2010; Mei et al., 2019). As a strategic concept, open innovation alone cannot comprehensively demonstrate the networking importance. Nevertheless, the wide operationalisation of this strategy illustrates that the common view shared among individual firms in different sectors or places that relational networks are critical to firm innovation.

Networks as the sources of cross-firm diversity

The networking perspective offers an important dimension to characterise the firm-level diversity and explains their different innovation performance. Many scholars adopting the RBV view which assumes the enduring competitive advantages of a firm coming from the rare, valuable and imitable resources (Barney, 1991), following which the networks composed of interrelations are treated as inimitable resources or the means to access inimitable resources and capabilities (Gulati, 1999; Dyer and Singh, 1998). Consequently, the differences in network resources across firms can generate various impacts, either in enabling or constraining, on firms to access competitive capabilities, knowledge, information for innovation, and therefore influence their innovation performance (McEvily and Zaheer, 1999; Gulati et al., 2000; Uzzi and Gillespie, 2002).

Besides treating networks as resources that influence the firms' innovation performance, networks can be distinguished by an array of dimensions. There are three major perspectives to characterise a network. A primary dimension is the structural aspect, which explores the networking differences by examining factors such as structural holes (Burt, 1992), the spatial location of contacts (McEvily and Zaheer, 1999), structural equivalence (Reagans and McEvily, 2003), tie strength (Granovetter, 1983), and the structural density (Gulati et al., 2000). For instance, firms situated in a geographically dispersed networks reduces the face-to-face interaction but enables the provision of nonredundant information (McEvily and Zaheer, 1999). Differences across firms in this respect become important causes of their variations in the acquisition of information, which further affects their innovation.

Furthermore, many scholars distinguish networks by focusing on the cognitive dimension (e.g., Nahapiet and Ghoshal, 1998; Inkpen and Tsang, 2005; Yoon et al.,

2015) by focusing on the context in which firms are embedded and the networks' underlying mechanisms (e.g., the shared cultures, norms, and trusts). For example, with a high-level of trust in place, information sharing is more likely to happen because trust reduces the opportunistic behaviour and promotes the long-term-oriented goals and increases the interaction transparency (Inkpen and Tsang, 2005). Therefore, networks with various cognitive basis influence firms' innovation performance by influencing the incentives, aims, and stability of their interaction with partners.

Moreover, the portfolio approach concentrates its focus on the attributes of interactive partners, such as the differences in partner types (e.g., customers and suppliers) (Belderbos et al., 2012; Faems et al., 2005), the foreignness of partners (Duysters and Lokshin, 2011), and the relative bargaining power (Lavie, 2007). Besides underlining the importance of building alliances with different kinds of partners in innovation, this perspective highlights that the firm-level differences in their network portfolios cab influence their innovation performance because they construct different kinds of complementarities between partners who bring in various kinds of knowledge and complementary capabilities.

These perspectives offer a critical analytical lens to understand networks. However, most of these approaches conceptualise the "network" as an abstract and holistic concept. This creates difficulties in delimiting the network boundaries and sheds little light on operationalising the network concept in observing focal firms. Moreover, the network-based studies have brought too many different dimensions to characterise and distinguish networks, which causes a lack of parsimony to explore the variations of networks and makes it hard to conceptualise the firm-level heterogeneity from the network perspective.

3.3.3 Operationalise the network concept by relationships

Physically, a network is an abstract sum of numerous relationships in different forms and with different characteristics. Conceptually, networking characterises the relational aspect of firms or any other organisation, which concerns a pattern of inter-organisational interaction and coordination. If a firm is taken as a focal point, its relationships with other actors can be conceptualised into the vertical-horizontal dimensions. The vertical dimension constructs relationships between the focal company, its suppliers, and customers. The horizontal perspective depicts a firm's ties with competitors, peers, and third parties such as government, universities and consultancy (Kühne et al., 2015).

Inter-organisational interaction

Relational and networking studies have made great efforts to examine the relationships with vertical and horizontal partners from different perspectives. For example, vertically, through the comparison between Japanese automakers and their counterparts in the US, Dyer (1996) indicates a positive relation between supplier-automaker specialisation and corporate performance in two aspects: (i) the positive effects of inter-firm human asset co-specialisation on the quality and new model cycle time; and (ii) the geographical proximity and lower inventory costs. Gruner and Hombury (2000) identify that interaction with customers, especially in the early or late stages, is essential to new product development and success.

Horizontally, some studies on the relationships with competitors underline the co-opetition dynamics (i.e., partners collaborate and compete at the same time) and their positive impacts on innovation by expanding product lines, addressing technological challenges and enhancing technological diversity and innovation (Quintana-García and Benavides-Velasco, 2004; Gnyawali and Park, 2011). Beyond the boundaries of inter-firm relationships, studies have also unveiled the importance of the relationships between firms and research, technological and political organisations. For instance, by investigating the SMEs in six European countries, Lasagni (2012) finds that SMEs who are proactive in improving relationships with laboratories and research institutes perform better in new product development.

For a firm, the establishment and maintenance of these networks (or relationships), and the relative importance of relations with different actors depend on several aspects. Internally speaking, the networks are subject to the influences from factors such as the firms' capabilities to possess and manage the network (Kale et al., 2000), the absorptive capacities (Cohen and Levinthal, 1990), the history of prior relationships (Kafouros et al., 2020), the in-house resources as well as the willingness (Gulati et al., 2000).

Externally, social norms and cultural factors, and the trust and reciprocity are important mechanisms governing the networks (Inkpen and Tsang, 2005; Dyer and Nobeoka, 2000). For instance, Sako (1992) finds that British business norms prefer information asymmetry in the bargaining process, while Japanese traders prefer open information disclosure. The relationships with different actors are also affected by the industrial and technological features[1] and varies in different historical periods and national or regional contexts. However, networking research often underestimates these institutional influences beyond the norms and culture, which calls on an integration of the institutional and networking approaches.

Conceptualise relationships

The above studies reinforce the importance of relational networking in defining firms' innovation performance. Furthermore, the diversity in relationships demands a more standard approach to conceptualising relationships. In the work of comparing inter-firm relations in Britain and Japan, Mari Sako (1992) develops an operationalised framework with various identifiable dimensions that can be used for analysing inter-organisational relations. Sako (1992) distinguishes relationships into two basic forms - the *arm's-length* and *obligational* relations. As summarised in Table 3.1, this framework characterises the key defining features and specificities of relationships from perspectives, including the commitment between partners, the sharing of risk, resources, costing and rewards, the coordinated activities, and the longevity of the relationship.

Table 3.1. Dimensions of inter-organisational relationships

Dimensions	Arm's length relations	Obligational relations
Transactional dependence	Low	High
Supplier selection	Blind bidding, price based	Preferred suppliers, prices negotiated
Trading commitment	Short-term and contract-based	Long-term oriented

[1] For example, Powell et al. (1996) find that research-intensive industries such as the pharmaceutical industry are presented with higher reliance on the collaboration with university scientists, research hospitals and competing competitors. Innovation in production-intensive sectors relies more on close cooperation with specialised suppliers and core clients and users (Pavitt, 1984; Castellacci, 2008).

Formalisation of procedures and contingencies	High, Codified procedures	Low, Tacit procedures
Communication	Narrow access, infrequent	Extensive channels, frequent, often extending beyond the business into socialising
Technology sharing	Limited to that contracted and paid to	Continuing and not always fully costed
Risk sharing	Little sharing of risk and explicitly agreed beforehand	Considerable sharing of risk on a continuing basis
Contractual trust	Production depends on written orders	Products start on the basis of the oral agreement
Competence trust	Thorough inspection by buyers	Little or no inspection
Goodwill trust	Multiple sourcing	Sole sourcing by the buyer, combined with the supplier's transactional dependence
The nature of economic relationships	Exit (a constant threat of seeking alternative trading partners)	Voice (an exchange of views within an ongoing relationship)

Source: author adapted from Sako (1992)

Essentially, Sako (1992) distinguishes the varying forms of inter-organisational trust built on different the bases of contract, competence, and goodwill. While the former two types are important and widespread in trading relationship, goodwill trust represents a higher level of trust and the mutual dependence, which becomes the key to differentiate the arm’s length and obligational relationships (Sako, 1992; Sako and Helper, 1998). In this respect, Sako’s framework demonstrates the inter-organisational relationships from the governance perspective, which is primarily affected by the modes of exchange - “exit” or “voice” that classify relationships according to how trading parties resolve problems (Hirschman, 1970; Sako and Helper, 1995a, 1995b). In the “exit”-governed relationship, the exchange between traders is managed by the continuous threat of changing partners, while “voice” relationships make changes and improvements with original partners.

Furthermore, the framework has been extended by distinguishing the collaboration at the “governance” level or the “task” level. According to MacDuffie and Helper (2006), trading partners may face uncertainty and changing nature of knowledge at specific tasks, which drives them to scrutinise their routines and past choices and to explore alternatives. Pragmatic collaboration happens at the task level (Helper et al., 2000), in which actors can build interactive co-design and interdependence by pooling resources and intimately exchanging information. This process generates trust at the task level to maintain their relationships throughout the tasks. However, lacking trust[1] at the governance level, the discretionary efforts in tasks and the information exchange beyond the task level are constrained.

Moreover, by differentiating different kinds of relational coordination, the consequences of the arm's-length or obligational relationships on the performance of firms, industries and economies can been explored. Sako (1992) offers an open answer to the causality by stating that there are neither conclusive causal linkages between the coordinating patterns and the organisational efficiency nor sufficiency to assert the conditions, under which the arm's-length or obligational patterns can achieve efficiency[2]. The sufficient conditions leading to the organisational efficiency or innovation outperformance, the causalities, and the micro-mechanisms governing relationships are subject to empirical investigations. Therefore, this framework leaves space for more empirical wisdom to be included and encourages the exploration of the causal linkages between the varying conditions and organisational innovation performance.

In summary, Sako's (1992) framework fulfils the aim of this research to operationalise the networking notion and to explore regional innovation without ignoring firm-level heterogeneity. Though this framework is developed from the evidence of the transactional relations between "buyers and suppliers", the specification of relational dimensions enables the empirical observation and conceptualisation of all kinds of relationships of a firm and the further understanding of the relational patterns at the regional or sectoral level. By labelling a firm's relationships as arm's-length or obligational without pre-determined impacts on innovation results,

[1] By "trust", the definition of MacDuffie and Helper (2006) specifically corresponds to the "goodwill trust" by Sako (1992).

[2] For example, goodwill trust is an important characteristic of obligational relations that ensures mutual dependence between traders over the long run. However, it may also lead to rigidity and complacency and reduces the incentive to make an effort.

3.3.4 Summary

This section demonstrates the importance of "relational networks" from two aspects. For one thing, it echoes the networking implications of regional studies and innovation research. For another, based upon the promise that each region or sector is composed of firms and organisations embedding into complex webs of networks, the relational network approach deepens our understanding of the sources the heterogeneity across firms. Networks with different attributes are posited with great explanatory power to interpret the diversities in firms' innovation behaviours and performance.

Deviant from those studies that primarily focus on the holistic network, a more operationalised way to explore networks of a focal firm by examining the coordinating relationships and label the patterns. More importantly, the relational perspective enables the exploration of causality between a type of relationship and the innovation performance of the firms in a neither pre-defined nor deterministic way upon the empirical investigation. On the one hand, this characterises the firm-level heterogeneity. On the other hand, by aggregating the relational pattern (being either "patterned" or "patternless") on the sectoral, regional, or national levels, the pattern is not immune from the institutional influences, though the actual institutional impacts are "mediated".

3.4 Regional Innovation of Marine Industry

As Section 2.2.2 discusses, China's definition of marine industry and marine economy, covers almost all economic fields and divides marine industry into major marine industries, marine scientific research, education, and management services industries, and ocean-related industries. Across different countries in the world, there are different practices to define and delimitate the marine industry. Because of the diverse coverage of marine associated activities, there is a continuing debate on how to properly define the marine sector and the marine economy, which will be reviewed in Section 3.4.1. Besides, driven by the regional focus, the "marine cluster" as a central analytical lens to inform the marine industrial research in regions will be introduced.

3.4.1 Marine industry and marine cluster

With increasingly diverse marine-based activities, various definitions of the marine industry have been developed by or for policymakers who demand accessible and reliable information about the size, nature, and contribution of the marine sector to better measure the marine economy and predict the impacts of environmental and economic changes imposed by the oceans (Morrissey et al., 2011).

In the United States, the National Ocean Economics Programme was established in 1999 to measure the ocean-dependent economy and its contribution to the national economy. Two related concepts underlie the data are identified (Colgan, 2003). While ocean economy refers to the economic activities which use the ocean (or the Great Lakes) as all or part of its input, coastal economy covers all economy activities in the coastal regions. This definition is strict, which neglects the service sectors, such as financial services, that often sustain water-based activities (Garland et al., 2019). In Canada, the ocean industries are defined as those industries that are based in Canadian maritime zones and coastal communities adjoining these zones, or those that are dependent upon activities in these areas for income. Inland water industries, such as shipping and fishing in the Great Lakes, canals and river systems are excluded (Fisheries and Oceans Canada, 2002b).

Aiming to estimate the economic contribution of the Australian marine industry, Allen Consulting Group (2004) characterises the marine industry according to the relationships of economic activities with the marine environment and distinguishes activities into the use of sea resources (e.g., commercial fishing), the provision of services relating to marine transport (e.g., shipping and port-based industries), and those benefiting from the positive attributes of the marine environment (e.g., marine tourism). In the study of Statistics New Zealand (2002), the marine economy is measured by "*… the sum of economies activities that take place in the marine environment, or produce goods and services necessary for those activities, and make a direct contribution to the national economy*" (pp. 2-3).

In Europe, there also exist different characterisations of marine industries. For example, the "French Maritime Economic Data" series reports published since 1997 measure the French marine economy, in which marine economy is defined as the set of activities linked to the seas and divides the marine industry into private industrial sector and non-commercial public sector (Kalaydjian and Bas, 2022). The French definition experience evolution over time. In measuring the marine-related activities in the United Kingdom, Pugh and Skinner (1996) characterise activities which involve working on or in the sea and activities involved in producing goods or providing services that directly contribute to activities on or in the sea. Morrissey et al. (2011) identify the Irish marine-based industries with two criteria - industries that directly use marine resources (e.g., marine fishery) and industries that provide products and services indirectly linked to the marine environment (e.g., marine tourism, and marine high-tech service industries). Moreover, Ketels and Protsiv (2017) in a report for the European Commission identify 18 macro marine sectors, while their aim is to generate a spatially informed understanding of the blue growth and offer a benchmark analysis of cluster policy in the EU.

Nevertheless, the above definitions are criticised by the geographers for lacking an integration of the sustainability and social justice principles (Garland et al., 2019). Marine economy, in the geographic terms, concerns more about environmental sustainability, aiming to identify the possibilities between economic and ecological aspects to develop new economic projects within biological processes and deliver sustainable benefits from the oceans (Winder and Le Heron, 2017). Garland et al. (2019) appeal to (i) establish a coherent understanding of the economy and the social carrying capacity and challenge the current power structures, (ii) understand the blue economy in different regional contexts, (iii) take the socio-ecological "fluidity" of the marine environment into consideration so that to overcome the scale mismatches or disparities.

Besides those national practices and geographical definitions, another important stream of literature on the marine industry centres on the "marine cluster". Based on the review of marine cluster literature, Doloreux (2017) summarises the three mainstream definitions of the maritime cluster, including: (i) an industrial complex based on the inter-industry transactions and connections by flows of goods and services, (ii) an agglomeration of interlinked industries connected through knowledge, skills, inputs, demand and so on, and (iii) a regional community-based network with the presence of a network of firms and supporting institutions. Commonly, these approaches highlight that marine clusters develop from complex relationships between interconnected firms and other organisations. They stress that marine clusters are related to coastal locations where sea-related activities are the decisive factors of building clusters, which to some extent reinforces the view that treating the ocean as natural capital, livelihoods, good business, and a driver for innovation (Silver et al., 2015; Voyer et al., 2018).

However, these definitions explore marine innovation from different perspectives. The first definition based on the input-output models offers information about the links between industries (e.g., Salvador et al., 2016). The second kind of definition adopts Porter's (1998) definition to explain cluster dynamics on the national level that cluster is a feature of some national economies driven by competitive and cooperative factors (e.g., De Langen, 2002; Pinto et al., 2015). This view has been widely used by national policymakers to understand the key characteristics of firms' strategies, innovation and competitiveness in clusters, but is less effective in identifying industrial and geographical boundaries. Compared with these two approaches, the community-based interpretation of the marine cluster emphasises the regional innovative and institutional environments, which is more relevant to the focus of this thesis (e.g., Doloreux and Shearmur, 2009; Chang, 2011; Monteiro et al., 2013). This underlies the importance of regions and is effective to understand the marine clusters in a specific region and the local conditions, while it neglects the activities and connections beyond the focused region.

According to Doloreux (2017), among the marine cluster literature, the attention has been concentrated on identifying the actors and institutions in marine clusters, analysing the benefits of clustering marine industrial and innovation activities, and examining the policies practices and impacts. The following sub-sections will review the relevant literature on "marine cluster". Mainly based on the empirical investigations, these studies adopt the cluster as an important analytical lens, which generates important implications for the research on the marine industry, especially on the regional scale.

3.4.2 Marine cluster: actors and institutions

In the research on the marine industry, the development of marine clusters has attracted significant attention. Besides the policy reason that treats clustering strategy as the key approach to consolidate the marine industries and drive regional economic development (Doloreux et al., 2016), an important reason is tied to the specific locational and physical features that marine industries are primarily located in coastal areas to access marine resources (Chang, 2011; Monteiro et al., 2013). Therefore, the historical and cultural circumstances, the preconditions and institutional arrangements, and the interaction among actors, mainly on the regional level, become the key focuses of literature on the emergence and evolution of marine sectors (Doloreux et al., 2016; Monteiro et al., 2013).

Scholars highlight different factors underlying the marine clusters, such as the presence of agglomeration effects (De Langen, 2002), the basis of existing manufacturing industries (Chang, 2011), regional policies (Doloreux and Shearmur, 2009), the inflow of external knowledge and technology (Elola et al., 2012), and many other local or global strategic factors (Stavroulakis and Papadimitriou, 2016). By focusing on different actors and institutions that are fundamental to the marine clusters, many studies on the empirical maritime clusters share the common argument that enhancing the networking interaction is one of the key factors to the formation and competitiveness of a marine cluster.

Jenssen (2003) examined how to develop and maintain the competitiveness of the Norwegian marine industry, which highlights that the importance for shipping firms to improve internal capabilities and build stronger interplay with organisations within and outside the maritime cluster. In the same national context, Benito et al. (2003) attributed the historically strong and dynamic industrial maritime cluster in Norway to the strong interdependencies between various actors. While this sector is still in good health when compared with other parts of the national economy, the competitiveness of the maritime industry has gradually eroded because of the weakened innovation and the cleavage between the various interlinked maritime sectors. Similarly, by examining the collaborative innovation practices of the marine cluster in the Portuguese Algarve region, the study of Monteiro et al. (2013) stresses the importance to stimulate and consolidate networks and raise awareness of operators for capital gains by sharing resources and services.

Beyond the European context, Shinohara (2010) investigates the cluster management in the Japanese maritime cluster. This study shows that the healthy and sustainable marine clusters in Japan have been dependent upon the reasons from three perspectives. The initial formation of the cluster cannot leave with the strong government supports for incubating each industry. Secondly, business networking, particularly long-term ones, and support from financial institutions, is critical. Moreover, human resource management based on the long-term and co-working spirit is essential. However, this study is highly contextualised in the Japanese well-functioned institutional and cultural systems that have been established over centuries, which restricts its applicability to other nations or regions.

Besides focusing on actors, their interactions, and the institutional arrangement, many scholars have also been interested in the formation and dynamism of the maritime clusters. For example, Elola et al. (2012) identified a series of specific factors driving the clusters' life cycle from local and global perspectives. By employing a dynamic lens, Karlsen (2005) investigates the dividing trajectories of the marine industries in the two regions, which goes beyond the voluntarism and determinism but underlies the importance of "path dependency". Moreover, the study of Fløysand et al. (2012) explores the process from how a cluster is triggered to how established clusters affect their constituent actors, institutions, and processes. Through empirical analysis, they identified two kinds of maritime clustering[1] - one is bottom-up from the material practices of firms into a prototype for cluster policy making, and the other is featured by a top-down process from the ideas and policies to the materialised cluster practice. The established clusters, as the relational complexes of actors, representations and tasks, continuously induce feedback loops and changes in networks, performance, and representations that maintain and construct them.

3.4.3 Marine cluster: benefits and policy practices

The above studies based on empirical cases highlight the marine clustering practices in different regions of the world. By emphasising on different factors, institutions, and mechanisms that are important to the formation and healthy development of marine clusters, they hold a promise that marine clustering activities can bring benefits to the actors and the region. What are the benefits of clustering marine industrial and innovation activities? What kinds of policy tools have been adopted and how about their effectiveness?

[1] This is also termed as the "spontaneous" or "constructed" dichotomy (Pinto et al., 2015).

Clustering benefits

The primary kind of benefits of marine clusters characterised centres on the agglomeration economies (e.g., De Langen, 2002; Wijnolst et al., 2003; Stavroulakis and Papadimitriou, 2016; Shinohara, 2010; Othman et al., 2011; Pinto et al., 2015). The spatial concentration of firms within an industry enables them to benefit from the externalities by exploiting the specialised labour pool, the supplier and customer base, knowledge spillovers, and lower transaction costs. In addition to the presence of agglomeration, the performance of a cluster can be further added by the existence of structural factors such as the internal communitarian competition, the entry and exit barriers, the heterogeneity of cluster population, and the social closeness inherited in the regional history and facilitated by the proximity (De Langen, 2002; Doloreux and Shearmur, 2009). These marine clustering effects enhance the competitiveness of the regional economy.

Furthermore, being in the marine clusters, the marine firms can benefit from cultivating special competitive advantages (Doloreux et al., 2016). The cluster of inter-related marine activities ensures firm to obtain access to communicate and collaborate with R&D institutes and stakeholder groups, which leads to the opening of new markets and integrated core competencies through relational skills that are hard to imitate (Wijnolst et al., 2003; Chang, 2011). Moreover, evidence has demonstrated that marine firms situated in clusters usually experience stronger growth and innovation. This is mainly because that regions with marine clustering activities can attract more start-ups, and subsidiaries, entrepreneurs than the other regions without a cluster, which makes cluster be regarded as a prerequisite for regional prosperity and a policy tool for economic development (Elola et al., 2012; Doloreux et al., 2016).

Policy practices

The development of marine clusters itself is strongly dependent upon policy (Stavroulakis and Papadimitriou, 2016). A number of studies on marine clusters have examined the policy practices in various empirical contexts and generated important implications. For example, Salvador et al. (2016) analysed the Portuguese maritime cluster seeking to identify the best strategy and policy mix for its future development. The results indicate neither strong inter-sectoral connections nor clear consensus on the best strategy for stakeholders to follow in order to facilitate the national cluster, which suggests future cluster policy to prioritise the development of strategic sectors and facilitate the development of main production factors such as good infrastructures, human capital, and R&D. Pinto and Cruz (2012) examined the tourism-centred maritime cluster in Portugal and the policy initiatives behind the cluster formalisation. In this case, the national-level clustering programmes and strategic plans offer guidance for marine industrial development, following which the regional political actions such as the industrial directions, the establishment of the local supporting platform that enables the training, trade, technical services, and networking activities have played important roles in the cluster development. Their study also implies the potential for cluster policy to depart from the local-based connections as networks may not be territorialised.

Notwithstanding the increasingly integrated marine development strategy and cross-cluster cooperation (e.g., the EU Integrated Maritime Policy Plan) in the EU, Europe is treated as a large "continental maritime cluster" (Wignolst et al., 2003; Salvador et al., 2016). As Wijnolst (2006) finds, though there are many dynamic clusters in the EU, they tend to be smaller and more fragmented than in the US. Cluster is regarded as an important policy tool to solve the fragmentation, while building contacts across complementary regional clusters within the EU is an important factor for the successful development of regional marine clusters. Ortega et al. (2013) explore the marine sectors in Spain and Portugal and how policies have influenced the clustering development. Though each country or region has particular marine strategies, it is advocated that policies should be aligned with the European guidelines to develop clusters and foster regional economy based on the sea.

Despite that clusters have penetrated policy thinking by treating cluster-building is as a major component of regional development strategies, many clusters do not attain the expectations and sometimes the "cluster" label is affixed only because of its popularity (Doloreux and Shearmur, 2009; Doloreux et al., 2016). For example, through investigating the Quebec's coastal maritime industry, Doloreux and Melançon (2008) find no clear evidence showing that firms within the clusters have benefited from the concentration and proximity to other firms and R&D organisations, which calls on the policymakers to move beyond the providers of knowledge infrastructures but become the "social animators" of the marine innovation system to stimulate networks, knowledge flows and social capital.

In peripheral regions, applying the cluster strategy is more problematic. The case of Tromsø shows the difficulty to construct an industry in peripheral regions. Favourable developments do not derive from the policy tools alone or the limited examples of best practices but rely on the “synthetic knowledge” (Karlsen et al., 2011). For regions far from large urban areas or without pre-existing conditions upon which functional clusters can develop, exogenous strategies such as linking the regional firms to knowledge sources and business partners outside the region, aligned with the regional institutional building are particularly important (Doloreux et al., 2009). However, this further raises concern on whether the cluster-oriented strategy is the best approach to support innovation and regional competitiveness when a region’s marine industry does not comply with the basic characteristics of industrial clusters, which calls on a shift of focus to a more nuanced policy approach beyond the cluster concept.

3.4.4 Summary

This section reviews the definitions of the marine industry and marine economy made by policymakers in different empirical contexts and scholars with different theoretical focuses. More related to the regional focus of this research, the analytical attention has been paid to the marine clusters, which is a regionalised concept highlighting the geographical concentration and networks. Empirical marine clusters in different regions put emphasis on the roles of different actors and institutions. Common to most of them, the interaction between actors within or beyond the regional scope is fundamental to the development of the cluster.

Besides, this section elaborates on the pursuit of marine clusters out of the assumed benefits for the firms and the regional competitiveness generated from the clustering of marine economic and innovative activities. This reinforces the prevalence of using clustering policies to support the regional development by policymakers as evidenced by the cases presented in this section. However, there is no “one-size-fits-all” policy recipe for various regional contexts. It is important for policymakers to be cautious of the common pitfalls like the over-reliance on the best practice and insufficient understanding of the regional contexts and characteristics.

3.5 Chapter Summary

This chapter reviews several representative streams of literature and theories are introduced and elaborated in this chapter, including the regional innovation systems (Section 3.1), the varieties of capitalism (Section 3.2), the relational networks (Section 3.3), and the regional innovation of marine industry (Section 3.4). By evaluating their validities, explanatory effectiveness, as well as the gaps and problems, this chapter justifies the importance to explore the research question of this thesis and builds theoretical foundations to compare regions and understand the causalities of the regional disparities in marine innovation. However, it is worth noting that, in many cases, these frameworks have been used analytically the empirical analysis or for normative aims to generate policy implications. The boundaries between the different perspectives have been blurred in literature. Therefore, the above literature review has not made a clear delineation of these differences.

Specifically, as Section 3.1 demonstrates, the RIS as the key analytical framework of regional innovation explains the regional innovation differences by stressing the contextual and institutional environments, the interactive relationships between actors, and the localised process of organising innovation activities. However, the focus on the internal mechanisms and localised learning in structuring the regional innovation risks treating a region as a closed system. Furthermore, the top-down dominated RIS studies render most empirical RIS analysis to attribute the different regional patterns of innovation to institutions, which leads to (i) an analytical deficiency of the bottom-up approaches, and (ii) the micro-level heterogeneity can hardly be coped with unless continuing to divide an innovation system into sub-systems[1]. Similarly, the VoC theory (section 3.2) assumes the institutional causality to explain the different specialisation and competitive advantages but lays more emphasis on the comparative analysis of the varying institutional structures or configurations and their complementarities and adopts a nationalist view.

The institutional explanation of these two streams of literature sheds light on this research in comparing regions and understanding the regional differences in

[1] Lundvall and Rikap (2022) recently introduced the concept of “corporate IS” in characterising two Chinese tech giants: Alibaba and Tencent.

innovation patterns and performance. Although the logic of explanation can be widely applied, as illustrated by many empirical cases discussed in sections 3.1.4 and 3.2.4, the theoretical frameworks developed out of the experiences of the Western economies face difficulties to incorporate the complexity of the transitional China with various sub-national models receiving the multiplex influences from the state and the political structure, the market mechanism, and the increasing globalisation resulting from the historical evolution. Similar issues exist in the marine cluster literature (section 3.4) which explores the formation, benefits, and policy implications of clustering marine activities but with little empirical evidence from China.

More significantly, the RIS and VoC frameworks adopt the firm-centric view and admit that (i) regional innovation is resulting from the collective and interactive act of a group of actors, (ii) individual firm strategies are important to regional innovation, and (iii) firms' activities are reduced to the coordination problems. However, they hold an assumption of homogeneous firms in their regional (or national) analysis. Alternatively, highlighting the important roles of the firms in regional innovation and their embeddedness in networks, the approach of the relational networks is adopted to characterise the firm-level diversity, which attributes the different innovative and business performance of enterprises to their differences in networks constituted by the key relationships with other organisations. By summarising the relational patterns, the regionally dominant networking patterns serve as the mediators - i.e., on the one hand, they tolerate the firm-level diversity, and are influenced and structured by the institutions on the other, which reconciles the conflicts between institutional-driven and firm-oriented approaches.

All in all, based on the evaluation of these frameworks and the ongoing debates in each stream of theory in combination with the theoretical implications from the regional marine innovation drew upon the empirical evidence of a number of marine clusters, an explanation incorporating the institutional and the firm-level relational networking lens to conceptualise the causes of regional disparities of marine innovation will be formulated.

Chapter 4. Research Methodology and Design

This chapter focuses on the research methodology and justifies the research design employed in this study. According to Creswell (2018), it is crucial for the researcher to contemplate three major issues in planning the study: philosophical assumptions, research designs, and specific methods and strategies that realise the research approach in practice. This chapter constructs the conceptual framework (Section 4.1), articulates the sub-research questions of the central research questions (Section 4.2), and discusses the philosophical stances of this research (Section 4.3). Section 4.4 introduces and justifies the multiple-case study method employed by this research, which is followed by the discussion on the research operationalisation (Section 4.5) and the evaluation of the quality of this research from the aspects of validity and limitations. Finally, section 4.7 summarises this chapter.

4.1 The conceptual framework

Given the lack of a ready-to-use conceptual framework which unifies the institutional approach and the micro-approaches of firms in exploring and explaining the regional innovation, this section proposes a tentative one built upon the key perspectives reviewed in the preceding chapters. A conceptual framework

> *"… explains either graphically, or in narrative form, the main things to be studied - the key factors, concepts or variables - and the presumed relationship among them" (Miles and Huberman, 1994, p.18).*

Reflecting on China's regional differences in marine innovation (Section 2.3) and the literature review (Chapter 3), this study considers that the regional disparities in marine innovation performance can be explained by the differences in the regional firms' behaviours, specifically the internal innovation commitment and the relational networks.

The relational networking literature in Section 3.3 helps to frame the key constructs to observe and understand firms' relational behaviours. The dominant regional patterns can be structured by regional institutions, while the institutional impacts upon individual firms are dependent upon how firms react upon. The RIS in Section 3.1 and the VoC in Section 3.2 stresses the importance of institutions interpreting the regional innovation and the mechanisms governing the regional innovation, which builds the analytical basis to understand the regional innovation. Moreover, China's empirical context (Chapter 2), literature about China's regional differences (Section 3.1.4 and Section 3.2.4), and the marine cluster literature (Section 3.4) help construct the conceptual framework for analysing regional innovation in the specific national and sectoral context. Figure 4.1 illustrates the conceptual framework.

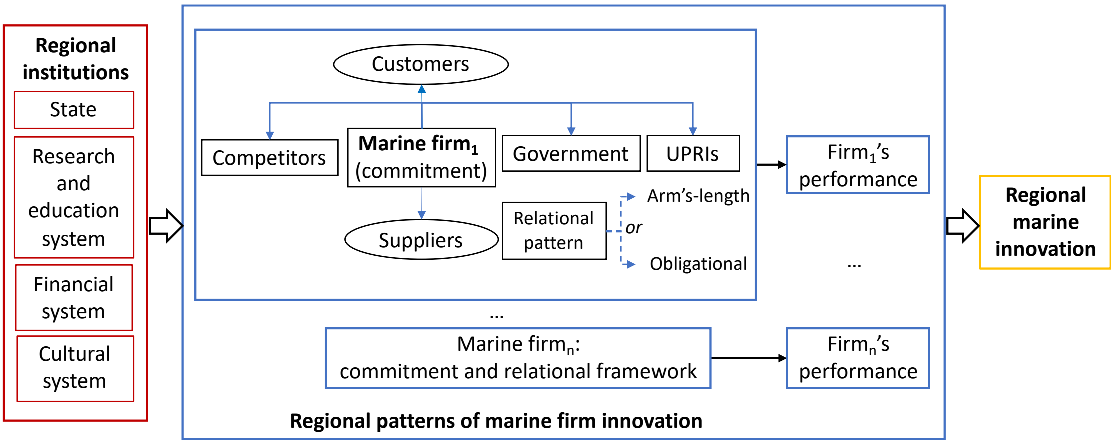

Figure 4.1. The conceptual framework.

Specifically, marine firms' *commitment to innovation* and the *relational networks* with vertical and horizontal actors (i.e., customers, suppliers, competitors, UPRIs, and government) within or beyond the region can influence marine firms' innovation outcomes. By the bottom-up approach, the idiosyncrasy of individual firms is characterised without adopting the homogeneous "representative firm". However, the primary aim of this research is not to explore the firm-level disparities because each kind of combination of different factors can be ideal to a specific firm while not to the others.

Built upon the analysis of various kinds of firms in a region, the *regional dominant patterns* of firm behaviours can be obtained. *Regional institutions* (i.e., the regional state, the research and education system - hereafter, the R&E system, and financial system, and the cultural system)[1] are assumed to generate impacts on regional

[1] The four institutions are chosen as the often-used institutional elements (Whitley, 2007; Hall and Soskice, 2001). Section 2.2 And Section 3.2.4 highlight the important roles of Chinese *state*. Section

innovation by structuring the regional dominant patterns of firms. By articulating the causalities, the disparities in regional innovation can be explained by the dominant firm behaviours contextualised in specific institutional environments.

4.2 Articulating the research questions

This study aims to answer the central research question, i.e., ***How can the regional differences of marine innovation be explained in the context of China?*** Exemplified by the regional cases of Qingdao and Ningbo and underpinned by the conceptual framework, this research question is restructured and articulated into a hierarchy of sub-questions to be answered, listed as follows:

Sub-question 1: What are the Chinese contexts of regional marine innovation? (Addressed in Chapter 2).

Sub-question 2: How have marine firms in different Chinese coastal regions built relational networks in innovation? (Addressed in Chapters 5 and 6).

Sub-question 3: How are the regional institutions for marine innovation in Chinese regions? (Addressed in Sections 5.1 and 6.1).

Sub-question 4: How have marine firms and regional institutions shape the marine innovation development in different regions in China? (Addressed in Chapter 7).

4.3 Philosophical stances

The research philosophy refers to the beliefs and assumptions about knowledge development, which underpins the methodological choices, research strategy and analysis, and interpretations of the data (Saunders et al., 2016). It describes the

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3.2.4 and Section 3.3 characterise the *social and cultural factors* underlying the construction of networks. *Financial Systems* and *Research and Education Systems* determine how capital and skilled labour is approached by marine firms (mentioned in Section 3.2), which are critical to resources to innovation and sometimes important aspects to innovation relationships.

ontological assumptions (i.e., the nature of reality), epistemological assumptions (i.e., the assumptions about the knowledge and how knowledge is known), as well as axiological assumptions (i.e., the role of values), and shapes the methodology (i.e., the process of the research) (Creswell, 2013).

The main debate among research philosophies has been dominated by two polarised views - positivism[1] and interpretivism[2]. This research adopts a critical realist perspective as the underpinning research philosophy. *Critical realism* assumes that the existence of reality is independent of our knowledge, but what distinguishes it from positivism which assumes a *naïve realism* ontology is that critical realism believes that reality cannot be observed or identified directly (Guba and Lincoln, 1994). Critical realist assumes a *stratified* ontology which differentiates the *empirical*, the *actual*, and the *real* domains (Bhaskar, 1978). The "empirical" is only a tiny fraction of the "actual" events, which occur as a result of the inherent capacities of the mechanisms operating in the "real" domain (Easton, 2010).

Epistemologically, critical realists acknowledge that social phenomena are intrinsically meaningful, and the meaning has to be interpreted and understood (Sayer, 2000). Recognising that social research involves both unobservable mechanisms and observable social phenomena, critical realism entails an epistemological assumption about identifiable causation through exploring the causes and effects underlying regular events (Johnson and Duberley, 2000). In another world, the world is socially constructed but not entirely, so the primary mission of social scientists following this philosophy is not to construct but to "construe" the world, i.e., to explain the observable events by revealing the causal mechanisms as much as possible (Easton, 2010; Danermark et al., 2019).

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[1] Positivism refers to applying natural sciences to studying the social world, which believes that the social world exists externally (Bryman and Bell, 2011). The positivist approach usually builds upon the existing theory, which generates hypotheses to be verified or falsified by quantitative analysis of large data sets (Easterby-Smith et al., 2015).

[2] Interpretivism emphasises that the research focuses on social sciences - people and their institutions are different from physical phenomena, which demands social sciences research to develop differently from natural sciences (Bryman and Bell, 2011). The social constructionism belief of knowledge encourages the engagement and reflexivity of researchers and implies more qualitative-based approaches aiming at sense-making, understanding and generating new insights (Easterby-Smith et al., 2015).

Critical realism implies three methodological implications. Firstly, it implies the explanatory importance of contextualisation because social facts are agreed on by human beings rather than existing independently. Thus, the causal mechanisms are analysed in specific contexts and the researchers' backgrounds (Sayer, 1992; Maxwell, 2004). Critical realism relies on researchers to collect numerous data or view the same data from different theoretical perspectives to enhance the understanding of the real world (Easton, 2010). Secondly, causality exists only as the potential correlation, which cannot be simply reduced to the "*statistical generalisations of empirically observed invariance of constant conjunctions of events*" (Reed, 2005, p. 1630). Lastly, critical realism implies the retroduction by moving from the superficial phenomena to deep mechanisms that may have conditioned or caused them, which represents looking backwards to postulate what processes and mechanisms should involve (Sayer, 1992). Theories are important, acting as the conceptualising and interpretative frameworks, which describe the structures and mechanisms that causally generate the observable phenomena, thus assisting mapping and explaining the social facts (Danermark et al., 2019).

4.4 Research strategy - the multiple-case study

After clarifying the research philosophy, it is important to consider the *methodology,* which refers to the approaches to inquire into a specific situation (i.e., how research should be undertaken) and the research *methods* concerning the specific techniques and procedures used in data collection and analysis (Saunders et al., 2016).

4.4.1 Selection of research approach - the qualitative approach

Creswell (2018) differentiates three major approaches adopted in social sciences, including the quantitative, qualitative, and mixed-method approaches. The quantitative approach is the one in which the researchers mainly hold the positivist or post-positivist views for developing knowledge, principally employs experimental and survey research strategies, and collects data through structured techniques such as questionaries, structured interviews and observation (Saunders et al., 2016). This approach develops hypotheses, and the collected data is measured numerically and statistically to verify the theories (Creswell, 2018). The primary focuses of the quantitative approach are measurement, causality, generalisation, and replication

(Bryman and Bell, 2011).

The qualitative approach mainly follows the interpretivism and realism philosophy in doing research. Different from quantitative approaches with the aim of verification and generalisation, qualitative researchers are more inclined to focus on descriptive details because of the importance of the context (Bryman and Bell, 2011). At the same time, the qualitative approach is also well-suited to generate a causal explanation for answering "why" questions (Maxwell, 2004, 2013). Instead of focusing on the variance theory[1], qualitative researchers adopt process theory by directly investigating the causal processes (Maxwell, 2004). Qualitative approaches employ strategies such as grounded theory, case studies, and narratives and gather non-numeric forms of data to understand the meaning of the phenomenon and answer more open-ended questions (Bryman and Bell, 2011; Creswell, 2018).

Mixed-method approaches refer to strategies combining quantitative and qualitative approaches in the research. The rise of this approach is highly influenced by the pragmatism knowledge claims, which believe the choice of one or a mixture of philosophical positions is helpful to research (Tashakkori and Teddlie, 2010). Concurrent, sequential or integrated designs can be adopted in mixed-method research, and both numeric and text data can be collected and analysed (Creswell, 2018). However, as warned by Bryman and Bell (2011), the mixed method is not a panacea, and the adoption of this approach has to be justified and dovetailed to the research questions and purposes.

Based upon the comparison mentioned above of different research approaches, this study selects the qualitative research strategy because the research aims to understand China's marine innovation in regional settings. The focus on an in-depth contextual understanding implied by the qualitative approach is well suited to the purpose of this research. Furthermore, this research seeks to explore regional innovation and construct the dominant regional innovation patterns following a bottom-up approach by focusing on the behaviours of heterogeneous local marine firms under the same institutional environments. It implies a process-oriented

[1] *Variance analysis* is concerned about variables and correlations by adopting quantitative designs viewing explanation as a demonstration of the statistical relationship between different variables (Maxwell, 2013).

exploration that the qualitative strategy can facilitate. Integrating the two aims, this study intends to explain the causal mechanisms through which the regional disparities in marine innovation patterns are interpreted by institutions and firm-level factors. The qualitative strategy enables the explanatory purposes both philosophically - by embracing the critical realism philosophy with the retroduction inference from empirical phenomena to causal mechanisms, and technically - by offering methods for collecting, analysing and interpreting non-numeric data.

4.4.2 Selection of research method - the multiple-case study method

Based on the justification of choosing qualitative strategy as the primary approach to guide the research design, the *case study* method is selected among the strategies among the qualitative approach. *The case study* has been a widely used research strategy in social science research. As defined by Yin (2014), the case study is an "empirical inquiry" that investigates the contemporary phenomenon in the real-life context with blurred boundaries between them and mobilises multiple sources of evidence. This section justifies the case study method over other strategies and articulates how case study, particular multiple-case study fits this research.

Case study vs. other research methods

According to Robson (2002), there are three main purposes of research of a real-world project - exploration, description and explanation. The hierarchical view of research methods argues that the case study approach is only appropriate for exploratory research, surveys and histories are for description, and experiments are the sole approach for explanatory or causal inquires (Shavelson and Towne, 2002). However, Yin (2014) rejected the hierarchical view and proposed that every research strategy can be used for exploratory, descriptive and explanatory purposes.

As shown in Table 4.1, different methods are distinguished by three conditions, including (i) the form of research questions, (ii) the requirement of researchers' control of behavioural events and (iii) the focus on historical or contemporary events (ibid.). Case study is especially appropriate to answer "*how*" and "*why*" questions about a contemporary event requiring little or no control from a researcher and to develop new theories (Yin, 2014, Eisenhardt and Graebner, 2007).

Table 4.1. Conditions distinguishing research strategies in social science research

Types of research methods	Form of Research Questions	Requires Control of Behavioural Events?	Focuses on Contemporary Events?
Survey	Who, what, where, how many, how much?	No	Yes
Archival analysis	Who, what, where, how many, how much?	No	Yes/no
History	How, why?	No	No
Experiment	How, why?	Yes	Yes
Case study	How, why?	No	Yes

Source: author developed from Yin (2014).

Case study is well suited for this research for three reasons. This research aims to answer questions like what the differences of innovation patterns reflected by the performances are in the two regions and *why*, and to give a causal explanation by exploring *how* regional institutions take effects and *how* firms' commitment and relational behaviours in innovation influence the innovation outcomes. Besides, the case study is well suited for the contextual characteristics of this research, in which the firm cases are embedded in two regional contexts and much broader national environments. The case study allows for analysing the contextual conditions related to the case (Yin, 2014). Moreover, the case study method is suitable for exploring the social phenomenon and generating extensive and in-depth insights into it. This fits the purpose of this research to conduct an in-depth investigation into regional innovation from the behaviours of individual firms.

Single- vs. multiple-case study designs

According to Yin (2014), there are two types of case study designs: single-case and multiple-case designs. This study adopts the multiple-case study design. As shown in Table 4.2, the single-case study often suffers critiques for its vulnerability and faces challenges in presenting rich data and information regarding the case (Eisenhardt and Graebner, 2007). However, the multiple-case study involving more cases can yield more robust, generalisable and testable results than the single-case design (ibid.). According to Yin (2014), the key rationale of multiple-case design is the *replication* logic, either in the form of *literal* replication predicting similar results or *theoretical* replication predicating contrast results according to the initial propositions. It is similar to the repeated experiments in natural science, which serve as replications, contrasts, and extensions to theory development (Eisenhardt and Graebner, 2007).

Table 4.2. Single-case design vs. multiple-case design: rationales, advantages and disadvantages

	Single-case Design	Multiple-case Design
Rationales	• A *critical* case • An *extreme* case or *unusual* case • A *common* case • A *revelatory* case • A *longitudinal* case	The *replication* logic • Each case predicts similar results (a *literal* replication) • Each case predicts contrasting results but for anticipatable reasons (a *theoretical* replication)
Advantages	Yield invaluable and rich insights into a phenomenon, More coherently fits the theory	More compelling, robust, generalisable and testable insights
Disadvantages	Vulnerable because "all eggs in one basket", Fears about the uniqueness or artifactual conditions surrounding the case	Require extensive resources and time

Source: author developed from Yin (2014), Eisenhardt and Graebner (2007).

This research adopts an *embedded* multiple-case design, where each region represents a case, and multiple firms within each region are the units of analysis[1]. Firms are the primary sources of empirical information and units of data collection and analysis. Through embedded case design, regional patterns are obtained from the multiple sample firms by exploring how the relational networking behaviours influence their innovation. The use of multiple-case designs enhances the robustness and generalisability[2] of this research. More essentially, the multiple-case design is well suited to answer the research questions and serves the attempts to make an explanation of the regional patterns of marine innovation following the conceptual

[1] According to Yin (2014), within either single-case or multiple-case design, there are two variants of design depending on the unit of analysis. *Holistic* design represents that there is a unitary unit of analysis, while *embedded* design involves multiple units of analysis. According to the criteria, this study adopts embedded multiple-case study.

[2] The justification of generalisability of this research is presented in section 4.6.

framework of this study.

According to Eisenhardt and Graebner (2007), sound empirical research starts from reviewing relevant literature to identify the research gaps and formulate research questions to address the gaps. The conceptual framework elaborated in Section 4.1 guides the empirical analysis and acts as the theoretical foundation to be compared with the emerging theories from the case evidence and empirical analysis. Adopting the multiple-case design as Figure 4.2 shows, we select regions as the cases and individual firms as the units and primary sources of empirical data with pre-defined criteria. Data was collected using various operationalised techniques, which will be illustrated in Section 4.5. In Section 4.6, limitations and the quality of this research are evaluated following widely applied criteria.

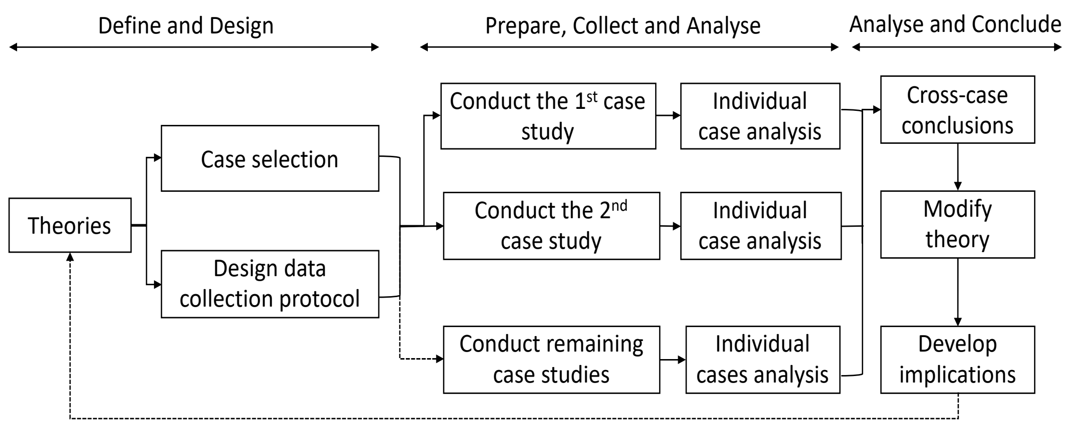

Figure 4.2. The design of multiple-case study

Source: author developed from Yin (2014).

4.5 Research operationalisation

4.5.1 Case selection - criteria and justification

The selection of cases is an essential part of the research process that determines the quality of the case study design (Eisenhardt and Graebner, 2007). In line with the research objective, the unit of analysis of this study is the marine firm cases in regions of China. Due to the vastness of the subject, this study decided to select a limited number of regions and firm cases to examine. This section will articulate the selection criteria of individual firm cases and the focused research regions and specify the key term for the marine industry.

The selection of cases - the regions

In order to fulfil the research purpose of comparing regional marine innovation in China, two regions - Qingdao and Ningbo were selected as the cases of this research. In mainland China, there are different coastal regions, and their development is uneven. The selection of the regions is hard to fits into the criteria of “representative” or “maximum variation” (Seawright and Gerring, 2008; Miles et al., 2014). Rather the selected two regions are among the most developed areas (i.e., the eastern coastal area) in China, and they are quite “homogeneous” (Miles et al., 2014; Saunders et al., 2016) and share similar identifiable characteristics in the economic, demographic and political aspects as summarised in Table 4.3, which demonstrate that the two cases are superficially similar. The homogeneous strategy characterises the importance of contextualisation in the qualitative study and aligns the aim of this research to compare and explain regional innovation patterns by deeply looking into the regional institutional details and the firm-level factors.

Table 4.3. Similarities between the research areas - Qingdao and Ningbo

<table>
<tr><th></th><th>Qingdao</th><th>Ningbo</th></tr>
<tr><td>Administrative positions</td><td colspan="2">• Municipality with Independent Planning Status under the National Social and Economic Development (jihua danlie shi in Chinese) [1],
• Vice-provincial city.</td></tr>
<tr><td>Opening-up</td><td>• Opened up since 1898,
• Coastal Open City since 1984.</td><td>• Opened up since 1844,
• Coastal Open City since 1984.</td></tr>
<tr><td>Industrial development trajectories</td><td>• Traditionally was strong in light industries,
• Gradually shifted to heavy sectors.</td><td>• Traditionally was strong in light industries,
• Gradually shifted to heavy sectors.</td></tr>
<tr><td>Regional economic</td><td>• 1200.15 billion yuan (the 12th in China)</td><td>• 1074.5 billion yuan (the 15th in China)</td></tr>
</table>

[1] This kind of cities enjoy the provincial-level economic authority. Public finance of these cities is directly linked with the central government, and their fiscal revenues are turned over to the central government. They are also labelled as “Municipalities Directly under the Central Government”. However, they are not definitely decoupled from the provincial government, and part of their fiscal revenues are handed into the local government. Part of the fiscal revenues still needs to submit to the provincial government in practice.

development (GDP in 2018)		
Population (by the end of 2018)	• 9.395 million	• 8.202 million
Provincial importance in marine economy (% of provincial GOP in 2018)	• 21.46% of the provincial GOP (the provincial highest)	• 20.35% of the provincial GOP (the provincial highest)
National-level projects in marine development	• National Pilot Area of Marine Economy Development (Shandong province and Zhejiang province), • National-level Demonstration Area for Innovation Development of Marine Economy, • National-level Demonstration City for the Innovative Development of Marine Economy during the Period of the 13th Five-year Plan, • National-level Demonstration Area for Marine Economy Development during the Period of the 13th Five-year Plan.	

Source: author summarised and calculated based on data from Qingdao Statistics Bureau (2019), Ningbo Statistics Bureau (2019a, 2019b), and MNR (2021).

Despite the two cities' homogeneity in the socio-economic environments and their important roles as the pilot regions for China's regional experimentation of marine economic and innovation development, there exist large differences in the marine economic development and marine innovation between the Qingdao and Ningbo and their situated provinces - Shandong and Zhejiang as suggested by Section 2.4.2. In 2011, the GOP and GOP per capita in Qingdao and Ningbo have no large differences. However, after one decade, the gap between the two cities in the size of the marine economy was largely widened. Looking at the time series data as demonstrated in Figure 4.3, Qingdao showed the greater momentum and doubled the annual growth rate of Ningbo.

Besides, though the GOP in both regions accounted for more than 20% of the provincial marine economy, their proportions to the regional GDP in the two cities show differences. As Figure 4.4 compares, in 2011, marine economy contributed to 15.8% and 16.8% to the regional economy in Ningbo and Qingdao respectively. However, in 2018, the marine GDP in Ningbo only accounted for 14.2% to the regional

GDP. And it further reduced to 13.5% in 2019. Behind the fascinating economy growth in Ningbo in the 2010s, the marine sector played limited driving role. However, in contrast to the circumstance in Ningbo, the marine sector is increasingly has gradually become the pillar of Qingdao's regional economy. In 2014, the contribution to the regional GDP was over 20% for the first time. In 2016, the number increased to more than one quarter.

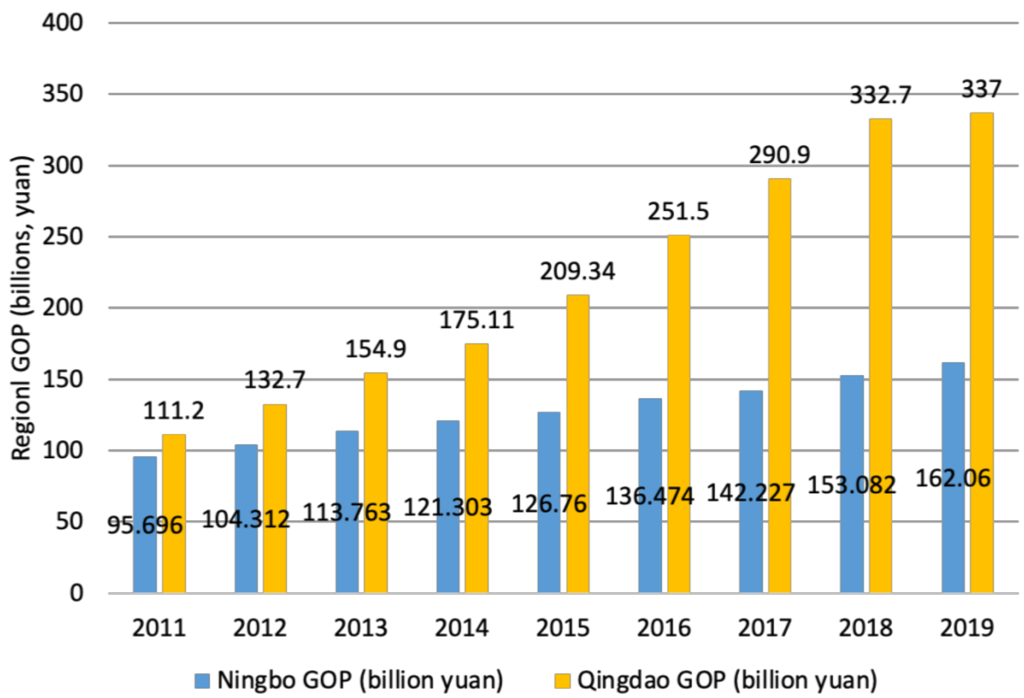

Figure 4.3. Marine economic growth in Qingdao and Ningbo from 2011 to 2019

Sources: Qingdao Statistical Bureau (2014 - 2020), Ningbo Statistical Bureau and Ningbo Oceanic and Fishery Bureau (2014 - 2017), Economic Daily (2018), Ningbo Development Research Centre (2021), Sohu.com (2020), Pengpai News (2022).

Moreover, innovation indicators like the S&T input-output efficiency and number of marine patent applications (see Table 2.3 and Figure 2.14 in Section 2.3.2), Qingdao was at the national leading positions across all kinds of marine cities or coastal cities in China. Nevertheless, the performance of Ningbo far lagged behind. Despite the insufficiency of marine data, especially on the city level, partly due to the late start of Chinese marine development, the above contents illustrate that there are hints that two selected regional cases have been differed in their marine economic development and marine innovation. The two regional cases - Qingdao and Ningbo, with similarities in the general backgrounds but different performances and trajectories in the sectoral innovative development of the marine industry provides empirical context for answering the research question by seeking explanations from the regional institutions and firm networking behaviours.

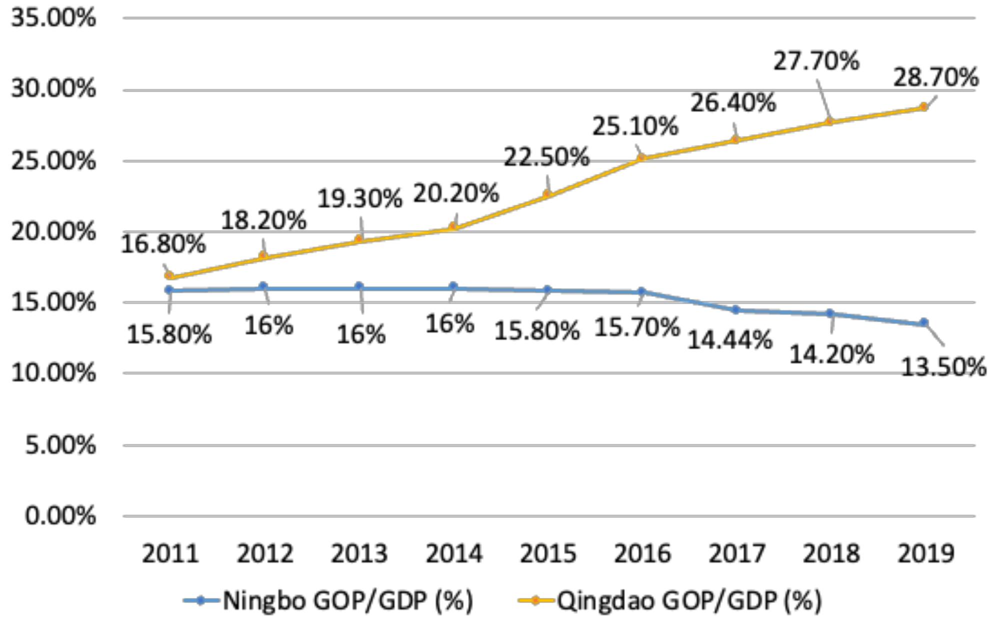

Figure 4.4. The proportion of marine economy to the regional economy in Qingdao and Ningbo from 2011 to 2019

Sources: same as Figure 4.3's sources.

The industrial focus

This study focuses on the marine sector - a compound sector involving several sub-sectors. Due to the vastness of the industry, this study decided to focus on firms in a limited number of sub-sectors. Sectoral issues are characterised because different sectors have different defining features such as their innovation patterns (e.g., radical versus incremental, or research-based versus engineering-based), technological intensities and maturity, which may have underlying impacts on firms' relational interaction with different partners. This further implies the importance to evaluate firms' networking patterns by focusing on the key constructs defining relationships.

The "purposive sampling" technique is adopted to answer the research questions of this study (Saunders et al., 2011). Specifically, two criteria were considered in selecting the sub-sectors, including (i) the importance of the industry in China so that the innovation is more prioritised, and (ii) the accessibility to interviewees and second-hand data. This research selected two sub-sectors: the marine equipment industry and the marine biotech and pharmaceutical industry. They are both essential configurations of the marine sector that have been highlighted by many national and regional marine policies and strategies[1].

According to Galindo-Rueda and Verger (2016), the two marine sub-sectors are "typical samples" belonging to the high-tech industries and medium-tech industries (including medium-high), respectively. Specifically, the marine biotech and pharmaceutical sector is science-intensive, usually underpinned by a scientific knowledge base (Castellacci, 2008; Garavaglia et al., 2012). Innovation is dependent upon internal capability and external collaboration, especially the UPRIs (Powell et al., 1996). Though the innovation of this industry is often labelled as "radical" with disruptive changes to the industry (e.g., Hall and Soskice, 2001), it also involves the incremental "inventing-around" activities based on the existing molecules and price competition. For the marine equipment industry, innovation in this sector is usually labelled as "incremental" where the technical changes depend more on the continuous improvement and refinement of product design and specificities (Breschi and Malerba, 1997; Malerba, 2002). Firms are usually production- and scale-intensive. A large number of innovators exist in the industry, which makes it difficult to sustain long-lasting competitive advantages and achieve appropriability (Castellacci, 2008; Breschi and Malerba; 1997; Malerba, 2002).

The selection of embedded units of analysis - marine firms

After the sub-sectors were decided, sample firms were selected according to (i) whether the firm is qualified as a marine company (i.e., marine business and innovation were key to the enterprise); (ii) whether the firm is locally based (i.e., the firm is located in the focused region independently, rather than as the branch); and (iii) the recommendations of the local expertise and interviewees. The selection of sample firms used "heterogeneous purposive sampling" by choosing firms across a broad spectrum to reflect firm innovation from different angles and achieve a greater understanding. This type of sampling is effective when the random sample is difficult to achieve (Etikan et al., 2016). In addition, some cases and interviewees were "snowballed" from earlier interviewees. "Snowball sampling" is an effective technique

[1] See the definitions in section 2.1.2. Adjustments are made by considering the often use of the definitions in policies, statistical census and media coverage which involve the blurred boundaries.

to identify and get access to samples (Saunders et al., 2016). It was argued that the main disadvantages are that this technique is non-random and has the potential for homogeneous samples (Lee, 2000). The shortcomings were overcome in this research by combining the researcher's judgement. Only qualified cases meeting the criteria were included in the sample sets.

In total, 20 firms in Qingdao and 13 firms in Ningbo were approached. Firms' sizes, ages, ownership structures and technical divisions vary. The summary and description of each firm is presented in Appendix E. The number of SMEs accounts for around three quarters of the sample. There is no single agreed definition of a SME. Since this research is going to explore marine firms in the Chinese, it follows the definition given by Chinese government, which employs two criteria: (i) the number of employee and (ii) the amount of turnover[1]. Ideally, firm cases should cover different kinds of ownership. However, the under-developed SOEs in Ningbo enhance the difficulty of accessing SOEs in the two focused sectors. This was compensated by selecting "previously SOEs (P-SOEs)" cases. Even though the sample size of Ningbo is smaller than Qingdao due to pragmatically limited access to a larger range of companies, the selected ones are justified to be heterogeneous with multiple backgrounds.

4.5.2 Data collection

Even though the cases of this research are the two regions, firms are the main focal points of the empirical analysis as well as the primary sources of data. This section illustrates the data collection methods employed in this research, the operationalisation of data collection, and the data summary.

Data collection methods - documentation and semi-structured interviews

According to Yin (2014), multiple sources of evidence (i.e., data triangulation)

[1] According to the National Bureau of Statistics of China (2017), to be classified to a size category, each enterprise has to meet the lower limits of both criteria. For large-sized enterprises (over 1000 employees), the turnover should exceed 400 million RMB. For medium-sized enterprises (300-1000 employees), the turnover should between 20 million to 400 million RMB. For small enterprises (20-299 employees), the turnover should between 3 million to 20 million RMB. And for micro firms (less than 20 employees), the turnover should not exceed 3 million RMB. Compared with the Chinese definition, SME's definition from OECD stresses more on fewer employees with a greater amount of turnover.

providing different measures of the same phenomenon are essential to intensify the validity of the case study. Case studies can accommodate data from various sources, such as interviews, observations, and archival records (Eisenhardt and Graebner, 2007). This research adopted *documentation* and *interviews* to collect secondary and primary data. The contents, strengths, and weaknesses of the two approaches are summarised in Appendix D.

Secondary data collection: documentation

For secondary data, the main sources are different kinds of documentation. Yin (2014) argued that documentation was an important source, while the researchers should be careful in using it by corroborating and augmenting the evidence from more than one source. Because this research focuses on marine innovation, data about marine industrial development and innovation in China were collected, with the major focus being on the researched regions and sub-sectors. Though the data origins were generally scarce, they were essential sources to acquire basic knowledge about marine innovation and information about the context and trends of marine industrial development. The key data sources include the reports of "National Marine Innovation Index of China", "Ocean Yearbooks", and "Ocean Statistical Yearbooks".

Besides, to deeply understand regional marine innovation and institutions, regional policies, documents, news and media coverage about the two regions were collected. Because the rise and development marine industry was highly politically driven, policy documents targeting the marine industry were collected. It includes national policies (e.g., "Five-year Plan of Marine Economic Development") and, more essentially, regional policies related to marine industry development and innovation, considering the regional focus of this research. The time frame is from 2012[1] to 2019. Data about the regional economic performance and marine industrial and innovation development sourcing from reports published by the local governments and mass media coverage were also collected to enhance the understanding of the regional context.

[1] Though China's marine S&T development entered the deepening stage from 2006, most regional marine policies started to emerge since 2012 when "Building China a Marine Country" was proposed and levelled up as a national strategy at the 18th National Congress of CCP.

Furthermore, secondary data relevant to individual firms were collected from documents to supplement the interviews as primary data sources. The data sources include companies' annual reports, company websites, the National Patent Retrieving and Analysing System of China, news, media coverage and general web search. Data covers the companies' background, operational situations, business activities, news and so on, which enables the researcher to obtain background knowledge of companies and to cross-check the primary data collected from interviews.

Primary data collection: semi-structured interviews

For primary data collection, *semi-structured interviews* were employed as the main approaches. The interview is a *purposeful* or *guided* conversation that enables the researchers to gather valid evidence related to the research questions and objectives (Saunders et al., 2016; Yin, 2014). This study uses semi-structured interviews among the various sub-types of interviews. In semi-structured interviews, the interviewer employs a list of themes and key questions, but the use is subject to change from interview to interview according to the specific contexts (Saunders et al., 2016). It is well-suited to this research with the explanatory aim to review the relationships between relational patterns and innovation results and is also helpful for the exploratory purpose by covering contextual information about the firms and the regions (ibid.).

This study involves interviewees from different sources. Interviews with managers from marine firms were the main focus of this research, providing information about innovation, relational interaction with partners, and the sensation of the regional environments for marine industrial development and innovation. The selected interviewees were mainly on the senior level and were familiar with the business, key technologies, and innovations of the sample firms. Interviews with participants or stakeholders of regional marine development were also covered to enable the exploration of the regional context and the institutional impacts on regional marine innovation. These informants include government officials, financiers, researchers or university representatives, and leaders in industrial associations. Some of the interviewees were mainly snowballed from other interviews.

Table 4.4 demonstrates the themes guiding the semi-structured interviews with company managers and informants. Key constructs were identified from the literature review and conceptual framework in Section 4.1. The detailed questions of the semi-structured interviews can be found in Appendix F[1], which was not directly used in the semi-structured interviews but was adopted as a detailed guideline to check and ensure the full coverage of information and guide the data analysis and the transcription.

Table 4.4. Semi-structured interviews with marine firm interviewees and informants

Interview guide with interviewees from marine firms	• The background of the company (e.g., age, size, main business and key technologies)
	• The innovation status of the company in detail (e.g., innovation input and innovation achievements)
	• The relational interaction with external partners in innovation (e.g., what kinds of partners, length of collaboration, mutual trust, impacts on innovation)
	• Understanding of the regional institutional environments for marine innovation (e.g., the local states, R&E systems, and financial systems)
Interview guide with informants	• The main responsibilities of the represented organisations in the regional marine development and innovation
	• Understanding of the regional institutional environments for marine innovation (e.g., the local states, R&E systems, and financial systems)
	• Understanding of the current status and future of regional marine innovation

Source: author.

Interview implementation and data summary

Before the interviews were conducted, a few pilot interviews were conducted with senior managers from companies, as shown in Table 4.5. The fundamental rationale behind the pilot research was to test the interview structures and questions concerning clarity and appropriateness (e.g., the sensibility of topics) through interacting with interviewees and collecting feedback. Pragmatically, it allows the

[1] Also see the Participant Information Sheet in Appendix G

.

researcher to be familiar with the interview process and the communication discourse and to test the time control.

Table 4.5. Pilot studies

Interview Code	Industry	Job Role	Length of interview	Pilot firm
Interview PF1 (not included)	Biotech and Pharmaceutical	General manager	1 hour (Telephone)	Pilot1
Interview PF2 (not included)	Equipment	Product manager	1 hour (Telephone)	Pilot2
Interview PF3 (included, QMBP1)	Biotech and Pharmaceutical	Vice President	2 hours	QMBPF1

Source: author.

Besides the common objectives, the three interviews were conducted for specific reasons. The first interview was with a large non-marine pharmaceutical firm (not included in the study). The interview aimed to clarify the main terminology and concepts about the pharmaceutical industry in general and to understand the main business and operation of the pharmaceutical firm. The second interview was with a large marine equipment manufacturer from Ningbo (not included in the study[1]). The purpose was similar to the first pilot interview to obtain fundamental industrial knowledge. In addition, it enabled the researcher to understand the regional context from the viewpoint of the local practitioner. The third pilot interview was with a large marine biotech firm from Qingdao (included in the study). The aim of the interview was similar to the aforementioned ones (i.e., to gain both marine industrial and regional knowledge). From these pilot interviews, minor revisions were made to the interview design.

The primary data collection was carried out in two rounds of fieldwork. The first-round fieldwork was conducted from November to December 2019 in Qingdao. Influenced by the covid-19 travel restrictions, the second-round data collection about Ningbo lasted from July to December 2020, combined with telephone interviews conducted in July and on-site fieldwork between November and December 2020. A total of 43 semi-structured interviews have been conducted, including 33 interviews (including

[1] The reason for excluding this case from the study was mainly because of this company only acts as the local representative of the parent company.

one pilot interview) with corporate managers and 10 with related informants.

The interviews lasted one to two hours, and all conversations were recorded by tape-recording. The distribution of marine biotech and pharmaceutical firms (MBPFs) and marine equipment manufacturing firms (MEFs) in the two cities is demonstrated in Table 4.6. And the interviews with firms and informants (with interview codes) are summarised in Appendix H.

Table 4.6. Distribution of interviewed firms in regions and sub-sectors

	Qingdao (20)	**Ningbo (13)**
MBPFs (15)	QMBPF1 - QMBPF9	NMBPF1 - NMBPF6
MEFs (18)	QMEF1 - QMEF11	NMEF1 - NMEF7

Source: author.

4.5.3 Data analysis

Unlike quantitative data with “thin abstractions of numbers”, qualitative data, typically in the form of words, is featured by richness, fullness and ambiguity (Robson and McCartan, 2016). Facing qualitative data, the researchers meet two dilemmas - data overload and data retrieval (Miles and Huberman, 1994), which increases the difficulties of qualitative data analysis and determines the importance of coding.

Data coding

Coding is the essential starting point for most approaches to qualitative data analysis (ibid.). As discussed by Gibbs (2007, p. 38), “*coding is how you define what the data you are analysing is about … several passages are identified, and they are then linked with a name for that data - the code*”. Coding (or “first-level coding”) is then followed by the process of “pattern coding” (or “second-level coding”), which classifies the initial codes into a smaller number of sets, themes, or constructs (Miles and Huberman, 1994). The logic of coding and pattern coding guides the data coding process in general.

In this study, semi-structured interviews were recorded and transcribed and then coded by employing the technique of *template analysis*. Template analysis is defined as “*… a style of thematic analysis that balances a relatively high degree of structure in the process of analysing textual data with the flexibility to adopt it to the needs of a* *particular study*" (King, 2012, p. 426). Template analysis usually starts from identifying themes (i.e., *a priori themes*) in advance of the analysis used for initial coding. This enables researchers to sensitise the important theoretical concepts or perspectives that have informed the study (Brooks et al., 2015).

Based on the priori themes and preliminary codes, the initial template is developed and further refined and modified iteratively along the coding process, from which the final template is developed and used for presenting and interpreting the complete data set. As mentioned earlier in the design of data collection, the prior sets of themes were developed mainly based on the literature review in Chapter 3. After the iterative coding process, the final constructs used in the research were revised as *background*, *performance*, *internal commitment to innovation*, relational *patterns with external partners*, and *regional institutions*. Details of the final template, including themes, codes, and sub-codes, were summarised in Table 4.7.

Table 4.7. Final template for data analysis

Themes	First-tire codes	Second-tier codes
Background	• Business	• Firm size (sales revenue and the number of employees) • Firm age • Business fields • Background of the founder(s)
	• Technology and innovation	• Technical fields • Industrial (or technical) position • Perception of innovation
Innovation performance	• Innovation output in three years (i.e., 2017 to 2019)	• Number of new patents (or invention patents) • Number of new products
Business performance	• Business output in three years (i.e., 2017 to 2019)	• Sales revenue
Relational patterns with external partners	• With customers • With suppliers • With competitors • With universities • With governments	• Establishment of relationships • Length of forged relations • Communicating frequency • Interaction relevant to innovation • Intensity of innovation interaction • Trust
Internal	• R&D input[1] in three years	• R&D expenditure / sales (%)

[1] According to OECD (2015), the R&D activities measures the creative work undertaken on a systematic

commitment to innovation	(i.e., 2017 to 2019)	- Sources of R&D expenditure • R&D employees[1] / headcounts (%) • External sources of capital • The proportion of governmental funds
	• Corporate-level Innovation platforms[2]	• Types of innovation platforms • Levels of innovation platforms
Regional institutions	• State institutions	• Central/provincial-local state relations • Industrial and innovation policies • Bureaucratical structure
	• R&E system	• Structure of R&E system • Strengths of the regional UPRIs in marine fields
	• Financial system	• Bank-based or credit-based • Marine financial products or services • Other financial channels

basis for the aim of enlarging the stock of knowledge and using this stock of knowledge to devise new applications, which covers the basic research, applied research and experimental development. R&D input is one of the most adopted indicators of innovation. However, innovation often requires more input than just doing R&D, which is a significant limitation of the R&D measures. Small firms without a formal R&D department but doing informal R&D may record and report their R&D input data in a less formal way, which also a limitation of the R&D data (Mohnen, 2019).

[1] The calculation of R&D personnel in Chinese companies includes three types of staff: (i) the research staff who are professionals conducting R&D projects; (ii) the technical staff who have the scientific and technical knowledge and experience in engineering technologies, natural science or life science, and participate in the R&D activities under the guidance of professional research staff; (iii) the auxiliary staff who are skilled workers and participate in the R&D activities.

[2] Innovation platforms include all kinds of engineering technology centres, enterprise technology centres, academician workstations, and so on, ranging from the city to the national level. The higher level of the platform, the higher requirements for input and the stronger the innovation capabilities are demanded. To be qualified as an innovation platform, a firm must go through strict evaluation processes. Firstly, a candidate firm must satisfy the criteria measured by multiple indicators, including the annual income, R&D expenditure, R&D personnel, and the value of essential equipment to enter the evaluation process. Then, the candidates will be evaluated by professional institutes appointed by the local authorities. Once qualified, firms will be reviewed in regular terms. If they cannot go through the review, the titles of innovation platforms will be cancelled. Therefore, the strict process from the establishment of innovation platforms to the evaluation and revision makes innovation platform a good indicator of firms' continuous input in innovation (i.e., the commitment).

	• Cultural system	• Cultural legacy • Dominant social norms and logics: state-centred or firm centred

Source: author.

Techniques of data displaying

In displaying the data, techniques of "categorising", "counting", and "quantitising" are adopted. Specifically, according to the conceptual framework, the relational pattern of each case with each type of external partner is labelled and distinguished into three types, i.e., "obligational", "arm's-length", and "N/A". Based on this, the number of firms in each category is counted to obtain the regional pattern of relational networking. If over half of the sample firms exhibit the same relational pattern, the regional pattern will be labelled as the same label as most firms. Otherwise, the regional pattern would be regarded as "heterogeneous". Furthermore, the degrees of firms' commitment to innovation are quantitised in different magnitudes: *Low*, *Medium*, *Considerable*, and *High,* based on the justification of the interview transcriptions. Quantitising the qualitative data would not make this research a quantitative or mixed-method one. Instead, it is a helpful strategy widely used to recognise the patterns, identify the causality, and discern the regularities and outliers to determine the homogeneity or heterogeneity (Sandelowski et al., 2009; Maxwell, 2010).

In measuring the innovation performance, the number of *new patent applications* or *invention patent applications* in a specific time frame (year 2017 to 2019) are used in analysing firms in different sub-sectors[1]. Patent counts are widely applied to measure the companies' innovation performance in terms of new technologies, processes, and products (Kogan et al., 2017; Mohnen, 2019; Hitt et al., 1991; Hagedoorn and Cloodt, 2003). Patents represents a claim of financial returns from the novel innovation, though the claims of either the public value or private value of patents differ, and the value are contingent upon the influence of various factors (Ribeiro and Shapira, 2020; Grönqvist, 2009). Studies have also found that patents are early indicator of the

[1] Data on the number of new products were collected. But due to the different understanding and interpretations of entirely new products and the improvement of the existing products by different firms and the difficulty to validate the data, this indicator was given up on the data analysis. The product information (including the product lines and main products) will be presented in the company profiles in Appendix E.

commercial activities, which makes the patents the measure of commercialisation (Shapira et al., 2003).

However, firms in different industries or in different technical fields have different propensities[1] in the patent behaviours (Pakes and Grillches, 1980). Therefore, to equipment firms, the number of patents is used without differentiating the types of patents is adopted in measuring the performance of the equipment firms. For equipment firms, their innovation involves a large extent of design and engineering work that it more appropriate to be protected by applying for the "utility model patent" (*Shiyong Xinxing Zhuanli* in Chinese) or "design patent" (*Waiguan Zhuanli* in Chinese). For the biotech and pharmaceutical firms, the number of invention patents is adopted to characterise their innovation performance. The shortcoming of the indicators will be further discussed in Section 4.6.

The innovation performances of sample firms collected from interviews and validated by the official dataset of the China National Intellectual Property Administration are transferred into four magnitudes: *Low*, *Medium*, *Considerable*, and *High*, each with a quantitative value from 1 to 4. Table 4.8 demonstrates the original data of patent counts and the calibrated innovation performance compared to other firms in the same sub-sector. In order to reduce the influence of the company size, the normalised data is demonstrated in the table.

The data illustrates the wide coverage of various kinds of sample marine firms in the two regional cases. By showing the average and median of the patents applied by firms in the same sub-sector, the table demonstrates that the selected sample firms in Qingdao generally performed better than the companies in Ningbo if measured by the number of patents. After nominalisation, the regional differences between the sample firms in the two sub-sectors reduced. Due to the small sample sizes, the simple average of firms cannot represent the regional innovation performance. However, the data provides important context for the qualitative analysis of the interviews with firms in the next two chapters. Rather than concentrating on the statistical discussion of the quantitative data presented here, the qualitative analysis will focus on the discussion of the relational networking of marine firms and the qualitative explanation on how the networks influence firms' innovation evidenced by the interviews.

[1] For example, biotech firms focusing on the platform technology seldom patent.

Table 4.8. Innovation performance of sample marine firms from 2017 to 2019

Sample marine firms	Number of invention patents	Innovation performance	Normalised patent data	Innovation performance (after normalisation)
MBPFs in Qingdao	**Average: 37 Median: 22**	**Average: Considerable (2.68)**	**Average: 0.127 Median: 0.055**	**Average: Medium (2.33)**
QMBPF1	61	High	0.055	Medium
QMBPF2	0	Low	0	Low
QMBPF3	24	Considerable	0.139	Considerable
QMBPF4	22	Considerable	0.037	Medium
QMBPF5	72	High	0.493	High
QMBPF6	18	Medium	0.095	Considerable
QMBPF7	1	Low	0.003	Low
QMBPF8	121	High	0.305	High
QMBPF9	16	Medium	0.015	Low
MBPFs in Ningbo	**Average: 16 Median: 12.5**	**Medium (2.00)**	**Average: 0.062 Median: 0.0265**	**Average: Considerable (2.33)**
NMBPF1	11	Medium	0.022	Medium
NMBPF2	5	Low	0.019	Low
NMBPF3	14	Medium	0.2	High
NMBPF4	6	Low	0.021	Medium
NMBPF5	27	Considerable	0.091	Considerable
NMBPF6	33	Considerable	0.031	Medium
MEFs in Qingdao	**Average: 49 Median: 24**	**Considerable (2.55)**	**Average: 0.151 Median: 0.107**	**Average: Medium (2.45)**
QMEF1	24	Medium	0.048	Medium
QMEF2	0	Low	0	Low
QMEF3	19	Medium	0.317	High
QMEF4	257	High	0.107	Considerable
QMEF5	37	Considerable	0.015	Low
QMEF6	11	Low	0.220	Considerable
QMEF7	16	Medium	0.032	Medium
QMEF8	51	High	0.879	High
QMEF9	42	Considerable	0.017	Low
QMEF10	14	Medium	0.175	Considerable
QMEF11	69	High	0.136	Considerable
MEFs in Ningbo	**Average: 22 Median: 16**	**Medium (2.14)**	**Average: 0.072 Median: 0.039**	**Average: Medium (2.14)**
NMEF1	16	Medium	0.036	Medium
NMEF2	38	Considerable	0.152	Considerable

NMEF3	0	Low	0	Low
NMEF4	37	Considerable	0.185	Considerable
NMEF5	8	Low	0.053	Medium
NMEF6	6	Low	0.039	Medium
NMEF7	50	High	0.042	Medium

Source: author summarised from the data collected in fieldwork and the Chinese patent database - China National Intellectual Property Administration.

Making sense from data analysis

After writing descriptive summaries of each firm case, transcribing, and coding the data, cases are contrasted and compared to draw conclusions from the data matrices created for organising the data (Miles and Huberman, 1994). Firstly, cross-firm analysis was conducted within the regional scope (i.e., with the same set of regional institutions). Making contrasts and comparisons of micro-level companies enable this research to identify the how relational behaviours influence the marine innovation without ignoring the firm-level differences. Based on this, regional patterns which characterised the consistencies or inconsistencies between idiosyncratic firms are concluded. Within each region, the illustrations are sub-sector based. The aim was not to compare sectors but to characterise and control the major industrial influences. Finally, a cross-regional analysis is made to synthesise the impacts of firm-level factors and regional institutions in explaining the regional innovation performance, which reflects on the conceptual frameworks. Techniques of *comparison* and *counting* were extensively adopted in the data analysis.

4.6 Validity and limitations

Although some researchers believe that *reliability* is more often connected with quantitative research and is the consequence of *validity* (Stenbacka, 2001; Golafshani, 2003), it has been increasingly argued that validity and reliability are both essential criteria in measuring the quality of the qualitative study (Patton, 2014; Miles and Huberman, 1994). *Reliability* demonstrates whether the operations of a study can be repeated and stable across researchers, methods, and time (Miles and Huberman, 1994). Reliability can be achieved by making the research steps as operational as possible (Yin, 2014). This research ensures reliability by well documenting the research procedures and the transcribed data.

Regarding *validity*, Yin (2014) distinguishes three types. *Construct validity* refers to the correct operational measures for the studied concepts (Yin, 2014). In this study, construct validity was enhanced by utilising multiple sources of evidence and maintaining a chain of evidence. *Data triangulation* was employed by involving different data sources complementing each other to generate collaboration (Miles and Huberman, 1994). In data collection, the information obtained from semi-structured interviews were triangulated against data collected from public documentation such as patent retrieving system, annual reports of companies, media reports, and companies' websites. The chain of evidence was maintained by tracing the links among research questions, research protocols, research methods, and data and evidence collected.

Internal validity evaluates the credibility of the research and is particularly relevant to descriptive studies that seek to construct the causal relations between some conditions (or variables) and others (Yin, 2014). In this research, internal validity was addressed by adopting *explanation building* from case studies in an iterative process, a *cross-case synthesis* specifically associated with multiple-case design (Yin, 2014) and *check the meaning of outliers* (Miles and Huberman, 1994).

External validity, also known as generalisability or transferability, concerns the issues of how far the research findings can be generalised or transferred to other contexts (Miles and Huberman, 1994). A case study mainly deals with *analytical generalisability* (i.e., the sample is the opportunity to shed light on the theories from an empirical perspective) (Yin, 2014). Though the sample size is small compared with the scale of marine firms in number, the analytical generalisability was enhanced by embracing the multiple-case study design with heterogeneous firm cases in two different regions as the unit of analysis. It enables the comparison across cases and regions, in which the conceptual framework constituted of the regional institution theories and relational networking theory were exhaustively tested, and new insights on firm innovation and regional innovation ecosystem were generated.

The research has several methodological limitations. Firstly, two regional cases with similar profiles were selected for in-depth research and analysis. However, because of the purposive sampling, there is a possibility that some valuable insights about regional marine innovation beyond the two regions could have been generated. Besides, because this analysis is region-focused, sectoral influences were recognised but not treated as influential factors to be explored in detail. There is a risk that insightful evidence about marine innovation could have been obtained from other kinds of firms, such as service firms.

As for the selection of sample firms, although this research sought to select sample firms as heterogeneous as possible, the sample size of the two regions was not balanced. As mentioned above, SOEs in Ningbo were not approached in this research. The numbers of different kinds of informants were also unbalanced. For example, informants from the local government in Qingdao were approached, while attempts to approach government officials in Ningbo failed. This could only be supplemented by gathering information about the local government from firm interviewees, informants from other organisations, and all kinds of government reports and media coverage. Furthermore, even though this research evaluated the relational patterns between firms and external partners, information was only accessed from interviews with marine firms rather than generating implications by combining information from both sides of the innovation interaction.

Furthermore, this study explores the firm-level differences mainly from the qualitative perspective and focuses on the explanation of causalities. The insufficiency in the quantitative measurements of firm-level differences is a limitation to this research. The different innovation performance of firms mentioned in this section is to demonstrate the wide coverage of heterogeneous firms. However, this research only adopts the number of (invention) patents as performance indicators. The new products data were collected but not used due to the large disparities of firms in interpreting what is a new product and the difficulty to validate the collected data. Although patent counts are widely applied to measure the innovation and the commercialisation, they suffer from critiques in the industrial differences of propensities to patent mentioned above. Firms also have different inclinations towards patent. Using patent counts underestimates the innovation of firms that do not or less inclined to apply patents. Despite that the data collection of this study characterises the industrial differences by distinguishing the types of patents, innovations are patentable. The varieties of sample firm in sizes and specific technological fields cause the bias of the patent counts. In the empirical context of China where firms' patenting activities have been subsidised, the quality of patents cannot be reflected from simply patent counts.

Moreover, it worth noting that the innovation performance does not equal to the firms' business performance. New patents may not always bring in profits. However, in general, it is difficult to disaggregate the sales revenue to determine which one is from innovation, and which one is not. Because the main focus of this research is on the innovation activities, though the interviews can partly reflect the influences on business performance, no statistical data or quantitative method has been adopted to associate the innovation performances and the firm performance.

4.7 Summary

This chapter discusses and justifies the research methodology and design of this study, which are driven by the research questions and built upon the conceptual framework. Multiple-case study as a qualitative-oriented method is selected as the primary strategy of this research. Detailed issues regarding how to operationalise this research have been dealt with. Specifically, two regional cases were selected purposively, and firms within the regions were the empirical focuses to sustain data collection. Semi-structured interviews with managers in companies supplemented by interviews with informants constitute the main approaches to collecting primary data. Documentation is the main access to secondary data. The analysis of data follows the guidance of template analysis. Various techniques, such as category and comparison, have been used to fulfil the analytical focus of this research. Lastly, the research design and methods were reflected and evaluated, and validity acted as the main criteria. Built upon the empirical and conceptual underpinnings and the research design and methodology elaborated in this chapter, the cases will be analysed in the following chapters.

Chapter 5. Regional Marine Innovation in Qingdao

Qingdao is a prefecture-level city in Shandong province situated in eastern China. As one of the 14 Coastal Open Cities authorised by the central government, Qingdao is among the first group of cities acting as the regional bridgehead to experiment China's open-up reform policy. Since 1986, Qingdao has become one of the five "Municipalities with Independent Planning under the National Social and Economic Development" (*jihua danlie shi* in Chinese). It was promoted to an administratively vice-provincial city in 1994, which grants this city the same administrative position as Jinan - the capital of Shandong. For decades, Qingdao has maintained the dominant leading position in the provincial economy. Following the two provincial-level metropolises - Beijing and Tianjin, Qingdao has maintained the third place in the economic development in Northern China.

Qingdao has a long opening-up history and has built a strong industrial foundation, particularly in the light industry. Clothing industry and food and drinks industry were historical pillars of Qingdao's economic development. Due to its geographical importance and port advantages, Qingdao became a German-leased land in the late 1890s and was built into a modern harbour city. Industries such as the food, textile, military, and locomotive sectors were gradually established. Even today, there are legacies of the German occupation in Qingdao, such as the German style architecture and the well-known beer. After World War I, Qingdao was taken over by Japan. The textile and food industries in Qingdao were significantly strengthened in this stage with a number of cotton mills, cigarette and food factories established. The most remarkable development was achieved in the textile sector which received a large number of human and pecuniary resources investment.

Besides maintaining the traditional advantages in light industries, Qingdao started to shift more focus to heavy sectors such as the petrochemical industry, auto and motor industry, naval architecture, and ocean engineering industry since the 1990s. In the 2000s, to respond to the call of the Chinese government to develop the blue economy, Qingdao, with some marine industrial bases, entered the new era of marine economic development. Great emphasis and resources have been input into the marine sector. In recent years, the marine GDP of Qingdao has kept growing and maintaining the provincial highest level (Qingdao Statistics Bureau, 2019). The marine economy is becoming a new brand of Qingdao.

This chapter analyses the regional pattern of marine innovation in Qingdao by exploring the causal dimensions identified in the conceptual framework (Section 4.1). Figure 5.1 demonstrates the core facilities of Qingdao illustrating the marine industrial infrastructures and the distribution of sample marine firms and the UPRIs. The empirical analysis of the regional case of Qingdao starts from the regional institutions which have conditioned the innovation of local marine firms (Section 5.1). This follows the firm-level analysis by investigating the commitment to innovation and relational patterns with vertical and horizontal (and firm and non-firm) partners of marine firms (Sections 5.2 to 5.7)[1] and how they are linked to the locality. As a finale of this chapter, Section 5.8 summarises the regionally dominant patterns of commitment and relational networks of marine firms in Qingdao and demonstrates the assumed combining effects of the firm-level factors in influencing the innovation and business performance of marine firms. This chapter lays the foundation for the comparative analysis of the two regional cases and the explanatory analysis of regional marine innovation in Chapter 7.

5.1 Regional institutions in Qingdao

Institutions are assumed to be important regional-level factors in structuring and influencing the regional patterns of marine innovation. This section explores the regional institutional environments in Qingdao and the characteristics of the core institutions, including the local state, the research and education system, the financial system, and the cultural system. They will be elaborated on from the marine-related perspectives.

[1] Data are presented by sub-sectors to acknowledge the industrial features.

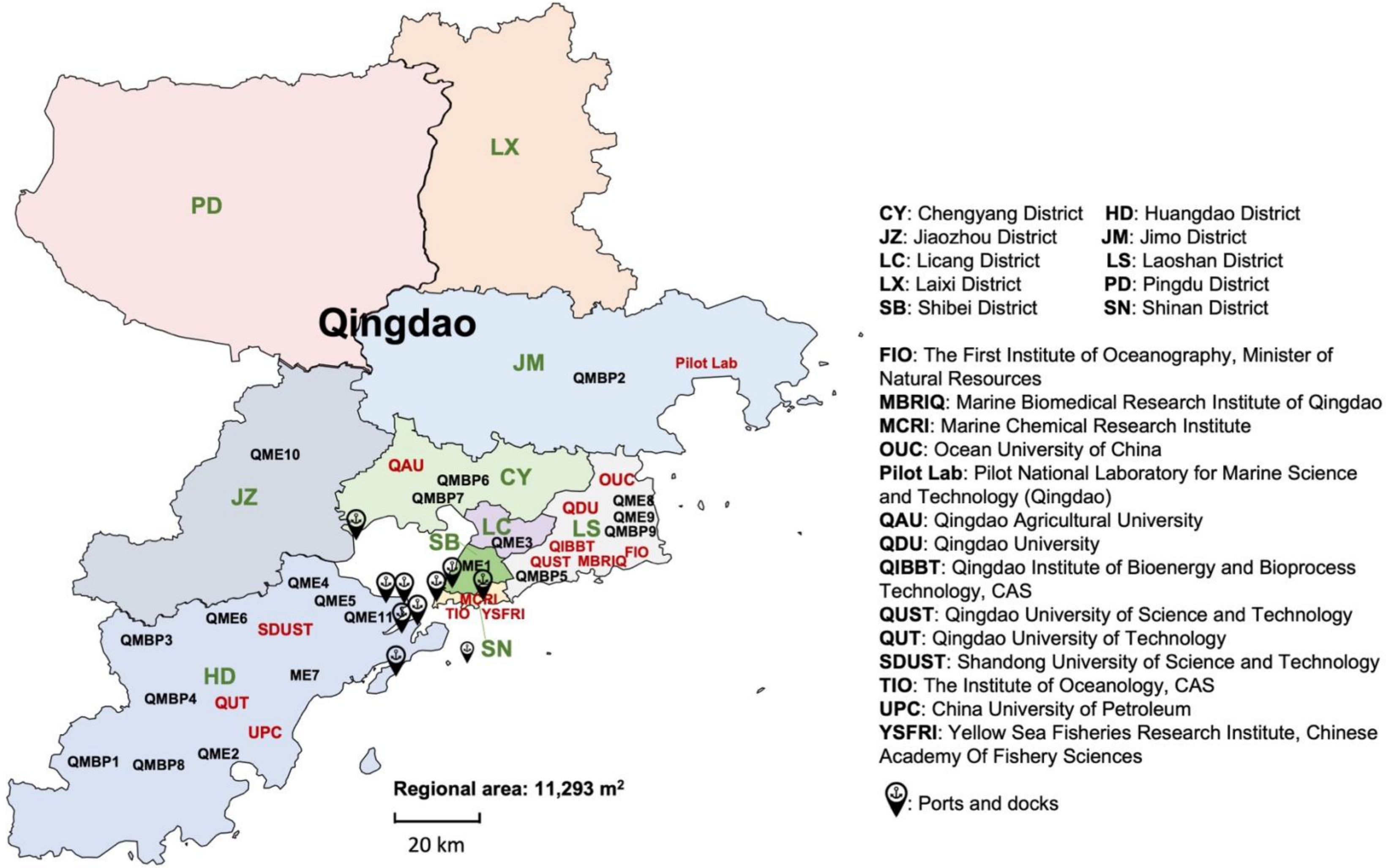

Figure 5.1. Map of Qingdao

5.1.1 The regional state in Qingdao

The regional state of Qingdao has functioned like a quasi-*developmental state* (discussed at length in Section 3.2.4) by playing decisive and initiative roles in shaping the industrial, economic, and innovative development at the regional scale and governing the local economy. Embedded in the multi-level political system in China, Figure 5.2 illustrates the dominant characteristics of the regional state of Qingdao demonstrating evident regional features associated with marine development.

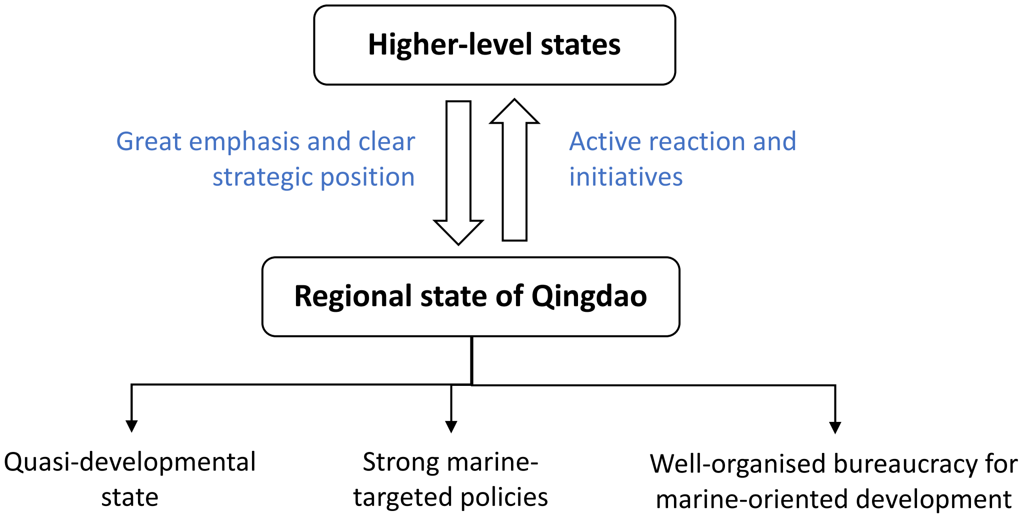

Figure 5.2. Regional state of Qingdao

Close central (provincial)-local relationships

As a northern coastal city with strategic importance in its geographic and economic position, Qingdao has historically maintained a close relationship with the central government. Observing the marine development trajectories in Qingdao, this city has closely followed the footsteps of the central government and actively strived for resources from the higher-level government.

(a) Follow the footstep of the central government

After former President Hu Jintao's tour to Shandong province in 2009 proposing to develop the blue economy in Shandong, Qingdao tracked Beijing's guidance and started to formulate policies and development plans based on the analysis of the local advantages and marine industrial foundations. Later in the same year, Qingdao set up the blue economy office and established three committees[1] made up of local experts. They drafted initiative marine policies such as the "Qingdao Blue Economic Zone Construction and Development Master Plan (2009-2015)", which set the tone and goals of blue economic development in the following years and proposed to build Qingdao into the pioneering region of China's marine development, the core of Shandong Peninsula Blue Economic Zone, and the cluster for marine indigenous R&D development and high-end industrial base (Qingdao Development and Reform Commission, 2009). In 2011, the State Council approved China's first marine-themed regional development strategy - the "Development Plan for Shandong Peninsula Blue Economic Zone", in which Beijing officially recognised and highlighted the central position of Qingdao as a marine city.

(b) Actively strive for resources

The regional state of Qingdao has been highly self-motivated in taking initiatives to strive for the first-mover advantages in the national background of the marine development, keen on discovering new opportunities, and actively seeking to attract more support and resources from the higher-level governments. For instance, in 2011, Qingdao's local state proposed strengthening Qingdao's position as the national marine S&T centre and building China's "Blue Valley" (*lanse guigu* in Chinese) in Qingdao, adopting the Silicon Valley metaphor. This strategy was authorised by the central governments and was highlighted in several national policies[2]. Besides, Qingdao has also interacted with Beijing and the provincial government in the development of marine sub-sectors. For example, following President Xi Jinping's visit to the Marine Biomedical Research Institute of Qingdao in 2019, this city developed the initiatives to build China's "Blue Medicine Base" (*lanse yaoku* in Chinese) in Qingdao and has been seeking to facilitate the inclusion of this plan into the national and provincial S&T development strategies.

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[1] The three Committees were the Planning Committee for Blue Economic Zone and High-end Industrial Agglomeration Cluster, the Coordination Committee for Blue Economic Zone and High-end Industrial Agglomeration Cluster, and the Advisory Committee for the Construction of Blue Economic Zone.

[2] For instance, "Bule Valley" was mentioned in the "12th Five-year Plan for National Marine Economic Development" (State Council, 2012) and the "13th Five-year Plan for National Marine Economic Development" (NDRC and SOA, 2017).

(c) The provincial advantages

Furthermore, as mentioned at the beginning of this chapter, Qingdao not only enjoys the same administrative level as the provincial capital city - Jinan but also leads the provincial development. Also, because Jinan is an inland city, the importance of Qingdao enables it to attract attention and resources from the provincial state in marine development and strengthens the local-provincial coordination. This further consolidates the strengths and willingness of the states on the two levels in interacting with the central state on marine-related affairs. The "Development Plan for Shandong Peninsula Blue Economic Zone" is a typical example of the close interaction between regional and provincial states. In other words, the regional state on the provincial and city level have reached a tacit agreement with a unified aim to develop Qingdao and the whole Shandong Province as a well-known marine city or province in China that have strong capabilities in marine economic and innovative development.

Diverse marine policy tools

Besides actively interacting with the higher-level government, the regional state Qingdao has played the developmental role in directing and promoting the marine development. A key strategy adopted by the regional state is the industrial policy tool. A series of policies, either directly targeting the marine industry or incorporating the marine industry as an important aspect, have been formulated and implemented in Qingdao as summarised in the below two figures. Even though these strategies are seldomly termed as clustering policies, the comprehensive policy system has been directing and pushing this region towards a marine cluster by agglomerating marine industrial firms, strengthening the local knowledge infrastructure, and promoting the regional-based interaction. Besides S&T policies to support regional marine innovation, the regional state of Qingdao has followed the national track by formulating policies in various aspects such as talent, industrial, and financial policies to support regional marine innovation. For example, aiming to strengthen the local marine knowledge base, talent policies are implemented in Qingdao in order to retain and attract more marine talents to Qingdao. Also, great efforts are put into introducing new companies to Qingdao and consolidating the regional marine industrial base.

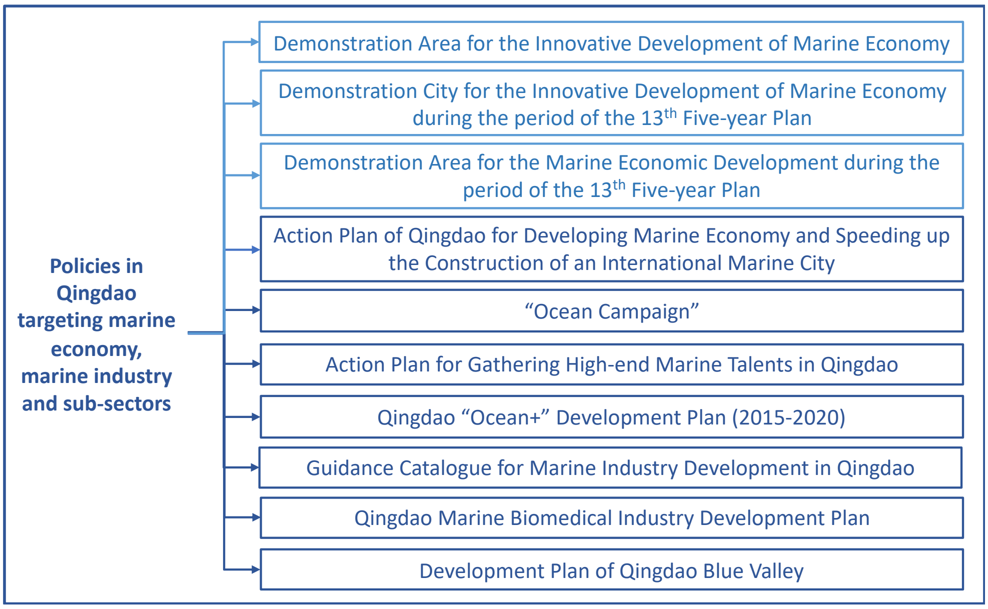

Figure 5.3. Policies in Qingdao directly targeting marine development

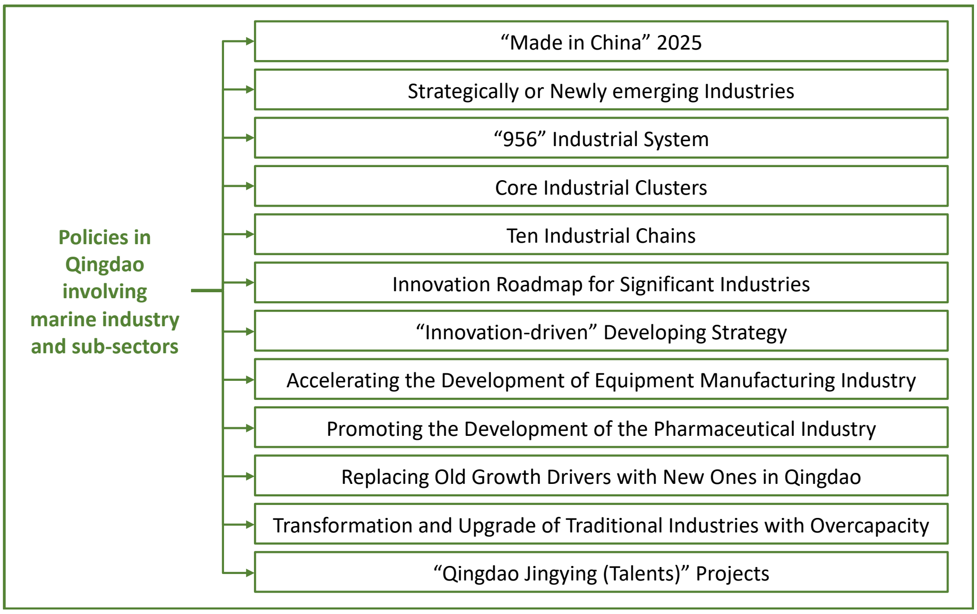

Figure 5.4. Policies in Qingdao involving marine development

Besides, the local state has played developmental roles by seeing up specific goals, action plans, and assigning tasks to different regional actors. For example, the “Guidance Catalogue for Marine Industry Development in Qingdao” directs the development of the marine industry and innovation by listing a series of prioritised marine products and essential technical fields. The “Ocean Campaign” (*haiyang gongshi* in Chinese) explicitly sets up the goal of establishing ten new high-end marine innovation platforms. These activities imply a strong sense of political guidance in regional development, reflecting the regional state's developmental role.

Furthermore, recognising the local advantages of marine R&E institutions (illustrated later in Section 5.1.2), the state of Qingdao has aimed to build a Qingdao model of marine innovation by relying on the local R&E system and has been highly active in playing the developmental role by policies in mobilising the local resources of marine scientific research and education, constructing the regional infrastructure, and strengthening the construction of a much more comprehensive marine R&E system. For example, the "Gathering Marine High-end Talents" strategy clearly articulates to attract talents based on the local marine R&E organisations. Also, a number of policies highlight the development by coordinating the industry-education-research strengths. As mentioned by one interviewee from a local university,

> *"The local state well understood that the best way to strengthen the marine research resources was to use them." (I_QU1).*

The regional state also highlights the importance of top-level marine scientists and researchers by incorporating them into the local think tanks to support the regional marine policy. For instance, the aforementioned strategy of "Blue Medicine Base" was first proposed by the leading researchers from the Marine Biomedical Research Institute of Qingdao. In addition, when the national-level UPRIs in Qingdao are well equipped to attract more resources and support from the higher-level governments, the local state has been active in directing and promoting the development of the regional-supervised marine research and education organisations[1] by investing enormous resources to them. As commented by a university interviewee,

> *"Compared with those minister-supervised universities such as the Ocean University of China, Qingdao University actually obtained the most support from the local authorities in funding and S&T projects". (I_QU2).*

Moreover, the local state of Qingdao has also acted as the developmental state in restructuring the local economic and marine industrial structure through policy tools. One decade ago, the local state primarily rested more on the marine SOEs. For instance, the "Suggestions on Accelerating the Development of Equipment Industry in Qingdao" issued in 2011 clearly mentioned to rely on the SOEs (e.g., QMEF4 and QMEF5 in this research) as the industry leaders to develop marine technologies and

[1] The classification of different levels of UPRIs will be introduced in Section 5.1.2.

products. Increasingly, local policies as exemplified by the Blue Valley strategy and the establishment of marine-focused high-Tech zones have witnessed the shift of the state focus towards the marine SMEs and private marine firms.

Organised and marine-oriented bureaucracy

As mentioned in Chapter 2, the marine industry is a compound sector. On the national level, the governance of the marine industry and innovation demands the participation and coordination of different departments. This also applies to the regional context. In Qingdao, the regional state has restructured and organised the local bureaucracy to facilitate the marine-oriented development in this region. As illustrated by Figure 5.5, the current bureaucracy of Qingdao is characterised as highly organised with clear features of marine orientation.

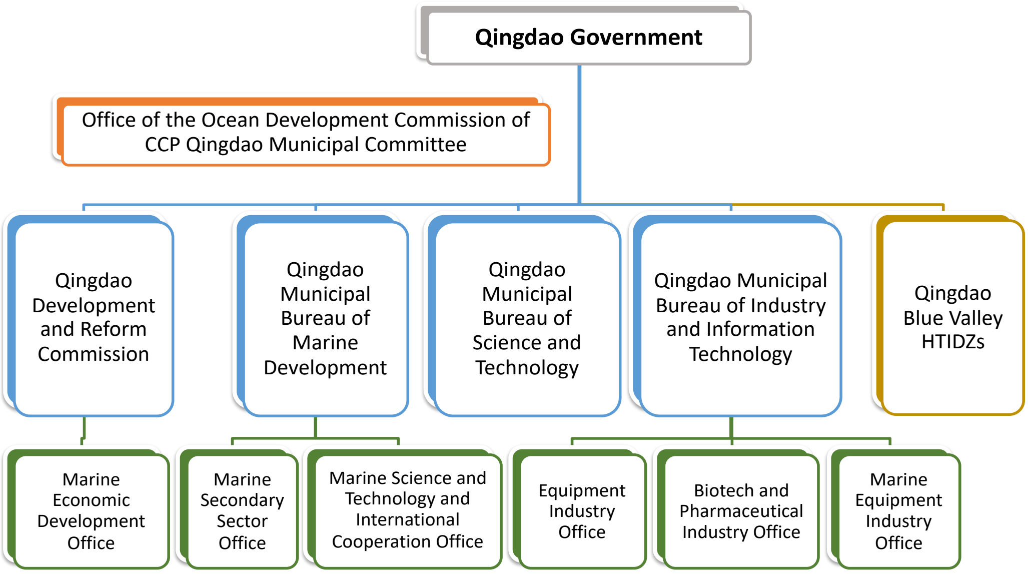

Figure 5.5. Bureaucratical structure for marine development in Qingdao

Firstly, Qingdao establishes the super-bureaucratical department governing the marine work of the whole city. This role has been undertaken by the Office of the Ocean Development Commission of CCP Qingdao Municipal Committee since the national institutional structure reform[1]. Before that, the coordinating role was

[1] The organisations built within the CCP committee often represent higher levels of authority than other internal departments. For instance, in 2013, the CPPCC established the Leading Group of Comprehensively Deepening Reform. Its administrative level was largely higher than the NDRC playing

historically played by the “Office for Constructing the Blue Economic Zone” set up in 2009 within the Development and Reform Commission of Qingdao. The existence of the super-bureaucratical office is in line with the internal structure of the provincial state of Shandong. Besides, to ensure the implementation of marine policies, tasks are often distributed to the leading officials of the regional government. For instance, the strategy of developing the “Modern Marine Industry” has been led by the deputy mayor of Qingdao with the assistance of the heads of relevant bureaus and their internal offices.

Furthermore, the state of Qingdao embraces marine characteristics by establishing and keeping the specific marine bureau since the last century. The Blue Valley targeting the marine high-tech industries was established as an important functional district to lead the local marine development and innovation. Moreover, the internal departments within the key municipal bureaus have been restructured to ensure the management of different marine affairs and support regional marine development. For example, the marine equipment office within the Bureau of Industry and Information Technology was targeted to supervise the MEFs. Involving different bureaus and their internal offices in marine governance enables the regional developmental state to direct and support industrial development from various aspects in more efficient ways.

5.1.2 The research and education system in Qingdao

Qingdao has been forming a well-structured R&E system composed of a hierarchy of organisations on different levels that underpins the regional development of marine skills and labour. In Qingdao, the national-level organisations are diverse, including universities, PRIs, and laboratories, while regional-level R&E organisations are mainly universities supervised by provincial- or city-level governments. By covering different marine fields, they are mutually complementary in providing formal education. Meanwhile, by institutional restructuring, Qingdao releases a degree of freedom in the governance of the regional R&E institutions, which favours the integration between the R&E system and the marine industrial innovation.

similar roles in economic reform.

National-level R&E organisations with strong capabilities

Figure 5.6 illustrates the organisational constitutions of the R&E system in Qingdao. The upper half of this figure list the core national-level organisations. Specifically, the Pilot National Laboratory for Marine Science and Technology (Qingdao), established in 2015, is the only national-level laboratory in the marine field in China, which represents the highest level of marine S&T research capabilities. This laboratory is built upon the joint efforts of the national-level authorities (e.g., MOST and MOE), the regional governments (both the provincial government of Shandong and the city government of Qingdao), and the top-level UPRIs in Qingdao (e.g., Ocean University of China). Within the lab, the sub-laboratories and research groups are conducting marine research and innovation in different fields.

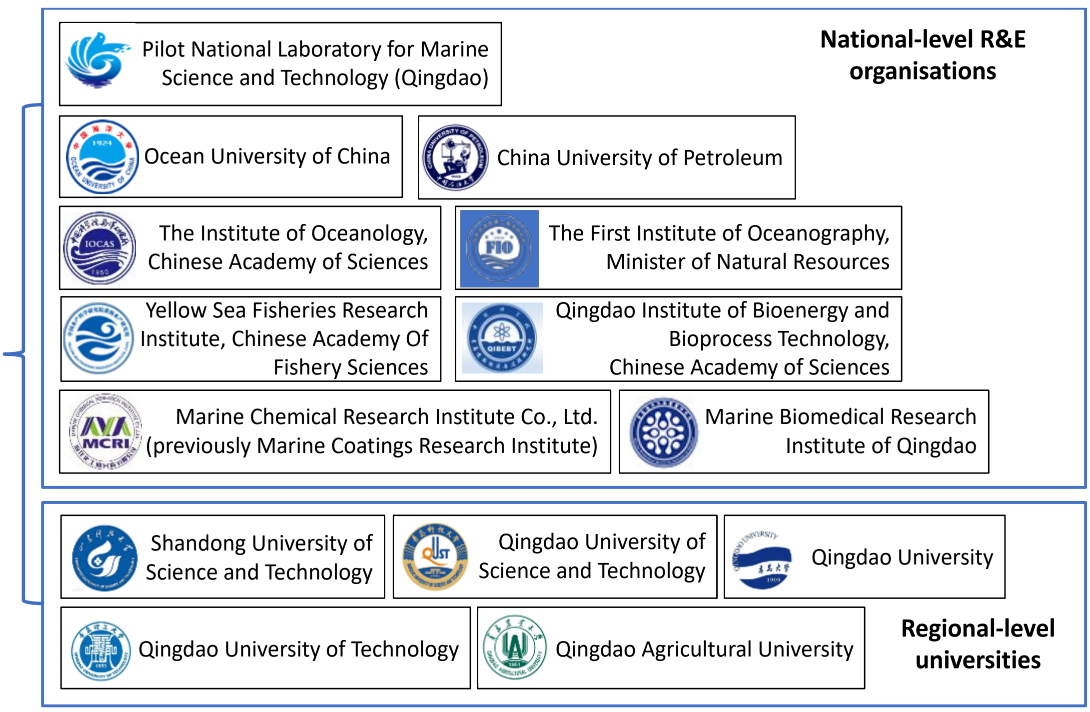

Figure 5.6. Regional R&E system and the composing organisations in Qingdao

Besides, there are a number of national-level UPRIs in Qingdao leading marine research in different aspects. For example, the School of Medicine and Pharmacy at the Ocean University of China is one of the leading organisations in the subjects of marine biotechnology and pharmacy in China. Based upon this school, several innovation platforms have been built, such as the Marine Biomedical Research Institute of Qingdao, the National Engineering Technology Research Centre for Marine

Medicine, and the Laboratory of Marine Medicine, directly governed by the MOE. Within the Ocean University of China and the China University of Petroleum, there are many research teams specialised in the marine equipment fields such as marine engineering science, submarine science, and detection technology. The national-level universities, PRIs and labs provide a large size of graduates and talents in marine majors. As the pillars of China's marine research, these organisations have been attracted great support and resources from the national-level states, which further reinforces the strengths of the regional R&E system.

Regional-level R&E organisations shift focuses to marine research

Furthermore, as shown in the bottom half of the Figure 5.6, the research system in Qingdao consists of regional universities that are supervised by the governments on the provincial- or city-level. They are not traditional marine R&E organisations like the national-level organisations but have accumulated innovation capabilities, knowledge, expertise, and resources in particular subjects, which can be transformed and applied to marine R&E. Based on their advantages, the regional universities have gradually established marine majors and shifted attention to marine R&E corresponding to the regional trend of marine development. All the five universities in Figure 5.6 have established marine schools or majors[1]. The increasing involvement in marine research and education makes these universities increasingly important in the R&E institutional system in Qingdao.

Relaxed governance of R&E organisations

[1] For example, Qingdao University has established a specialised institute of marine bio-based materials. Qingdao University of Technology which is traditionally strong in civil construction involves research in ocean-based construction. Built upon the Marine Engineering Research Institute, Shandong University of Science and Technology established the College of Ocean Science and Engineering in 2019 in collaboration with the First Institute of Oceanography, which concentrates on the research of shipbuilding and marine engineering products. Qingdao University of S&T traditionally strong in mechanical engineering and automation, applied chemistry, and materials established the School of Marine Science and Biological Engineering in 2017 concentrating on chemical engineering and biological engineering S&T research and the training of marine talents. Much earlier, Qingdao Agricultural University aggregated the resources in the major of fishery science and built the School of Marine Science and Engineering in 2012.

UPRIs are often criticised for doing research far from reality. With the appeal to develop an "industry-education-research" coordinated model, the regulation in managing the R&E organisations and the internal researchers has been relaxed in the governance of the industrial interactions and the commercialisation of technologies. By this means, the UPRIs and the researchers or research groups in Qingdao shift more focus to industrial needs. They seek to integrate the knowledge and training provided by the educational organisations and the corporate demand for skilled human resources and favour the regional firms by conducting applied research and encouraging the high-end researchers to "serve" the local firms in different forms. As argued by the interviewee from the Ocean University of China,

> *"We strongly support the researchers to accept positions in companies. If they would like to set up their own companies, we also promise to retain their university positions in a given period of time. This was unimaginable before and had to go through a series of strict processes of review, evaluation, and discussion on formal university-level meetings." (I_QU1.)*

5.1.3 The financial system in Qingdao

In China, the marine sector is an emerging and political-driven industry. A number of its sub-sectors like the MBP industry and the ME industry covered in this study are capital intensive, which demands not only internal capital but also effective external sources of capital to facilitate the production and innovation development. The financial system determining how capital is available to firms becomes important. In the regional case of Qingdao, the financial system demonstrates two features, including (i) the bank-centred nature and (ii) the development of blue financing which illustrates the attitudes of the regional state towards supporting the marine industrial development.

Bank-centred system

The financial system in Qingdao is primarily bank-based and highly dependent upon the regional state. When the venture capital industry is blooming in China, the resources are mainly concentrated in metropolitans such as Beijing, Shanghai and Shenzhen. Besides, when large companies with strong internal capabilities are encouraged to obtain more capital by listing on the stock market, it is unrealistic for most SMEs or the new entrants in the marine industry in Qingdao to obtain risk capital and other financial resources[1], either formal or informal. As mentioned by an officer from the local Bureau of Private Economic Development of Qingdao,

> *"Informal financing was not popular in Qingdao compared with regions in southern China like the cities in Zhejiang Province. This is mainly due to the cultural difference. In Shandong, if there is no policy or regulation allowing informal lending, no one would like to use this method to raise capital. However, in the south-eastern China, no prohibition means permission." (I_QG1).*

In such case, bank loans become the main external accesses to funding for the firms in Qingdao. The access to bank loans largely favours the SOEs or P-SOEs that have historically maintained a close relationship with state-owned banks. Large enterprises with strong capabilities also face few restrictions on accessing bank loans. Nevertheless, private SMEs and start-ups historically faced more discrimination from the banking system. Solving this problem requires more policy guidance and direction from the state. In the case of Qingdao, the regional state not only sets up a specific bureau to support the development of SMEs and the private economy but also seeks to reduce the difficulty of SMEs and private firms to access bank loans by implementing a series of strategies such as establishing the "easier loan platform" based on the big data and sharing the firm information with the banks, providing guarantee loans for start-ups with low or zero interest, and promoting the bank loans based on the pledge of intellectual properties targeting the high-tech SMEs.

Blue financing

Moreover, the development of an industry in a region depends on the attitudes of the local states that are empowered with greater autonomy in regional economic development and more financial resources as discussed in the literature review. As the economically developed region in China, Qingdao enjoys rich financial resources. Treating the marine industry as the new pillar of the regional economy, the regional government aiming to promote the marine industrial development influences the

[1] Marine firms in Qingdao also turn to stock markets and joint ventures. However, access to these capital sources is highly dependent upon the capabilities and industrial positions of firms.

amount of capital available to firms in this industry.

Characterising the marine development trend, the financial organisations in Qingdao collaborate with the local state and makes this region a pioneer in China to develop "blue finance". In 2015, Pudong Development Bank established China's first financial service centre supporting the blue economy in Qingdao (Li et al., 2016). Financial products, such as subsidised loans, have been released for technical-oriented marine firms (I_QF1). Other region-based financial organisations such as the Bank of Qingdao and the local branch of the Bank of China also launched blue financial products. In 2019, Qingdao further issued the regional policy - "Suggestions on Promoting Finance-served Marine Economic Development in High Quality", which reaffirmed the determination to support the "blue" finance. These characteristics of the financial system offer regionally institutional benefits to the marine firms.

5.1.4 The cultural system in Qingdao

As the origin of the Confucianism[1], Shandong province where Qingdao is situated has been significantly influenced by this culture. The most important Confucian beliefs include the examples of emphasising the paternalist trust, stressing the social orders by holding "tropism of the bureaucratic prioritisation" (*guanbenwei* in Chinese) that influences the centrality of the state in a region and "the natural destiny of a man who excels in learning is to be an official" (*xue er you ze shi* in Chinese) which influences the education and the preference when choosing the career path. Even though Qingdao has a long history of being colonised and open-up, it cannot avoid the impacts of the conservativeness in thinking and behaviours and those common values of norms that are deeply enrooted in the regional cultural system.

The cultural system and the industrial organisations

The state-centred cultural system directly influenced the regional industrial structure and the further clustering of marine firms. Historically, state ownership dominates the regional economy. Large SOEs are the pillars of the economic development of Qingdao.

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[1] Confucius, one of the most important philosophers, political scientists and educationalists in ancient China, developed a number of social rules that deeply affected the formation of Chinese cultural systems.

Although the private economy has become increasingly important in Qingdao in recent years, the industrial characteristics of the marine manufacturing industry in the political-driven development and the interdependence with the national marine strategy determine the continuing strong roles of the state control in certain sub-sectoral areas and the important roles of the large firms, especially in the early stage of the marine development. After years of development, a number of marine firms with strong capabilities have gradually established in different marine sub-sectors and become the “blue brands” of Qingdao.

However, the cultural system highlighting the centrality of the state also determines the state-organised associational mechanisms and industrial clustering. On the one hand, the local industrial associations are mainly formed and promoted by the state rather than by the self-organisation of the individual companies. On the other hand, the state-centred thinking and the previous concentration on the large SOEs historically depressed the entrepreneurship in this Qingdao and the wider Shandong province and restrained the development of small firms and the private economy in this region. There is a lack of the bottom-up kind of industrial agglomerations not only in the marine industry but also in different industrial sectors in Qingdao, which are identified to be important in the development of many Chinese regions as discussed in the literature review.

Although with the increasing development of the legal system and the reform of the state, reliance on illegal personal relationships with government officials to strive for resources has been reduced, for private firms and SMEs, as the latecomers to the marine industry, besides developing the internal capabilities, previous business connections and the personal relationships such as family members, friends, and school alumni are still supposed to be important in building the business partnerships. For this region, besides forging the business connections based upon the state efforts and the basic local advantages in natural resources and geographical position, the integration and completeness of the industrial chain linking various companies in a marine sub-sector or in different but related marine sub-sectors are considered to be further strengthened.

To summarise, the contents above have articulated the regional institutions of Qingdao and their characteristics. The analysis characterises the institutional advantages in general in Qingdao. However, how marine firms react upon the regional institutional impacts is analysed upon the evidence from the firm-level interviews, which will be elaborated compared to the regional case of Ningbo in Chapter 7. The following sections of this chapter continue the intra-regional analysis of marine firms. Recognising the idiosyncrasy of individual firms, the main aim of bottom-up firm analysis is to obtain firm-based illustrations of the regional pattern of marine innovation in Qingdao.

5.2 Innovation commitment of marine firms in Qingdao

Though it has been generally acknowledged that innovation is a non-linear process, and the input alone is insufficient to lead to innovation success, input is an indispensable aspect of firms' internal innovation and is critical to show firms' commitment to innovation. Therefore, this section combines the three-year numerical data of marine firms in R&D input including the R&D expenditure and R&D staff with acknowledged drawbacks, the qualitative measurement of corporate-level innovation platforms[1], and the narratives to measure the internal innovation commitment of marine firms in Qingdao.

5.2.1 R&D input of marine firms in Qingdao

Table 5.1 shows the R&D input of the sample marine firms in Qingdao from two aspects, namely (i) the R&D expenditure relative to sales and (ii) the percentage of the R&D personnel to the total headcount. In the three years from 2017 to 2019, sample marine firms in Qingdao under investigation have input 10.64% of their sales income into R&D and maintained 17.36% of the R&D staff. To a large extent, the regional-level R&D data has been levelled up by the MBPFs.

Specifically, the expenditure data of MBPFs in Qingdao almost triples the data of MEFs. Though the difference in the scale of R&D personnel is not as significant as the R&D spending, MBPFs' input into R&D human resources still doubles the input of MEFs in the same region. Also, considering the small sample size and the existence of extreme values, medians are demonstrated. Typically, sample marine firms in Qingdao have

[1] See definitions of these indicators and the drawbacks in the footnotes of Section 4.5.3.

invested 6.50% of the sale revenue in R&D and kept 14% of R&D staff with more input in typical MBPFs than their MEF counterparts.

Table 5.1. The R&D input of sample marine firms in Qingdao from 2017 to 2019

R&D input (three-year average)	TOTAL n = 20	MBPFs n = 9	MEFs n = 11
R&D expenses / sales (%)			
Mean	10.64%	16.56%	5.79%
Median	6.50%	8.00%	5.00%
R&D personnel / total personnel (%)			
Mean	17.36%	24.89%	11.20%
Median	14.00%	18.00%	10.00%

Sources: fieldwork interviews and annual reports of companies.

Interviewees from the local marine firms mentioned that it was easy for them to recruit the suitable employees and there has been a high level of retention of R&D staff. They do not have to rely on a high salary or any specific conditions to retain the R&D staff. And the size of the R&D team is in steady growth. On the one hand, in a non-first-tier city like Qingdao, the mobility of people has been kept at a relatively low level. On the other hand, a large proportion of the R&D staff are graduates from the local universities or are local people (i.e., in the same province), which contributes to the stability and encourages employees to develop firm-specific knowledge.

Furthermore, in the R&D investment, besides relying on internal sources of capital, marine firms in Qingdao require external sources of finance. According to the fieldwork interviews, funding in the form of tax returns, funds, rewards, and subsidies from governments on different levels (see more details in Section 5.7.1) constitutes a major source of external finance, which directly contributes to the innovation of marine firms. According to the firm interviews, in the three years from 2017 to 2019, different kinds of governmental funding accounted for around 14.74% R&D expenditure of the sample marine firms in Qingdao. The percentage is slightly higher in the sample MBPFs in Qingdao (~16.85%) than in the MEFs (~13.02%) in the same region. How marine firms have approached government financial support will be further illustrated in Section 5.7. Moreover, in accessing external finance, marine firms in Qingdao heavily rely on the bank loans with some firms also using equity financing (mainly through the stock market), and in very rare cases, private lending from family members or close friends.

R&D input of MBPFs

According to the fieldwork interviews, the proportion of the R&D expenditure to sales has remained stable across different years. However, because the sales income increased yearly, the total R&D spending would also keep growing. Besides, though most MBPFs in Qingdao argued that their innovation currently focuses primarily on generic drugs and biosimilars with some investment in innovative drugs, innovation of firms in this industry involves higher risks, uncertainty, and time, and requires more investment and capital compared with other sectors.

Under two major circumstances, the R&D spending would significantly increase. Firstly, despite the budget plan, the R&D input will increase if there are important R&D projects to be launched. For example, the interviewee from QMBPF3 mentioned that they had an R&D project a few years ago with an initial investment of around 300 million RMB yuan, which was several times their sales revenue at that time. Secondly, for MBPFs, particularly those young and research-driven companies targeting innovative drugs, their R&D spending can be exaggeratedly high in the early years of their establishment, particularly because of the low sales revenue. As argued by the interviewee from QMBPF5 - a university spin-off whose innovation involves more advanced technologies and seeking to be the industrial pioneers,

> *"For new companies in this industry, earning money in the first several years would be hard. All money is invested in R&D. Gradually, we had some products going on the market, and the profits of drugs are generally high. So, the proportion of R&D to sales will also return to normal." (I_QMBPF5).*

Because of the existence of this company and its extreme data in the ratio of R&D expenditure to sales, the overall regional scale of R&D expenditure in Qingdao has been levelled up. Besides, regarding the proportion of R&D personnel to the total headcount, MBPFs usually maintain the R&D teams in large sizes partly resulting from the science-driven nature of innovation in this sector. Among the sample MBPFs Qingdao, even the firm with the smallest R&D team (i.e., QMBPF6) has accounted for 11% of the total number of employees in this company.

R&D input of MEFs

The R&D spending of the MEFs in Qingdao in the three years from 2017 to 2019 was stable with no significant differences across MEFs in different ownership structures, sizes, and histories. Belonging to an industry where the innovation involves lower risks but relies more on the continuous improvement and refinement of products and the enhancement of manufacturing and production efficiency - investment in equipment is not counted as R&D expenditure, there is a lower chance for MEFs to meet sudden occasions to significantly improve the R&D expenditure. According to the technical manager from QMEF5, "*this is an industry with the relatively low level of R&D input. On the industrial level, it would be outstanding if the level of R&D expenses relative to sales can attain 3.5%.*" (I_QMEF5). The level of R&D expenditure in Qingdao indicates a high level of commitment to innovation.

Concerning the input measured by the R&D personnel, sample MEFs in Qingdao maintain 11.20% of R&D staff on the regional average level. Because of the industrial features and innovation direction, to most MEFs, a large proportion of their R&D staff are technical engineers and skilled workers who have rich experience and professional operational skills to facilitate the design and test of products and tackle specific technical problems. Purely research-driven staff accounts for a generally low percentage in the MEFs.

5.2.2 Innovation platforms of marine firms in Qingdao

While the R&D expenses and personnel across several years are the direct and quantitative ways to measure the commitment to innovation of marine firms, different kinds of company-based innovation platforms mentioned in Section 4.5.3, as the official approval to the innovation capabilities, calibrate the innovation commitment as an integrated indicator from an indirect and qualitative perspective. Across the sample marine firms in Qingdao, three-quarters have established the innovation platforms granted by the government on different levels, which covers nearly 90% of the sample MBPFs and around two-thirds of the sample MEFs. The wide coverage indicates the commitment of marine firms in Qingdao, though the specific levels and types of these platforms vary across firms. And the higher levels and the more diverse kinds of innovation platforms are often associated with the higher level of commitment and innovation capabilities of the firms.

According to fieldwork interviews in Qingdao, being qualified for corporate-level innovation platforms can help firms build the corporate brand image, strengthen the corporate innovation system, and attract more resources, especially in attracting talents, approaching new innovation collaboration opportunities or governmental S&T innovation projects. For example, QMBPF1 have established different kinds of platforms on different levels such as the national key lab, the national S&T centre, the national-regional coordinating engineering R&D centre, and the provincial-level and regional-level key labs and S&T research centre and expert workstations. As argued by the vice president of QMBPF1,

> *"In our company, the National Key Lab mainly focuses on basic research. The Technology Centre is mainly for the in-depth research of advanced and emerging technologies. The Engineering Centre targets the engineering and industrialisation of technologies. And the Academician Workstation and Post-doc Workstation help us to attract high-end talents to facilitate innovation. Moreover, we also build an incubator to support start-ups. We establish the different kinds of platforms in order to support our innovation and build the platforms of collaboration in more comprehensive and systematic ways." (I_QMBPF1).*

5.2.3 Regional patterns of innovation commitment in Qingdao

This section demonstrates the commitment to innovation of marine firms in Qingdao. On the regional level, marine firms in Qingdao have continuously invested in R&D expenditure and human resources and established the firm-based innovation platforms in different types and on different levels. Within the same region, disparities exist across firms, especially across the MBPFs, which is partly a result of the industrial characteristics that different development stages, innovation directions, and innovation projects are highly influential to the R&D input in some years. Moreover, the input of MBPFs tends to be more intensive than the MEFs in the same region due to the different nature and driving forces of innovation, though the industrial differences are not the main analytical focuses of this research. To summarise, based on the numeric data and indicators combined with the qualitative evidence and narratives from firm-level interviews, it can be concluded that, on the regional level, marine firms in Qingdao are generally committed to innovation.

5.3 Interaction between marine firms in Qingdao and customers

Customers constitute one of the most crucial external knowledge sources of marine firms, contributing to the R&D of new products and the improvement of existing products by acting as significant inspirers, knowledge nodes and feedback providers. All companies under investigation have mentioned that to realise innovation success and boost development, their innovation nowadays is predominantly driven by the market demand reflected by the customer needs and requirements, and they initiatively endeavour to interact closely with their customers. Besides being inspired by customers, a large number of marine firms in Qingdao have formed more intensive and interactive relationships with customers by incorporating customers into the innovation process or being included in the innovation of the final products of their customers, which has realised the in-bound and out-bound of knowledge flow in different degrees. The following contents demonstrate the customer relationships of marine firms in Qingdao - the regional majority with cross-firm disparities, investigate the impact of impacts of this relational dimension on the focal firms' innovation, and summarise the relational patterns on the regional level.

5.3.1 Interaction between MBPFs in Qingdao and customers

The composition of MBPFs' customers is diverse, including business companies, hospitals with doctors taking the helm of prescriptions, and individual patients as the final users of products. Upon the implementation of the "two-invoice system" (*liangpiao zhi* in Chinese)[1] and the centralised government procurement targeting generic chemical drugs, drug producers cannot sell human-use drugs directly to individual customers. For over half of the sample firms in Qingdao, public- or private-owned hospitals constitute the essential parts of their customer groups. The rest of the MBPFs that produce animal drugs or supply medical substances mainly target business customers. However, because of the speciality of the products, it is inevitable to characterise the roles of doctors and patients. Therefore, this analysis will not make a clear distinguishment of the buyers, users, and prescribers. The relationship between

[1] See details of the drug circulation process in China in Appendix I.

MBPFs in Qingdao and their customers is mainly featured by the obligational pattern, which facilitates MBPFs' innovation in different aspects (see Appendix J for details of individual firms).

Geographical sources of customers and the interacting basis

Even though the innovation and business directions of the MBPFs demonstrate significant geographical feature, the sale of their products in the form of drugs or medical substances are determined by the effects, indications and usage, which faces little constraint in the geographical terms. This is different from the supplier relationships analysed in Section 5.4.1. Because of the industrial specificities, the customer sources of MBPFs are diverse. Except for QMBPF3, all sample MBPFs in Qingdao state that they mainly trade and interact with domestic customers. Their customers are distributed all over the country but particularly the first-tier cities like Beijing and Shanghai and the provinces with a large size of population such as Shandong which Qingdao belongs to, Jiangsu and Henan provinces.

Shandong where these firms are located is an important locality that has gathered a large number of customers or users, which generates locational advantages for MBPFs. According to the interviews, most sample MBPFs in Qingdao mentioned the advantages of physical and cultural proximity they enjoyed with the inner-provincial customers. On the one hand, MBPFs in Qingdao can easily approach and build connections with customers in the same region. On the other hand, knowing better about the intra-provincial policies regarding medicine procurement and distribution, and the needs, common diseases and habits of drug usage of the local customer bases, MBPFs enjoy cultural closeness to the local customers.

MBPFs' interaction with customers does not entirely depend on whether they have already established trading agreement, especially in terms of new product development. Customers usually participate in MBPFs' innovation as the stakeholders to the end products. In this context, almost all the sample MBPFs in Qingdao argued that the long-term relationships and trading experiences with the customers (and users) have been important to their interaction in innovation. The accumulated trust in the long run is highly conducive. Besides, while customer sources are diverse, the bridging roles of the local UPRIs that have close collaborative relationships with both

MBPFs and their customers in hospitals or business firms provide an important underlying basis for the initial establishment of innovation collaboration. These regional advantages associated with the universities have been highlighted by over half of the sample firms. Similarly important are the personal relationships between doctors and the research and technical staff of MBPFs characterised by one-third of the sample firms, which facilitates the interaction beyond the trading relationships.

Obligational relationships with customers

No matter whether the final products are used for human patients or ailing animals, the drug innovation process involves a high level of risk. The innovation process of the MBPFs' products, from the concept to the final products on the market, is usually long, which involves various uncertainties and requires strict examination and review processes to obtain approval. The innovation of generic drugs often takes at least three years. Customers participate in the different stages of innovation in various ways.

(a) Customers as sources of innovation ideas

Market research and feasibility analysis are essential tasks for MBPFs in the early stage of their new product innovation. Due to the complexity of products, the innovation of firms in this sub-sector is not that sensitive to market dynamics and customer demand. Therefore, the customer views are mainly general- and disease-oriented, which influences MBPFs' innovation in more indirect ways. According to the interviews, through interacting with customers, MBPFs are enabled to know the latest trends in the market and clinical needs, which forms the very early concepts of innovation. As commented by the CEO of QMBPF2 - an animal drug producer, with numerous directions of innovation, the demand of their main customers serves as the insights to start the innovation.

> *"The trendy disease guides our innovation directions. For example, when the African swine fever was spreading, our customers suffered a great deal of loss. Under this condition, we quickly shifted the R&D focus to this disease. We have established a long-term collaborating alliance with our main customers. We frequently ask them if they have met any problems that we may be able to address. On some occasions, they would come to us for a solution." (I_QMBPF2).*

Similarly, MBPFs learn from doctors and prescribers in hospitals about the practical usage of products. As argued by the research manager from QMBPF4,

> *"Before officially launching and starting an innovation project for a new product, we would talk first with doctors in hospitals, so that we can know what products are expected for in clinics." (I_QMBPF4).*

(b) Customers as important sources of external knowledge

Besides being inspired by innovative ideas, sample MBPFs in Qingdao learn from customers in the innovation process through information exchange. Acknowledged by most MBPFs in Qingdao, customers are important external sources of knowledge to them. With limited resources and capabilities internal to the company, MBPFs require knowledge about disease and clinical practice, which is critical to their product design. Besides, after the experiment stage in the lab, comments from users in the later stages of the clinical or field trials are essential for the successful launch of new products. The relationships with customers facilitate the in-bound knowledge flow of MBPFs from customers. As mentioned by one interviewee,

> *"Our knowledge, capabilities, and expertise concentrate more on the fields of pharmacology and toxicology, which is insufficient to fulfil the product innovation. For different aiming diseases, the effecting mechanisms are different. Therefore, we often demand practical knowledge such as disease-specific information from hospital physicians or technical staff in farmers." (I_QMBPF4).*

Furthermore, QMBPF1 and QMBPF5 have forged more interactions with their customers by co-R&D of new products, which involves a higher level of exchange of information, resources, facilities, investment, and risks. This kind of collaboration is often included as an important part of their strategic collaborative relationships aiming to develop innovative products in emerging areas, which can hardly be reflected in the innovation outcomes in the short term.

(c) Customers as feedback providers

Moreover, MBPFs in Qingdao also closely interact with customers in the marketing and after-sale stages. On the one hand, as the developers and producers of products, MBPFs need to specify the use of drugs, the reacting mechanisms and possible symptoms and reactions to their customers such as doctors, individual patients, and farm managers. This ensures the attainment of the appropriate conditions in product usage, thus ensuring the realisation of the expected effects of products and the effectiveness of innovation. On the other hand, collecting feedback, especially the side effects and allergic reactions, from customers constitutes an important part of their collaboration. Due to the specificities of drugs and medical products in influencing health, the feedback loop between MBPFs and customers is highly necessary, which pushes the continuous improvement of existing products.

5.3.2 Interaction between MEFs in Qingdao and customers

To the sample MEFs in Qingdao, their main customer groups are constituted by business firms (~100% of the sample). A small number of sample equipment firms have also built vertical relationships with the UPRIs (e.g., QMEF1 which manufacture equipment for scientific expeditions) and individual customers (e.g., QMEF10 which manufacture yachts and pleasure boats). In addition, the geographical sources of their customers are also diverse, while Qingdao provides a number of locational advantages to the MEFs. Nevertheless, the customer relationships of MEFs in Qingdao are featured by the obligational pattern (see Appendix J for details of individual firms).

Geographical sources of customers and the locational advantages

According to the fieldwork interviews, the customers of MEFs in Qingdao demonstrate higher degrees of internationalisation with nearly half of the MEFs (~44% of the sample) mentioning that overseas companies constituted roughly half of their customer groups. Despite this, domestic customers are still the primary sources of the MEFs' customers. Besides, due to the products' specificities, the customers of MEFs are mainly located in coastal areas. Their domestic customers concentrate in coastal cities, such as Qingdao, Yantai, Dalian, and Ningbo. In this case, the locational choice of Qingdao becomes important to the MEFs and their interaction with customers.

Qingdao offers MEFs several advantages. First of all, being situated in this city enables many MEFs to obtain advantages in proximity to the coastal customers in Qingdao, or in other marine cities within the Shandong Province (e.g., Rizhao) and other northern regions in China. This becomes an important reason behind the decisions of many firms to establish in Qingdao in the beginning. In addition, Qingdao provides sites and marine infrastructures like ports, harbours and docks for MEFs, which is crucial for the building, testing and further delivery of products such as the ships and the drilling platforms. It is also an important aspect of their customers' consideration in selecting collaborating MEFs. Lastly, as a well-known marine city in China, Qingdao often organise marine trading fairs and exhibitions, such as the Ocean Science and Technology Exhibition, and the East Asia Marine Exposition. This provides MEFs with opportunities to approach new customers and establish connections.

Obligational relationships with customers

The majority of the MEFs in Qingdao proactively seek to maintain close interaction with their customers based on the relationships built on the trades, which has strongly influenced the innovation process of the sample MEFs. Because of the industrial specificities and technological maturity, customers often influence the innovation of MEFs in the direct manner.

(a) Customers as sources of innovation ideas

Customers are also important external sources of MEFs' innovation ideas. Sample MEFs in Qingdao argued that their customers often proposed specific requirements for the products. In such a context, MEFs' innovation is directly oriented by the customer needs. Because of the relatively lower uncertainty in the innovation of equipment and machinery, the outcomes of product innovation are more expectable, which means that the customer demand can be better responded to and satisfied.

In such context, besides a few sample firms whose innovation involves many new analytical designs (e.g., QMEF1), the innovation of MEFs in Qingdao mainly centres on the modification and improvement of the product design and engineering for the specific application scenarios, which is significantly dominated by the customers. In this process, the experiences and expertise of MEFs are important in validating the feasibility of customer ideas and transferring these thoughts into the practical implementation. The interviewee from the QMEF2 producing ship-used consoles mentioned that,

> *"We have to adjust our products by taking into account several situations such as the shape of the boat, the power transmission and distribution system, and the operation habits, which often vary across different customers." (I_QMEF2).*

(b) Interaction with customers in the innovation process

Most innovation interaction between MEFs and customers is based on the trading agreements or projects that are currently going on. Because the innovation of MEFs demonstrates the feature of customer orientation, customer feedbacks in the process of product design and development are important for the MEFs. According to the fieldwork interviews, MEFs in Qingdao are generally proactive innovators that seek to double check customer needs and collect customer feedbacks in different stages of product development. Customers are also willing to participate in the MEFs' innovation process, especially in the detailed product design and testing stages, though they are not obliged to do so.

Besides, nearly half of MEFs state that, when they meet product design and development problems, customers are willing to offer help by sharing knowledge, technologies, and technical or engineering staff. By discussing with customers and continuously improving product design and specificities, MEFs would obtain external sources of knowledge and technologies, develop capabilities of product design and engineering, and accumulate project experiences. Also, MEFs have formed a high level of project-based trust with customers The trading experience and the accumulated project-based trust would gradually transform their relations into more interdependent ones, which generate mutual trust built on competence and goodwill. As mentioned by the interviewee from QMEF4,

> *"There are many engineering staff from the side of customers who will participate in the project. For one thing, due to the complexity of the product, the on-site stay of customers is to ensure (i) their requirements are well understood by us and (ii) there are no obstacles in our communication. For another, their engineers are willing to help us in the product design and provide professional insights and guidance from their side." (I_QMEF4).*

Furthermore, according to the data collected from Qingdao, the collaboration between MEFs and customers in innovation takes place in other forms. Several MEFs would co-design and co-accomplish the innovation of a new product with their customers, which often occurs in the government-funded S&T programmes, for example, the 863 project, that MEFs are incorporated as an important part to tackle a crucial technical problem. Moreover, nearly two-thirds of sample MEFs in Qingdao mentioned that, besides benefitting from customers in innovation ideas and product design, they have increasingly focused on the provision of services and the whole set of development plans around their products. As mentioned by the interviewee from company QMEF3,

> *"In most cases, we do not only provide a single product but an integral plan or solution relevant to the products provided by us." (I_QMEF3).*

The different modes of collaborative relationships with customers by involving the high levels of information exchange and some extent of resources and risk sharing directly facilitate the innovation of MEFs. Due to the customisation, MEFs and customers would continue their interaction for the later maintenance and repair of products. However, also resulting from the high degree of customisation and interexchange of information in the innovation process, the sample MEFs demonstrate lower reliance on customers to obtain after-sales feedback on the continuous improvement of the existing products. Moreover, on some occasions, the over dependence on a specific group of customers may cause the lock-in problems of MEFs that restrict their business potentials, technological capabilities beyond the existing expertise, and the further market expansion in the long run.

5.3.3 Regional patterns of business-customer relationships in Qingdao

According to the above analysis, marine firms in Qingdao have generally formed a close interaction with their customers, which demonstrates the ***obligational*** pattern and benefits marine innovation. Table 5.2 labels and summarises the key characteristics of the regionally dominant pattern of customer relationships. Even though the customer sources of marine firms in Qingdao are diverse demonstrating the extra-regional or even international features, Qingdao provides locational advantages to the marine firms in the aspects of (i) the proximity to coastal customers, especially those in the same province, (ii) the bridging roles of the local UPRIs, (iii) the marine infrastructures that are important to customers' selection, and (iv) the organisations of different kinds of marine-related exhibitions and trading fairs. However, the regional market is too to satisfy the development of marine firms.

Table 5.2. Business-customer relationships of marine firms in Qingdao

Dimensions of customer relationships	Marine firms in Qingdao
Establishment of innovation interaction	• MBPFs: disease-driven and non-trade-based, interactive basis include the collaborative experiences, relies on the coordination of the local UPRIs and the regional-related personal relationships. • MEFs: trade-based, Qingdao offers significant locational advantages in facilities and events.
Communicating frequency	Frequent
Length	Long-term
Intensity of innovation interaction	High
- **Information exchange**	High
- **Resource sharing**	• MBPFs: limited • MEFs: some (firm dependent)
- **Risk sharing**	Limited
Trust	• MBPFs: goodwill trust • MEFs: competence and goodwill trust (some are accumulated from the project-based trust)
Relational pattern	**Obligational**

Sources: fieldwork interviews.

Specifically, while the interaction between MBPFs and customers is mainly disease oriented, which influences the innovation in more indirect ways, MEFs' innovation is directly driven by customer demand and their interaction in innovation is also dependent upon their trading relationships. While MBPFs interact with customers mainly in the early stage of marketing research and in the experimentation and test, and the after-sales feedback, MEFs collaborate with customers closely in product design and engineering. These differences lead to the reliance on goodwill trust by the MBPFs in the innovative collaboration with customers, and the long-term oriented trust in competence and goodwill between MEFs and customers transformed from the project-based type. Despite the differences in the sub-sectoral features and the cross-firm differences in the specific forms and details of collaboration with customers, through long-term and frequent interaction, marine firms in Qingdao have demonstrated a high level of homogeneity in the interactive relationships with their customers, which builds a strong basis to sustain the vertical collaboration.

5.4 Interaction between marine firms in Qingdao and suppliers

Suppliers are essential to the vertical chain of the relationships of a manufacturing firm. Similar to customer relations, innovation collaboration with suppliers is usually embedded in trading relations. This section analyses the relationships between marine firms in Qingdao and their suppliers.

5.4.1 Interaction between MBPFs in Qingdao and suppliers

The business and innovation of MBPFs require the supply of materials and equipment. On the one hand, depending on the differences in the types of materials, MBPFs in Qingdao interact with various kinds of suppliers from different sources. On the other hand, the R&D-intensive characteristics make accuracy and quality the prerequisite of equipment, which determines the common preference of the MBPFs in selecting foreign equipment suppliers. Despite these industrial commonalities that influence the supplier relationships of the MBPFs in Qingdao, firm cases differ in several aspects but demonstrate the dominant pattern of arm's-length relationships with suppliers on the regional level (see Appendix J for details of individual firms).

Proximity to the marine materials and similar choices of other suppliers

MBPFs manufacture products by using and extracting the components or lead compounds from marine organisms or for ocean use. Therefore, an essential part of their material demand is the raw materials from the ocean, such as marine life, microorganisms, and algae, which can mostly be satisfied by the suppliers from the local or nearby coastal areas such as Yantai (in the same province) and Dalian (in the nearby Liaoning province) [1]. In such context, Qingdao provides these MBPFs place-

[1] QMBPF1 and QMBPF3 have integrated the supply chain of these marine materials either by setting up their own cultivating materials bases overseas or domestically. The integration of the supply chain

specific advantages in the proximity to the supplying base of the marine materials and determines the locational choices of some firms (e.g., QMBPF2 and QMBPF5) in setting up the factories and manufacturing bases.

In addition to the marine materials, MBPFs in Qingdao also have a large demand for the normal materials such as reagents, active pharmaceutical ingredients (API) and pharmaceutical excipients that are common to the manufacture of drug or bioproduct producers. Qingdao lacks such supply bases. Pursuing higher levels of precision and stability, a few MBPFs would import certain materials from European countries. But the majority (~over three-quarters) of MBPFs buy materials that come from domestic areas, such as the provinces of Hebei, Jiangsu, and Anhui. As argued by an interviewee,

> *"APIs are mainly controlled by several large domestic enterprises such as Shijiazhuang Pharma Group. As for Chinese medicines, the origins of natural materials are important. That's what we call 'authentic medical materials' ("daodi yaocai" in Chinese). As for the pharmaceutical excipients, there are limited differences across different suppliers." (I_QMBPF4).*

Moreover, situated in a highly competitive industry, MBPFs in Qingdao tend to invest significantly in equipment. Nearly all the sample MBPFs stated that they would prefer equipment made in Germany, Japan, and the United States, especially for the core devices, such as the bioreactors, the freeze dryers and testing equipment, despite their higher prices sometimes being well over two or three times the domestic ones. Sample MBPFs argue that the imported equipment can achieve a higher level of automation, testing accuracy and efficiency and lower energy consumption so that enable them to reduce the risks of innovation at least from controllable aspects. This is more evident in biomedicines that are sensitive to the manufacturing process.

The prevalence of arm's-length supplier relationships

The majority of the MBPFs in Qingdao rarely learn from material suppliers in innovation. They exchange information about price and market and negotiate the delivery time and material quality. However, most of the materials are basic and stable

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enables them to control the materials from the sources, reduce the reliance on external suppliers, which constitute important aspects of their internal innovation.

without large room for improvement or cannot be modified. The technological expertise of MBPFs centres on processing, fermenting, and synthesising, which is also the central innovation process of generic drugs (i.e., from API or other materials to Preparation[1]). For innovative drugs, the discovery of new chemical entities, molecules and targets is more essential. Though an important assumption of developing marine drugs is that marine life can be important sources of lead discovery, this is beyond the R&D capabilities and innovation strategies of most sample firms in Qingdao. Furthermore, nearly half of the sample MBPFs in Qingdao select suppliers through public tending or invitational tendering targeting a limited range of suppliers in their supplier pools or purchase catalogues. Once the suppliers are selected, MBPFs would not easily replace suppliers due to the "related review requirement" (*guanlian pingshen* in Chinese) in China. As argued by an interviewee,

> *"Quality control of drugs and medical products is strict. If there were no extremely severe quality or trust problems that breach the contract, we are unwilling to change suppliers to avoid unnecessary costs and document work." (I_QMBPF2).*

Moreover, as equipment is essential to MBPFs because it influences the quality and precision of the final products and the efficiency and capacities of the process of innovation and production, MBPFs in Qingdao mentioned that they designed the production line and established the standardised manufacturing processes. Besides complying with Good Manufacturing Practice, equipment often needs to be modified in moulds or shapes. In this aspect, most MBPFs in Qingdao turn to equipment suppliers who are more specialised in equipment design and planning the production system but with written contracts that restrict the selling of the modified products (e.g., the specifications of modules) through invitational tendering or negotiated bidding[2]. However, this kind of interaction is discontinuous, which usually happens in the initial establishment of companies. And the aim of MBPFs is to realise their core technological expertise, standardise the manufacturing process and improve the efficiency of production, and adapt to the space of the workshop, their interaction

[1] Drugs intended for human or veterinary use are presented in their finished dosage form. See the definitions from the National Library of Medicine: https://www.ncbi.nlm.nih.gov/mesh?Db=mesh&Cmd=DetailsSearch&Term=%22Pharmaceutical+Preparations%22%5BMeSH+Terms%5D.

[2] This often occurs when there is only one or two suppliers can satisfy the firms' requirements.

with the equipment firms would not extend their knowledge boundary to co-solve problems met in innovation or to innovate.

Deviant MBPF cases in Qingdao

A few MBPFs in Qingdao demonstrated supplier relationships different from the regional dominance. QMPBF2 and QMBPF5 both build obligational relationships with material suppliers but have different innovation outcomes. Company QMBPF2 is a company producing animal drugs. According to the CEO, their interaction with suppliers generates important insights to their suppliers to improve production efficiency and process innovation. However, besides enhancing the mutual understanding, QMBPE2 hardly enjoys the innovation outcomes of suppliers in the short term. Differently, QMBPF5, as a university spin-off company, has a strong research background and cutting-edge technological capabilities. This firm has forged joint R&D agreements with core suppliers to discover new chemical entities and co-develop new reagents used for drug production. In their interaction, they learn from each other and combine their expertise, which has transcended the normal vertical relationships between customers and suppliers but more like cooperating alliance partners. This benefits the focal firm's innovation over a long time.

5.4.2 Interaction between MEFs in Qingdao and suppliers

The suppliers of MEFs can be distinguished into the suppliers of materials, components, and equipment. To most MEFs in Qingdao, materials and components are both important to their production. And equipment is also an essential source of MEFs' improvement in process innovation. The relationships between the MEFs in Qingdao and their suppliers demonstrate the regionally arm's-length pattern with several firm cases that have built more intimate supplier interactions (see Appendix J for details of individual firms).

Limited reliance on the local source of suppliers

As for the sources of MEFs' suppliers, the regionalised feature is not so evident. Most of the interviewed MEFs in Qingdao choose suppliers from domestic areas, especially the southern coastal regions such as the Jiangsu province. Generally speaking, Qingdao where the economy was traditionally dominated by the large SOEs has not built a strong and well-developed supply base for the MEFs. However, several sample MEFs in Qingdao, particularly the SOEs, also indicate a preference for the local suppliers. For these companies, after years of development in this region, they have maintained a group of local suppliers who live upon them. As will be referred to in Section 5.7.2, the cooperation of the local government agencies is also critical in nurturing of the local supplying networks surrounding the large central SOEs. Compared with the component and material suppliers, foreign firms are more important to the supply of equipment for MEFs in Qingdao. Transnational connections account for over one-third of the supplier relationships of the sample MEFs. Nevertheless, in the recent few years, more and more MEFs have increasingly shifted to domestic equipment suppliers for similar quality but easier access and lower price.

Dominant arm's-length relationships with suppliers

According to the fieldwork interviews in Qingdao, the MEFs innovation capacities are largely dependent upon the performance of key materials, such as metals, alloys, and high polymer materials. However, to the majority of the MEFs, the materials presently available on the market can well satisfy their product requirements. Therefore, the long-term but trading-based supplier relationships sustain the innovation of MEFs in Qingdao, though the marine firms seldom learn from the material suppliers. For the MEFs in Qingdao, though intrinsically similar in the interactive patterns, their relationships with material suppliers and component suppliers demonstrate somewhat different degrees of intensity.

Different from the interaction with material suppliers, the MEFs in Qingdao engage more closely with their component suppliers. As Section 5.3.2 discusses, innovation of MEFs often involves a high level of customisation driven by the customer need, which also leads to some extent of modifications of the key components. However, the innovation of MEFs centres on product design and engineering. By strictly elaborating the design and specificities of the required components, the interaction with suppliers involves little knowledge flow from external sources to the MEFs and has not extended their knowledge boundary either. In other words, MEFs in Qingdao rarely learn from the component suppliers.

According to the fieldwork interviews in Qingdao, despite the commonalities in the long-term and frequent interaction, MEFs have demonstrated some intra-group differences behind the long-term orientation. Most SMEs, though being customers, actually stand at the weaker positions in trading with large suppliers of materials. With restrictive bargaining power and facing limited choices of suppliers, especially in terms of the material and equipment suppliers, their frequency of switching suppliers has been reduced. Attracted by the reputations and competencies of large suppliers, they are more likely to commit to the existing customer relationships. However, with trust built upon the contracts and competence, most SMEs argued that there would be a large possibility to replace the existing suppliers with better choices. This also determines the arm's-length nature of the supplier relationships.

Many MEFs in Qingdao, as the leading SOEs, face stricter rules on supply chain management. Goodwill trust is hard to achieve. Thus, on the one hand, they would rely on public tendering to approach new suppliers. On the other hand, they also emphasise building their supplier bases based on the revision and regular examination of the candidate suppliers' credentials and abilities. This is combined with the efforts to establish the local supply base in Qingdao mentioned above and later in Section 5.7.2. To these SOEs, because of their large sizes, the central state-owned background, or their outstanding technological capabilities and business performance, they usually enjoy dominant negotiation power over the price, payment and delivery time, and have flexible choices over a large group of suppliers. This causes the asymmetry between their relationships with small suppliers, which further reduces the reliance on goodwill trust.

Moreover, the investment in the equipment is an important way for MEFs to enhance manufacturing efficiency and hence facilitate innovation capabilities, especially process innovation. However, most sample MEFs in Qingdao only require the standard equipment, which requires little customisation. Also, the equipment can generally operate for five to ten years or even longer. Thus, most of the sample MEFs in Qingdao describe their relationships with the equipment suppliers as one-shot deals. Several firms require the customisation of equipment. For example, QMEF2 and QMEF3 have built collaboration with equipment suppliers to fulfil the overall design and improve the automation of their production lines. QMEF1 also mentioned that it has experiences of providing feedback to the equipment producers and has benefitted from the improvements of equipment, which rarely happens. Therefore, despite the innovation of MEFs in Qingdao has been enhanced by purchasing equipment, their relationship with equipment suppliers is less frequent than with component and material suppliers. And their interaction is limited to the training on the equipment use, the maintenance and the repair within the warranty period. As argued by an interviewee,

> *"After the warranty period, we would repair by ourselves or contact a local repairing team. Contacting the equipment manufacturer for the repair or maintenance often costs too much." (I_QMEF7).*

Obligational firm cases

Though it is not a regional phenomenon, a few MEFs in Qingdao have built obligational forms of supplier relationships. Specifically, the interviewee of the QMEF9 mentioned that they have forged exploration-driven collaboration with material supplies beyond the trading relationships. Believing that its innovation is affected by the new technologies in the related material sector, QMEF9 opens to the possibility of new product design based on the latest refinement of materials by forging more close interaction with the material suppliers. As referred by the interviewee from QMEF9,

> *"On some occasions, the suppliers bring us new materials and we would collaborate to co-design a product and do the following-up test and experiments of the materials. This is mainly future-oriented and has not brought many benefits to our innovation and business by now." (I_QMEF9)*

Besides, QMEF2 is a company producing ship-used consoles. Situated in a competitive market dominated by mature technology, its innovation emphases on product design, which is highly contingent upon the performance of the electric components. By establishing strategic relationships with its core supplier, it obtains access to the most advanced components and sometimes learns from the supplier to satisfy the specific customer demand. Besides, the strategic collaboration and the reputation of the supplier constitute a key part of QMEF2's innovation capacities, which enables it to expand to the larger market. However, the case of QMEF2 also illustrates the limitation of the intense collaboration with the supplier only. Though QMEF2 has accumulated experience and professionalism in product design and engineering, the overreliance on the specific supplier and the dominance of the supplied components combined in innovation are likely to restrict the innovation of this firm and increases the operational risk in a long time.

5.4.3 Regional patterns of business-supplier relationships in Qingdao

The above analysis has shown that the relationships between marine firms in Qingdao and their suppliers are mainly ***arm's-length*** trading relations. Overall, the supplied materials, components, and equipment contribute by injecting stability and facilitating the realisation of innovation and production, while marine firms seldom learn new knowledge, insights, and technologies from suppliers through interaction. The region of Qingdao offers firms closeness to marine materials suppliers and the local supply base of components, while it has not formed regionally clustering advantages of marine-related sectors identified to be increasingly important to marine clusters as demonstrated in Section 3.4. To a large extent, marine firms in Qingdao rely on interactions with extra-regional relationships with suppliers. Table 5.3 summarises the key characteristics of the supplier relationships and labels the regional-level dominant patterns.

Table 5.3. Business-supplier relationships of marine firms in Qingdao

Dimensions of supplier relationships	Marine firms in Qingdao
Selection of suppliers	Quality > experience > price
Communicating frequency	Frequent with material (and component) suppliers, infrequent with equipment suppliers
Length	Long-term-oriented with material suppliers, heterogeneous with component suppliers, discontinuous with equipment suppliers
Intensity of innovation interaction	Low
- **Information exchange**	Low with material and equipment suppliers, some information exchange with component suppliers (MEFs)
- **Resource sharing**	Limited
- **Risk sharing**	Limited
Trust	Mainly contractual trust
Local advantages	Local supplying base of marine materials to MBPFs and some components, not evident in general

Relational pattern	Arm's-length

Sources: fieldwork interviews.

Moreover, some sample firms have built goodwill trust and obligational relationships with their suppliers (mainly in components and materials). However, this is highly dependent upon the firm-specific characteristics and combines the use of arm's-length relationships with other suppliers. Their obligational supplier relationships can be ideal for the specific firms, while they are not the phenomenon on the regional level. More importantly, the firms with obligational relationships with suppliers have not demonstrated to be more successful in innovation or market performance when compared with their counterparts with arm's-length relationships in the same region. Therefore, supplier relationships must be reviewed in combination with other relational factors.

5.5 Interaction between marine firms in Qingdao and competitors

This section demonstrates the relationships between marine firms in Qingdao and their competitors. Unlike vertical interactions, collaboration with competitors is not a regional phenomenon across firms in Qingdao. Besides characterising the regional situations of competitors relationships, this section explores the marine firms that have established cooperation with competing firms aiming to understand the conditions upon which their collaboration has been established and interpret the influences of competitor relationships on the marine firms' innovation, especially in the regional context of limited interactions with competitors.

5.5.1 Sources of the competitors

Horizontal collaboration with companies in either the same or different industries is an important kind of external relationship for marine firms. This section mainly focuses on the interaction with firms in the same sector.

Geographical sources

According to the data collected from Qingdao, were asked about the sources of their main rivals, most of the interviewees argued that their competitors came from other domestic regions in China. Frequently mentioned areas include Hainan, Jiangsu, and Guangdong provinces by the MBPFs and the provinces of Jiangsu, Zhejiang, and Liaoning by MEFs. Besides, about one-third of the sample companies argued that their main competitors are foreign firms. Also, similar to the costal stickiness of the reported sources of customers and suppliers, when most marine firms argued that the sources of competitors come from other domestic coastal areas, the sample firms seldom recognised other firms in the same industrial field in Qingdao - the "so-called competitors" as the main rivals.

The reason behind the non-regional recognition of competitors is partly because of the differentiating development of the marine sector, especially in the marine equipment sub-sector, within the regional scope of Qingdao. In this aspect, the industrial agglomeration of marine firms relies on gathering different marine firms in the related industrial fields but with differentiated capabilities in the same region. This reduces the direct intra-regional competition between firms and enhances the regional attractiveness to suppliers and customers with the marine sector in multiplicity.

Identifying competitors

According to the interviews, marine firms usually treat enterprises that (i) are industry leaders or (ii) are equipped with similar capabilities and hold similar industrial positions as main rivals, especially the latter. On the one hand, though belonging to the same marine sub-sector, firms are specialised in different technological fields and have different innovation directions. As exemplified by the QMEF4 and the QMEF7, they both produce offshore platforms but for different use. While QMEF4's products are mainly used for oil drilling, QMEF7 is mainly focused on the offshore platform for workers' living support in the offshore operation. They have no direct competition. On the other hand, firms' innovation and business directions differ upon their sizes, capabilities, and market positions[1].

[1] As argued by an interviewee, *"there is another company doing the same business as us in the same district. However, their scale, technological capabilities, sales, and output value are not comparable with ours, and we do not see them as competitors."* (I_QMBPF1).

5.5.2 Interaction between MBPFs in Qingdao and competitors

Collaboration with competitors is not a regionally widespread phenomenon in Qingdao. Four sample MBPFs under investigation have such experiences, while the forms, contents, and intensities of collaboration vary across different firms, which influences the marine firms' innovation in different ways.

Project-based collaboration

QMBPF9 has built project-based collaboration with domestic competitors outside of Qingdao. Their interaction happens when the focal firm faces constraints in time or resources. Focusing on generic drugs, efficiency is crucial for the firms like QMBPF9. However, investing in specific equipment or facilities for non-recurrent or urgent tasks is not the most cost-efficient way for them. Therefore, by agreeing on the contents in the written contracts, QMBPF9 would "buy" technical services from competitor firms, through which its product innovation benefits from the partnership, while its innovation still significantly depends on the internal capability configuration. As argued,

> *"We entrust the competitor firms to undertake tasks like some experimental tests. We first do on-site auditing to check their R&D capabilities and sign contracts and agreements. There involves no exchange around the intellectual property rights." (I_QMBPF9).*

Strategic collaboration

A few MBPFs in Qingdao have built strategic collaborations with competitors or "so-called" competitors. The relationship between QMBPF1 and its overseas competitors is a typical example. Holding the world-leading position in the market of bioproducts based on marine algae, QMBPF1 holds both marketing and technological advantages and pursues cutting-edge technologies and industrial application by product design. By setting up the joint venture, QMBPF1 collaborates with competitors (i) to develop new products for expanding the market based on the specific technological advantages but without sharing the core technologies and IP rights, and (ii) to conduct exploration-driven co-R&D of revolutionary products and technologies. This not only enhances the innovation and the market position of QMBPF1 but also opens possibilities for new markets and innovation directions.

Besides, QMBPF5 and QMBPF8 have built innovation cooperation with each other, and they would not treat each other as competitors**.** As a university spin-off, QMBPF5's collaboration with QMBPF8 is inherited from the university-business relationships lasted for over twenty years. They benefit from each other in their respective advantages of the R&D capabilities and advanced technologies with the research background and the industrial experiences and applied technologies for product development and commercialisation. Initially driven by the aim to develop into the niche market of marine medicines and promoted by the efforts of the local government to bridge the collaboration, their interactive relationships are embedded in the marine featured RIS.

5.5.3 Interaction between MEFs in Qingdao and competitors

Through the fieldwork, it is interesting to find that many MEFs believe that competitors are important sources of their innovation ideas. Nevertheless, these insights are mainly from trading fairs rather than collaborating relationships. Across the MEFs in Qingdao, collaboration with competitors is rare. Less than a third of the sample firms reported that they occasionally collaborated with competitors. There are two major types of cooperative relationships that generate different impacts on the focal firms' innovation.

Collaboration driven by customer demand

According to the interviews, most competitor collaborations are not out of their own initiatives but requested by the customer demand when the innovation and production of new products require joint efforts of different companies (QMFE4, QMEF9). This kind of collaboration is merely project-based and happens within their knowledge boundaries. In such situations, the innovation of MEFs does not benefit much from the interaction with competitors. Their interaction neither continues after the project nor extends to the governance-level partnership. As argued,

"Customers sometimes gather different companies to co-conduct one project. We

would be distributed in different tasks and have some collaboration and information exchange with the competitors for the project aim." (I_QMEF9).

Co-opetition interaction

The "co-opetition" interaction can be exemplified by QMEF8. As one of the first and leading domestic companies in China in the underwater exploration equipment market, QMEF8 seeks to develop more advanced technologies and seize the first-mover advantages in the Chinese market. They collaborate with the market leaders in the same and relevant sectors to co-develop new products, particularly in the aspect of product design, and explore new market opportunities. Though there exist technological barriers, QMEF8 knows well about their advantages and closely follows the advanced technologies emerging on the global market that can complement and reinforce its innovation. As mentioned by the vice president from QMEF8,

"In the area of underwater exploration equipment, the global market is dominated by overseas companies. As the leading company in China, we collaborate with foreign companies by establishing technology exchange, purchase and transfer agreement. This enhances our technological capacities and strengthens our leading position in this field." (I_QMEF8).

By integrating the technology of its competitors in the innovation activities, QMEF8 expands their product line and extends its knowledge expertise through technological exchange and communication. Besides enhancing the corporate innovation performance, QMEF8 is able to penetrate more extensively to the domestic market by providing advanced products with world-leading technologies and better services but at lower prices, which reinforces its competitive position in the Chinese market. Furthermore, although the relationships are not regionally based, the competitor interaction is derived from the place-specific relationships with the local university. In forging the collaboration, the university in Qingdao, especially the academic relations of the researchers, have played important roles as the bridging nodes. This generates localised advantages, which fit the innovation and development strategies of certain firms like QMEF8 in this region.

5.5.4 Regional patterns of business-competitor relationships in Qingdao

This section illustrates those sample marine firms in Qingdao that have interactive relationships with competitors and how their innovation and business development have been influenced by the competitive relationships. This section identifies the positive impacts of obligational collaboration with competitors on the innovation of marine firms, but in neither necessary nor sufficient conditions. However, it would be hard to attribute the performance of these firms simply to the competitor relationships. Though with no or arm's-length relationships with competitors (e.g., QMEF4), some firms also demonstrate innovative outperformance if simply measured by (nominated) patent counts and sales. Therefore, by analysing data,

On the regional level, collaborating with competitors is not a widespread phenomenon shared by the majority of marine firms in Qingdao because of the subdivisions of technical and business fields and the unmatching capabilities and industrial positions. According to the fieldwork, there have been increasingly more industrial associations targeting marine firms established regionally in Qingdao and Shandong province or nationally in China, which aims to facilitate communication between companies in the same industry (illustrated in Section 5.7). Most marine companies covered in the fieldwork also believe that the boundaries between competition and coordination are continuously blurring. Yet only a few of them would like to collaborate with enterprises vying with them out of the lack of appropriate opportunities, collaborative experiences, and more importantly, the concerns about technology leaking.

5.6 Interaction between marine firms in Qingdao and UPRIs

Different from the vertical relationships that are naturally embedded in the trade and competitor relationships rooted in industrial or technical similarities, it is not always necessary for marine firms to build connections with UPRIs. However, UPRIs are identified as important external partners that facilitate the innovation process or relevant aspects of the firms. In the regional case of Qingdao with a strong R&E system, as 5.1.2 discusses, most marine firms have chosen to build collaborative relationships with the local UPRIs. This section characterises the localised feature and the key analytical focus is put on the locally embedded kind of business-research (education) relationships in Qingdao.

5.6.1 Marine firms interact with different UPRI agencies in various forms

Firms interact with the agencies of UPRIs on different levels, as Figure 5.7 shows. Collaboration between firms and lower-level agencies (i.e., individual researchers and research groups) is often project-based and driven by specific technical issues. This kind of collaboration does not always need to go through the administrative department of the university or college, especially if it involves no exchange of IP. Despite the focus on projects or specific issues, their collaboration can be different in the interactive basis, length and orientation.

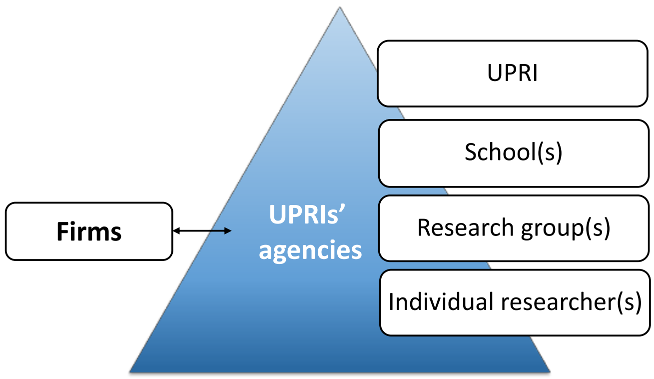

Figure 5.7. Firms collaborate with different UPRI agencies

Collaborations with the university- or school-level agencies often represent a higher-level partnership, often in the form of strategic collaboration, which involves interaction in much broader aspects and in more flexible forms. The strategic alliance is usually underpinned by collaborative experience and accumulated trust. In some situations, the bridging and coordinating role of the government is important. Correspondingly, this kind of collaboration involves higher expectations towards innovation and imposes higher requirements on the companies. In most circumstances, strategic collaboration covers or has been transformed from the innovation interaction between firms and lower-level UPRI agencies.

Multiple forms of collaboration

Innovation cooperation between firms and UPRIs[1] is in multiple ways (see Appendix

[1] From the UPRI perspective, their S&T projects are divided into "horizontal" or "vertical" projects depending on whether the projects are firm-oriented, aiming to solve industrial problems for companies

K), which involves the sharing of resources and risks in various degrees. Firstly, firms and UPRIs collaborate in the ideation of innovation, which sometimes takes place in informal ways. By information exchange, they act as the sources of innovation ideas to each other in a bidirectional way. On the one hand, firms can be inspired by frontier science and technologies. On the other hand, UPRIs obtain access to understand the latest industrial needs, which informs their applied research. While this kind of collaboration only involves sharing resources of information, its interacting basis is contingent upon the specific situations. The exchange of innovation insights is often embedded in other forms of alliances.

In the process of innovation, from the invention and product design to the production and commercialisation, business-UPRI interaction takes place in four primary forms, including (i) technical services, (ii) technical consultancy, (iii) technology transfer, and (iv) joint R&D. These kinds of collaboration, especially the first two, usually aim at the specific technical issues in the innovation process. They can be either formal or informal. Typical examples include companies entrusting UPRI agencies to fulfil certain research tasks, consulting the researchers or asking for help informally when they meet any technical problems. In these cases, firms learn from the UPRIs with knowledge and technology flow from the external sources to the internal of the companies.

Besides, technology transfer is almost the most formal way of interaction between firms and UPRI agencies, which is mainly based on the written contracts as requested by the law because it involves the transfer of IP. Also, according to the interviews with universities, the transferring agreement between firms and individual researchers or research groups usually requires the participation of the university-level agency (e.g., the S&T Office of the university) to avoid the loss of state-owned invisible assets (I_QU1, I_QU2, I_NU2).

Furthermore, incorporating some collaboration in the first three forms, joint R&D involves the higher degree of sharing of resources and risks that the firms and UPRIs "co-invest" in the innovation and share the outcomes or returns. In most cases, the UPRIs would obtain more scientific outputs like academic papers and the firms care more about the business profits. And the co-R&D collaboration can be promoted not

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or aiming for S&T progress and achievements.

only by the cooperating bodies but also by other actors, for example, government agencies. Compared with the other forms of interaction, joint R&D often starts earlier and lasts longer. Thus, it also represents the most intimate kind of business-UPRI collaboration.

Moreover, beyond the innovation process, firms interact with UPRIs in more generalised forms to support the innovation. In some cases, firms and UPRIs collaborate by setting up companies or incubators for specific innovations or business directions. This represents a high level of mutual commitment and involves the participation of higher-level agencies. The most common forms of innovation-related interactions are training and talent cultivation, which includes internships or other industrial opportunities targeting undergraduates, S&T-oriented collaboration targeting postgraduates and postdoctoral researchers, and corporate-level workstations of professionals and academicians. For firms, their innovation benefits from the access to more talents, which provides the basis for innovative collaboration with UPRIs in other forms. For UPRIs, the talent collaboration with firms fits their pursuits of applied research and practical training for students.

Based on the above knowledge about the major forms and contents of firms' collaboration with different UPRI's agencies in China, by presenting and analysing the data collected from the field interviews in Qingdao, the following sections elucidate the interactive relationships between the sample marine firms in Qingdao and the UPRIs, especially the local ones, explore the impacts of the collaboration on firms' innovation, and summarise the regional patterns.

5.6.2 Interaction between MBPFs in Qingdao and the local UPRIs

The interaction between the MBPFs and the UPRIs demonstrate strongly regionalised features. On the regional level, a dominant pattern of obligational relationships with the UPRIs has been generated. More importantly, taking advantage of the strong R&E system constituted by a large number of marine UPRIs, over two third of the sample MBPFs in Qingdao treat the local UPRIs as the most important collaborating partners from the research domain. This section focuses on the local-based interaction. The extra-regional relationships will be briefly discussed in Section 5.6.4.

The local basis of firm-UPRI relationships

Considering the non-trading-based nature of their relationships, the interacting basis of the MBPF-local UPRI relationships - how the interactions have been established is worth investigating. According to the fieldwork interviews in Qingdao, there are two major channels[1] by which they can establish collaborative relationships with the UPRIs. Over four fifth of the sample MBPFs indicated that the coordinating roles played by the local government agencies are critical. Also important are the personal relations between the R&D or management staff and the researchers from the UPRIs, which has been reported by around three-quarters of the MBPFs in Qingdao. However, the interviewees mentioned that personal relationships mainly take effect in the early stage of innovation by enabling them to build contacts and exchange the intentions of collaboration between the two parties. In Qingdao, the effects of personal relations are particularly evident on the regional scale, in which the graduates from the UPRIs have played significant roles. As argued by the R&D director from QMBPF4 - a manufacturer of Chinese medicine,

> *"Most researchers that we collaborate with are our previous teachers, cohorts, or the seniors or juniors in the same major. We have known each other for a long time. Even if we are not acquaintances, it's easy for us to build connections through personal relations. Therefore, the researchers from the local UPRIs are always our primary choices of collaborators. This has become a tradition." (I_QMBPF4).*

Relationships with the local UPRIs mainly in the obligational pattern

As demonstrated in Section 5.3, customers are recognised as the important external sources of innovative insights to MBPFs in Qingdao, which have indirectly influenced the ideations of their innovation. According to the interviews in Qingdao, most of the sample MBPFs highlighted the importance of local UPRIs as external sources of ideas to inspire their innovation. Situated in the research-driven sector, MBPFs in Qingdao seek to build close relationships with the UPRIs by which to access advanced knowledge and technology and to find opportunities for industrialising emerging technologies, even though their primary focus is still on generic products. Through the frequent communication, MBPFs learn from the local UPRIs that generate much more

[1] Different channels are not mutually exclusive.

direct impacts on their innovation compared with the insights from customers.

(a) Interaction in technical support

The most common ways of interaction between MBPFs in Qingdao and the local UPRIs are technical supports. According to the interviews, two-thirds of the sample MBPFs in Qingdao mentioned that they often turned to the local collaborators when they met technical difficulties or faced internal restrictions on their technical expertise and resources. In this case, local UPRIs are important external sources of knowledge and technology to the MBPFs by providing them with technical services and consultancy, which also improves the efficiency of the internal innovation of MBPFs. As mentioned by the interviewees from QMBPF7 and QMBPF9,

> *"Sometimes, we turn to universities and ask them to do toxicological tests for us. They have more professional equipment and experiment conditions. It saves time for us." (I_QMBPF7).*

> *"When doing the pilot test, collaborating researchers often provide scientific guidance for us." (I_QMBPF9).*

As referred to in 5.6.1, these kinds of cooperation are usually task-oriented and short-term-based. Most communication centres on the exchange of information without sharing the risks of innovation. Also, written contracts and formal agreements are used on some occasions, for example, in the case of QMBPF7 who has no other long-term or closer forms of interaction with the universities. Other MBPFs in Qingdao differ from it by establishing diverse forms of collaborating relationships with the local UPRIs, through which they have accumulated higher-level trust beyond the short-term services or projects.

(b) Interaction in technology transfer and co-R&D

According to the fieldwork interviews, nearly half of the MBPFs in Qingdao conduct industrialisation-driven innovation based on the preliminary research already done by the local UPRIs. In this case, the major design of the product has been fulfilled in the lab stage, while MBPFs spend more effort on the experimentation in the later stages, the clinical tests, and the commercialisation of products, which is usually beyond the expertise of the research bodies. Collaboration in this form often involves the transfer of IP, which requires the commitment to the written contract. Even though the process of product development and engineering is iterative involving high degrees of uncertainty, the innovation of the local MBPFs has been validated in the lab, which curtails the length of the process of drug discovery and scientific verification and reduces the overall risks of innovation. By transferring research outputs to firms, local UPRIs contribute to the industrial development and obtain profits from research.

Furthermore, a high proportion of MBPFs in Qingdao (two third of the sample) have built cooperative relationships with local UPRIs in joint R&D. As mentioned in Section 5.6.1, this kind of collaboration represents a higher level of intensity of their interactive relationships. As evidenced by the sample MBPFs in Qingdao, their innovation has been largely benefitted from the R&D collaboration with the local UPRIs to develop advanced technologies, despite not all the outputs of these co-R&D projects can be transformed into commercialised products in the short term. Joint R&D often takes place in the form of S&T projects that are funded by the government or aimed to obtain governmental funding. Therefore, instead of relying on the contracts, this kind of collaboration often requires mutual understanding and trust accumulated over the long time of collaborative experiences between the two parties, which ensures that they are matching partners and well know the internal capabilities, knowledge base, and advantageous resources and expertise of each other. And how the MBPFs and local UPRIs exchange resources and share the outputs differ upon the specific cases and projects. As argued by the vice president from QMBPF8 - a firm that has rich experiences in co-R&D with the local universities,

> *"Usually, we provide pecuniary investment and facilities for the co-R&D projects. Universities provide research staff, technologies, and knowledge. Some projects can receive funding or earn an S&T award from the government. The distribution of research outputs, such as intellectual properties and profits, is negotiated upon the specific situations. In some circumstances, we jointly own the IP and co-share the profits of new products. In other cases, we may agree with universities that we take all the profits and buy out the IP rights. In general, universities concern more about research outputs and S&T advances than us." (I_QMBPF8).*

(c) Interaction in talent training

Moreover, according to the data collected from Qingdao, two-thirds of the sample MBPFs have built collaborations with the local universities in the aspect of talent cultivation and training. Generally, collaboration in the cultivation of talents - one of the important resources in innovation - is usually long-term-oriented, which lays the foundation for their collaborative relationships and interaction in other aspects of innovation. Most of the samples highlighted the importance of the research-oriented collaboration targeting postgraduates or through doctoral co-cultivation, postdoctoral workstations, and academician workstations.

Through this kind of collaboration, MBPFs in Qingdao obtain the professional knowledge and the S&T expertise external to the company that facilitates the innovation process. The R&D staff internal to the firms can learn or be trained by the researchers from the UPRIs through close engagement. Also, the local UPRIs can benefit from the talent exchange in terms of the applied research. Moreover, in very rare cases, a few MBPFs have collaborated with the local universities to set up new companies and incubators, which opens possibilities of widening the business scopes of the MBPFs, enhances their regional impacts, and facilitates the regional atmosphere of industry-research integration that is highly encouraged by the local government (I_QMBPF1, I_QMBPF3).

5.6.3 Interaction between MEFs in Qingdao and the local UPRIs

Similar to the MBPFs, MEFs in Qingdao also demonstrate a regionally obligational pattern in interacting with the UPRIs that are mainly from the local area. Recognising the localised feature, this section explores how their relationships have been established and how these relationships have influenced the innovation process or the relevant aspects of the innovation of the MEFs (see Appendix J for details of individual marine firms).

The local basis of firm-UPRI relationships

For the sample MEFs in Qingdao that treat local UPRIs as the main collaborators, the ways in which they establish relationships are much more diverse than their MBPF counterparts. Similarly, two-thirds of these MEFs have characterised the importance of the local government agencies in bridging their collaboration initially and over half of them mentioned inter-personal relationships. The lower reliance on personal relationships is mainly due to the higher proportion of SOEs in the sample MEFs.

Restricted by the strict ownership and management control, these SOEs demonstrate lower reliance on personal relations in forging collaboration with the local UPRIs. Moreover, their parent companies have played important backing roles. As the subsidiaries of the conglomerates owned by the central state, the credibility, reputation and internal capability of these MEFs are backed by the central state, which lowers the difficulty for them to seek matching high-level UPRI collaborators and build direct contacts. Their dependence upon the local government to bridge the cooperation is lower, though they are seen as the critical constituents of the regional marine cluster.

Moreover, besides the above channels, a few MEFs also mentioned the industrial associations (e.g., QMEF10) and customers (e.g., QMEF2), especially the former, that have played significant roles in bridging the business-UPRI partnerships. According to the interviews, a number of industrial associations have been formed in Qingdao and Shandong province composed of marine firms with the local marine UPRIs being important participants and the regional and provincial governments as the important driving forces. By organising industrial activities, the regional-based industrial associations offer opportunities for the MEFs to communicate and approach suitable UPRIs, which have become an important interacting basis between MEFs in Qingdao and the local UPRI agencies.

Obligational relationships with the local UPRIs on the regional level

The local UPRIs are important external sources of knowledge and technology to the MEFs in Qingdao, though individual firms may be different in their specific purposes of interacting with the UPRIs. Situated in the practice-driven sector, most MEFs in Qingdao share one common aim to build close and long-term relationships with the UPRIs to obtain technical support for the innovation process, through which to support the internal R&D and enhance their technological competitiveness in the market. The local UPRIs with academic and technological expertise in the marine field offer regional-specific advantages proximate to the MEFs.

(a) Innovation inspired by the local UPRIs

According to the fieldwork interview, the innovation of most MEFs centres on product innovation by modification, improvement and continuous perfection of the products based on the stereotype and the process innovation to enhance the efficiency of production. However, the research and R&D of the local UPRIs relevant to the MEFs concentrate more on the aspects such as the analytical designs, physical structures and materials, which are often science-driven and too academic to be transferred into the commercialised products. Therefore, not all MEFs in Qingdao can be enlightened by the UPRIs, especially those focus on incremental innovation rather than pursuing the development of cutting-edge technologies.

Despite the primary reliance on customer demand as the major source of innovation ideas, a number of MEFs in Qingdao seeking to develop advanced products have been inspired by the local universities, which offers them a chance to develop into the emerging and research-driven field. In this kind of collaboration, MEFs interact closely with the local UPRIs to develop a new product from the beginning used for the exploratory-driven aims as a part of the government-funded S&T research programmes (i.e., the vertical projects of UPRIs). Even though these products may not be able to be commercialised and industrialised, the innovation of the MEFs has largely been enhanced. The strong innovation capabilities, the innovation experiences and the outcomes often bring business opportunities to the MEFs. For instance, QMEF1 once collaborated with a local university in the co-R&D of a ship for the scientific investigation of the deep sea. With this experience and internal capabilities, they have entered into a new business field of "special equipment" (*tezhong shebei* in Chinese). Also, the interviewee from QMEF9 also mentioned the partnership with a local university for the research aim.

> *"Universities require our collaboration to develop products with particular specifications for the research purpose, which are normally beyond the civil use and require more advanced technologies." (I_QEMF9).*

(b) Project-based collaboration embedded in the long-term partnership

For MEFs in Qingdao, their interaction with the local UPRIs often takes place in the stages of detailed product design and production. MEFs argued that they mainly interacted with the UPRI agencies in the form of technical services and technical consultancy driven by their practical needs. The local UPRIs are approached for advice on the process innovation to improve the efficiency of R&D and manufacturing processes of MEFs, which is an important means to face the competitive market. Besides the process innovation, as the recipients of these technical services support, MEFs in Qingdao have benefitted from the local universities from the technological perspective in enhancing product functions of existing products and designing and developing new products. This also saves time for the MEFs to finish the innovation tasks within the given time limit. As argued by the interviewee from QMEF4,

> *"Universities provide lots of technical support for us. When we met technical problems that the internal R&D department could not solve, we would ask universities to aid in tackling these issues. Or in other cases, they helped us to do stress-strain analysis to ensure the internal stability of the product." (I_QMEF4).*

Besides the technical collaboration surrounding the internal innovation, MEFs rest on the local UPRIs to transfer technologies to them. This usually happens when UPRIs have finished the analytical designs and the firms value the market potential and would like to continue the product development by finalising the detailed design and commercialisation. By integrating the new technologies of the UPRIs and the internal capabilities of firms, the MEFs are able to overcome the lack of R&D capabilities and resources in doing advanced research or analytical design, develop new products in an efficient way, and continue to expand the market. By sharing or transferring the research outputs, the interdependence between the collaborating partners is strengthened.

Moreover, exemplified by QMEF1 and QMEF9 discussed above, slightly over one-third of the sample MEFs in Qingdao have collaborated with the local universities in joint R&D. Due to the industrial maturity and the reliance on the strict requirements of customers on the products based on the existing analytical design, the co-R&D interactions to develop entirely new products have beyond the innovation focus and strategies of certain MEFs. However, joint R&D often involves a higher level of exchange of resources, returns, as well as risks. As argued by the interviewee from QMEF8 that has undertaken joint R&D projects with the local universities,

> *"In most situations, joint R&D started before we confirmed the details. We often begin the collaboration as soon as the researchers have good proposals. If we only buy out their technologies or services without participating in the innovation process, our innovation capabilities will not be largely enhanced and we have to ask them for help in the following-up issues, such as installation and maintenance. This is inefficient." (I_QMEF8).*

According to the fieldwork interview, nearly two-thirds of the sample MEFs in Qingdao mentioned that their short-term interaction with the local UPRIs was built upon the long-term association and the accumulated trust between them. Except QMEF10 mentioned that "in most situations, we would entrust researchers in the collaborated researchers to do the design for us so that we can save more time for the later stages of testing and production." (I_QMEF10), the short-term and project-based collaboration between MEFs in Qingdao and the local UPRIs has been internalised into their daily interaction and communication. By establishing "symbiosis" relationships with the local universities and building the high-level interdependence, the MEFs would seek help from their stable collaborators rather than flexibly turning to different partners for various kinds of projects or tasks. Therefore, the commitment between them relies less on the enforcement of the formal contracts with clarified duties and profits but more on goodwill and confidence in the collaborators' competence.

(c) Interaction in talent training

Moreover, over half of the MEFs under investigation collaborate with local universities in training the talents. Most of their cooperation is less innovation-oriented but centres on offering students the opportunities to understand the application of knowledge in practical industrial scenarios, which accumulates potential human resources for the MEFs in Qingdao and strengthens the long-term orientation of their relationships. A few MEFs also build the corporate-level workstations of postdoctoral researchers or academicians. This kind of interaction facilitates the innovation of MEFs in the building and training of the R&D teams. It also provides the embedding basis for short-term technical supports, access to the advanced technologies of the local UPRIs, and the possibility to develop more company-focused and industrialisation-driven emerging products.

5.6.4 Interaction between marine firms in Qingdao and non-local UPRIs

As mentioned at the beginning of Section 5.6, only around one-fifth of sample marine firms in Qingdao treat non-local UPRIs as their main collaborators from the research domain. Some of these marine firms have also built connections with the local universities, while they demonstrate a lower reliance on the local ones. The reasons driving this group of marine firms to rely on extra-regional relationships are different.

To the MBPFs (i.e., QMBPF2 and QMBPF6), these main products and R&D directions are the animal vaccines and antigens, which require expertise and knowledge of animal science. Even though the UPRIs in Qingdao have relevant research and majors, they are in disadvantageous positions with insufficient expertise and capabilities, especially when compared with the other better choices of MBPFs like China Agricultural University. The ways for them to approach UPRIs outside of Qingdao are different. While QMBPF2 mentions the industrial associations, QMBPF6 relies on the parent company that the extra-regionals partnerships are parts of the strategic collaboration between its parent company and universities. Their interaction with non-local UPRIs covers technical services, technology transfer and some degree of joint R&D. By collaborating with universities, they obtain external knowledge sources to address the technical problems met in the innovation process and conduct co-R&D of new products.

When the reasons behind MBPFs' decisions on the extra-regional UPRIs are primarily industrial determined, MEFs choices are mainly affected by the preference of firms. For example, the interviewee from the QMEF5 argued that their main collaborators were the internal research institutes within their group company. The interviewee from the QMEF6, a small private-owned company, mentioned that their choice of non-local partners was determined by the personal relationships of their founders. Their ways of collaboration with UPRIs are also contingent upon innovation strategies and industrial positions. While QEMF5 has interacted closely with the internal research institutes in multiple ways ranging from basic information exchange to intensive co-R&D, the collaboration between QMBEF5 and the non-local university centres on the industrial training of undergraduates and recruitment and technical supports.

5.6.5 Regional patterns of business-UPRI relationships in Qingdao

This section illustrates the collaboration between marine firms in Qingdao and the local UPRIs and briefly discusses the relationships with UPRIs outside of Qingdao. Based on the analysis of the divergent forms of business-UPRI collaboration, a regionally ***obligational*** and ***localised*** pattern of relationships can be summarised, which to a large extent have benefitted the innovation of the local marine firms in Qingdao. Table 5.4 presents the key characteristics of the dominant regional patterns of business-UPRI relationships. The region of Qingdao not only provides marine firms with the local research and education base in the marine field but also establishes multiple channels to coordinate the local marine firms and the local UPRIs.

Table 5.4. Business-UPRI relationships of marine firms in Qingdao

Dimensions of business-UPRI relationships	Marine firms in Qingdao
Sources of UPRIs	Mainly local ones
Establishment of innovation interaction	The local bridging channels are important Incl. the local government, personal relations, parent company and industrial associations
Communicating frequency	Frequent
Length	Long-term
Intensity of innovation collaboration	Considerable
- Information exchange	High
- Resource sharing	Considerable
- Risk sharing	Some
Trust	Mainly competence and goodwill trust
Relational pattern	**Obligational and localised**

Sources: fieldwork interviews.

In the collaborating relationships, MEFs demonstrate relatively lower reliance on the local UPRIs in the innovation ideation and a higher preference to interact with the local UPRIs on specific technical issues and build practice-driven talent collaboration due to the highly customer-driven nature of innovation and the industrial characteristics. Some MEFs also interact with the local UPRIs to conduct joint R&D, which enhances their internal innovation and opens new business possibilities. However, the MBPFs in Qingdao with science-driven feature are more inclined to treat the local UPRIs as the external sources of scientific ideas of innovation, to collaborate in co-R&D projects, and to exchange and conduct co-training programmes targeting the research students or R&D staff.

Commonly, most sample marine firms in Qingdao argued that their collaboration with local UPRIs is long-term-oriented. Besides the reliance on written contracts in the exchange of IP, the collaboration between marine firms and the local UPRIs has accumulated mutual understanding and trust in competence and goodwill. Though project collaboration involves some trading features, most of the interaction has been internalised into their frequent communication and long-term relationships, which facilitates the sustainability of their relationships. On the regional level, the intimate horizontal interaction between the industrial marine firms and the local UPRIs has also been essential to the formation of the marine cluster.

5.7 Interaction between marine firms in Qingdao and the government

As external players, governments are important to marine firms by providing them with financial support and constructing the regional innovative environments without directly involving in the process of innovation as the firm and research organisations analysed above. The main analytical focus of this section is on the interaction between marine firms in Qingdao and the governments (primarily the regional government) in these two aspects. Evidenced by the interview data, this section demonstrates how the innovation of marine firms has been influenced by their relationships with governments, and how regional innovation is impacted by business-government relationships. Appendix J summarises the major forms of interactions between the individual sample marine firms and the regional government in Qingdao.

5.7.1 Major forms of government financial incentives in China

In China, with increasing emphasis on the innovation-driven development, there are a wide range of innovation incentive programmes launched by the governments on different levels to provide financial incentives to firm innovation. The first major type of government financial scheme is the tax break. Besides the value-added tax (VAT) cut for the manufacturing industry from 17% to 13% and the return of VAT credits, an important programme to encourage innovation is the "R&D expense super deduction". Manufacturing firms can claim a bonus deduction of Corporate Income Tax (CIT) at 75% on eligible R&D expenses incurred in the R&D activities for CIT purposes[1]. The more a manufacturing firm spends on R&D, the less tax will be levied. On this basis, firms granted as "High and New-Technology Enterprises" (hereafter High-tech Enterprises[2]) are offered additional tax reduction[3]. Besides the benefits of tax reduction, High-tech Enterprises are also prioritised when they apply for government R&D funding, low-interest loans, S&T projects, land use and so on.

For the majority kinds of tax, the regional governments in China are not empowered to decide the tax rates. However, in order to attract new firms to a region, the preferential tax policy which is an often-used strategy by many regional governments. As exemplified by the firm cases in the later discussion, regional governments often offer to reduce tax, exempt firms from certain kinds of tax, or return part of the regional-retained tax directly or in the form of financial subsidies and rewards to firms. Many preferential policies are also associated with how long firms have stayed in this region. These tax incentives were induced from the GDPism and regional tournaments in China's political systems, as discussed in Section 3.2.4. Many firms have been attracted to certain regions, while these behaviours could cause severe problems of regional protectionism, which hinders the cross-regional interaction and is harmful to sustainable regional development in the long time.

The second major type of financial support is mainly project-based funding associated with different kinds of innovation projects, S&T programmes, and the implementation of national or regional industrial policies[4]. In Chinese transformation towards the firm-

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[1] Alternatively, if the R&D expenses are capitalised as intangible assets, firms are allowed to amortise the intangible assets based on 175% of the actual cost incurred.

[2] To apply for this title, firms have to meet the requirements on various aspects such as R&D personnel and expenditure, high- and new-technology income, and innovation capacity. And their qualifications are reviewed every three years.

[3] Qualified High-tech Enterprises enjoy the preferential CIT rate of 15% for three consecutive years, which is 10% lower than the standard CIT rate.

[4] Typical examples include the National High-tech R&D Programme (863 Programme), "Made in China 2025", "Development of Emerging Industries of Strategic Importance", five-year plans, S&T funding, and innovation funding ranging from regional to national level.

based innovative development, more projects and funding opportunities have been shifted to support the innovative SMEs and private firms. Compared with the market-oriented venture capital though often in a higher amount, governmental funding aiming to reduce the financial burdens of innovative firms and provide financial incentives to encourage firm innovation imposes less market pressure on firms to deliver new products at the end of the project but focuses more on the technological breakthroughs. By participating in government-funded projects, the reputations and credibility of the firms can be enhanced, by which they could obtain more opportunities and resources in innovation and business development. These factors largely increase firms' willingness to undertake projects and apply for funds from the government.

Moreover, governments also reward and subsidise firms for innovation. Some are the bonus for winning prizes or contests, for example, the Prize for Progress in Science and Technology, and the Prize for Marine S&T Innovation. Some are the rewards for applying for patents or developing products such as the First Set of Major Technical Equipment and "specialised, sophisticated, distinctive and new" ("*zhuan, jing, te, xin*" in Chinese) products. Some are subsidies for technical transformation and upgrading. Some are talent-oriented for establishing professional workstations or introducing leading talents and R&D teams, as well as some rewards and subsidies for firms obtaining titles such as HNTEs, "little giants" (i.e., technologically advanced SMEs), "gazelle enterprises" (i.e., young and fast-growing SMEs), and "champions in individual fields" (i.e., enterprises leading a particular manufacturing field), and for setting up innovation platforms.

5.7.2 Business-government interaction in Qingdao in financial incentives

As mentioned in Section 5.2.1, marine firms in Qingdao have relied on external capital sources to support their R&D expenditure with government funding in various sources accounting for over 10% in the three years from 2017 to 2019. The amount of government funds received by the sample marine firms in Qingdao range from hundreds of thousands of yuan to tens of millions each year. Despite the different levels of governmental funding, the interaction mainly happens between marine firms and the regional government.

Access to government financial support

Despite the often-mentioned use of personal relationships with government officials to access benefits and secure protection in the literature on Chinese networking capitalism mentioned in Section 3.2.4, marine firms in Qingdao refuted the wide use of *guanxi* in obtaining financial support. Most firm interviewees admit that personal relations can be supplementary to maintaining the relationships with the regional officials, while the use of *guanxi* neither provides sufficient conditions for them to obtain government funds nor is the compromise that they have to make. To most firms, it is difficult and risky to obtain resources simply by establishing close personal relationships with several officials. The weight of *guanxi* with the officials has been largely reduced following China's transition.

According to the fieldwork interviews, the communication between marine firms in Qingdao and the local government primarily relies on (i) the official approaches offered by the local government and (ii) the industrial associations. Sample marine firms in Qingdao have mentioned that benefiting from the local government's efforts to build communicating channels and the development of mobile devices and telecommunication applications in China, their business-government interaction has become much easier and more frequent in these years. As argued by the interviewee from QMEF11,

> *"Every year, the local government formulates manuals and brochures which specify the financial supporting programmes and the required conditions to apply and distribute them to the local firms. It saves our time on searching. Besides, they have built many new communicating channels like group chats and official accounts*[1] *on WeChat that are popular in China." (I_QMEF11).*

MBPFs and the regional government

According to the fieldwork, the sample MBPFs in Qingdao are all qualified as High-tech Enterprises and have been granted this title for more than five years. Therefore, the tax cut and deduction are the most important kinds of government funding to support

[1] It is similar to the official accounts on Twitter or Facebook, which can send notices, news, and information in different forms (e.g., texts, pictures, audio, videos and the mixed) to the subscribers.

the R&D of MBPFs in Qingdao. Because the preferential policies associated with the HNTEs and CIT deduction are implemented by the central government, therefore, the regional government mainly acts as the regional implementer of the central policies and offer practical guidance and support to the local firms in tax calculation. According to the fieldwork, the regional tax department in Qingdao regularly organises tutorials and Q&A sessions and provide one-to-one help to local firms. As mentioned by the interviewee,

> *"The local tax bureau provides tutorials for us in claiming taxes. After reviewing our accounts, they thought our calculation of the eligible R&D expense for the CIT deduction was too conservative, thus helping us to recalculate and return the overpaid taxes in the last two years. The deduction and return of taxes saved us around 35 million yuan in total. We have reinvested all this money in R&D and innovation, which is a very large impetus to the innovation." (I_QMBPF8).*

Besides, as mentioned in 5.7.1, regional governments in China often provide additional tax incentives, which causes regional protectionism. Evidenced by the fieldwork, this phenomenon also occurred in the regional case of Qingdao. For instance, QMBPF7 mentioned that in order to build the Qingdao HNTIDZ into the blue biotech and pharmaceutical cluster, the regional government of Qingdao persuaded them to move from another district of Qingdao to the HNTIDZ and offered to retain tax to them. This firm was largely attracted by the preferential tax policy. As stated by the interviewee from QMBPF7,

> *"We finally decided to move to the HNTIDZ when we considered building the new factory. We signed a contract with the local finance and tax bureau. They would return us all the regional-retained VAT in the first two years. In the following several years, the district-retained VAT (12.25% of the total) would be returned to us." (I_QMBPF7).*

Furthermore, over two-thirds of sample MBPFs in Qingdao recognise the importance of government funds for S&T and innovation projects. As mentioned in Section 5.2.1, innovation of the MBPFs often involves massive investment, high risks, and high uncertainty. In such case, MBPFs would like to apply innovation projects to obtain the governmental funding for the explorative innovation in advanced technologies.

According to the fieldwork, most projects they have undertaken are on the regional and provincial levels such as the Corporate Technological Innovation Projects of Qingdao. Because of the marine orientation in Qingdao, relevant projects are supported. Besides setting up marine-related policies as will be mentioned in Section 5.7.3, marine-related S&T projects without attaching to specific policies are often prioritised.

Besides, national projects such as projects from SOA and MOST are also important, while firms face more competition in the application. Besides, in China, more and more funding opportunities have been available to SMEs and micro firms. For example, the interviewee from QMBPF7 mentioned that they once obtained the Technological Innovation Funding for SMEs by MOST several years ago. However, to apply for national-level projects, firms can hardly interact with the ministry-level agencies directly but usually communicate via the regional ones.

Therefore, for most MBPFs paying close attention to the opportunities of government projects on different levels, communication with the regional government agencies is important. In such case, the regional government is not only the potential financial provider but also assists the local companies by sharing the project information and providing help in the project application. These actions have reduced the information asymmetry between companies and the authorities in terms of the available opportunities and the criteria of the selection and revision process. As stated by the two interviewees,

> *"In case we miss the opportunities, the government officials, mainly from the S&T Bureau and the Industry and Information Technology Bureau would remind us to apply for the appropriate funds so that we could reach the criteria. The officials often come to our companies for fieldwork, so they know our under-research products and projects. They also help us in preparing the required documents." (I_QMBPF4).*

> *"We have new projects that got approved and often receive funds in several millions every year, which generate incentives for us to continue to invest in R&D. The projects we proposed every year are in line with our development goals and adjusted according to the regional supporting directions. The funding is usually*

given out in different stages according to the innovation progress." (I_QMBPF9).

While many sample MBPFs believe that government financial supports are important to innovation, a few cases, for example, QMBPF2 are reluctant to apply for innovation projects. According to them, government schemes do not always fit in their directions of innovation. For those projects aiming at the whole industry, they stand at the disadvantageous position and face fierce competition with other firms. In such case, even though could successfully obtain the innovation funding, the amount would not be very high, which was sufficient for their demands. Therefore, when many other companies interact closely with the regional government to obtain information about the financial schemes, these firms maintain a distant relationship with the local authorities.

Moreover, over half of the sample MBPFs mentioned that financial rewards for winning prizes or being granted titles are significant kinds of financial supports to their innovation by the government. However, this kind of support is less continuous compared with the first two types. For those winning national or provincial prizes or titles, the local government of Qingdao often offers additional rewards. For instance, in the policy of "Implementation Roles for A Number of Policies on Promoting the Accelerated Development of Advanced Manufacturing Industries in Qingdao" issued in 2017, the local government stated that to offer rewards targeting the local manufacturing firms that have extraordinary performance, such as being granted for "national-level manufacturing champions in individual fields". Increasing awards are accessible to SMEs. As indicated by an interviewee,

"For enterprises being granted as National Technological SMEs, the regional government of Qingdao offers us an additional 5% reward according to the amount of the eligible expenses incurred in R&D activities for CIT purposes. It is important for small companies like us." (I_QMBPF7).

MEFs and the local government agencies

The amount of government funding gained by the MEFs in Qingdao demonstrates a clear divergence between firms of different sizes. Each year, when large companies can get financial support up to tens of millions of yuan in various forms every year, small firms only have access to generally under one million yuan. For these small firms in Qingdao, the lower amount of funding accessed by them is mainly because that they fail to meet the criteria of innovativeness. However, it is not always because of the lack of capabilities or the small size. QMEF8 mentioned that its development was not so dependent upon the funding support from the government which was in a small amount far from their needs for development and they would not like to spend much time on preparing the paperwork. According to the fieldwork, to the sample MEFs as High-tech Enterprises in Qingdao except QMEF2, tax deduction and return are the most accessible financial support from the governments, which were also important to their internal R&D. As mentioned by the interviewee from QMEF5,

> *"Only in 2019, the tax cut by the super deduction of CIT based on the R&D expense, an extra preferential rate of land-used tax for HNTEs, the accelerated depreciation and so on saved us around 30 million yuan in total." (I_QMEF5).*

However, only about one-third of the interviewed MEFs in Qingdao have a lower level of involvement in conducting innovation projects and obtaining associated funding. As mentioned in Section 5.3, the innovation in MEFs is highly driven by customer demand. In this case, many MEFs focusing more on satisfying customers in product innovation and market development are reluctant or have no appropriate opportunities to apply for S&T projects. In some cases, MEFs would co-undertake S&T projects and apply funds with their customers and UPRIs. For example, QMEF9 is a representative firm. Participating in the innovation project enables them to accumulate specialised knowledge and capabilities, data, and project experiences about deep-sea environments. Besides obtaining access to more resources, its reputation has been enhanced for being able to make products used for harsh environment, which helps them to approach more opportunities and supports. As argued by the interviewee,

> *"The government funds we gained are partly associated with the S&T projects to tackle the significant technical problems. This happens when our customers are central SOEs representing the state agencies. New products and technological advances are developed as the outputs of S&T projects. For instance, without such projects, we cannot develop products used for the deep sea which is the national strategical area. And not all firms have such opportunities." (I_QMEF9).*

Furthermore, despite the majority of sample MEFs in Qingdao being qualified for HNTEs, many sample MEFs in Qingdao face more pressures of technological transformation. Concentrated in industrial areas with mature technologies and intensive scale, they used to be the driver of the economic development in China. However, in recent years, they became the targets of the national campaign to eliminate overcapacity and accelerate the transversion from traditional large-scale manufacturing to innovative development. Under this background, financial support in the form of subsidy targeted at those companies in traditional technical fields works as an important means to encourage, "force" and compensate for the transition of these companies towards innovation-leading development. Moreover, besides these subsidies, more than 80% of the sample MEFs in Qingdao mentioned that they obtained *ex post* rewards for their innovation achievements. As indicated by the interviewees from QMEF4 and QMFE2,

> *"Take the YM project for example, we were granted over one hundred S&T prices on different levels for the S&T achievements in this single project." (I_QMEF4).*

> *"The local government pays increasing attention to SMEs. Early this year, we obtained the credential to manufacture special-used products. One day, we got a call from a district government official who told us that we could apply for a bonus which is a part of the regional support for marine firms. It was actually the first time we applied for S&T rewards. The attitudes and efficiency of the regional government left us a very good impression." (I_QMEF2)*

5.7.3 Business-government interaction in Qingdao in constructing marine clusters

The above contents demonstrate the interaction between marine firms and the regional government in financial support. This section shifts the analytical focus to the business-government interaction in regional industrial development such as communicating in industrial policies, establishing regionalised networks, and facilitating the formation of regional marine clusters. By the interpretations, it shows that the business-government relationships are not simply "rule-takers" and "rule-makers", but interdependent players in the innovation system or industrial clusters on a regional basis.

MBPFs and the regional government

According to the fieldwork, around half of the sample MBPFs in Qingdao were not traditional marine firms. Guided by the regional orientation of the marine economy, traditional marine firms have kept strengthening their advantages. Meanwhile, many other companies started to explore the marine fields and broaden their scopes of innovation by involving more blue-oriented R&D. For instance, QMBPF4 and QMBPF7, whose primary business fields lie in Chinese medicines, shifted the R&D based on the natural resources and extracts from the ocean. In the background of the government-initiated transformation towards innovative and high-tech-driven development, the regional government of Qingdao guide the local firms to embrace marine-oriented development, which offers many companies at the crossroad new insights regarding the directions of development. As indicated by the interviewee from QMBPF3, which was once a traditional chemical firm,

> *"The initiation of this subsidiary is to act as a pioneer of transforming and upgrading the group company. We are located in the West Coast New District of Qingdao seeking to gather marine firms and build the regional marine cluster." (I_QMBPF3).*

Although the regional government cannot directly intervene in the decision making of the firms, through the policy means, they can advocate and encourage the local companies to shift the development focus to the marine fields. Many innovation projects discussed in 5.7.2 are parts of the regional policies. For example, the "Specialised Project for the Development of Marine Biological and Pharmaceutical Technology Innovation" was issued in 2017 following the implementation of the "Suggestions on the S&T Innovation Development in Qingdao" in 2016. Rather than viewing the governmental behaviours as the coercive powers imposed on them, most sample firms believe in the prospects of the marine direction and hold positive attitudes. On the one hand, firms have more opportunities to obtain the financial resources targeting an emerging industry and the first-mover advantages at least in the regional scope. On the other hand, with a common vision of the blue-oriented economy, the brand image of Qingdao as a marine city could be consolidated.

Furthermore, the regional-based networks have been emphasised by the regional government of Qingdao. As the interviewee of QMBPF3 mentioned, *"when we planned to transform into a marine biotech company, the regional government introduced us to well-known marine-area researchers from the local universities. Based upon our traditional advantages in fermentation technologies, we started the R&D on bio-fermentation technology using marine microalgae"* (I_QMBPF3). Clustering strategies have been implemented. For example, the Qingdao Blue Valley was built aiming to be the world-leading marine S&T centre and national demonstration area of marine science and technology. The Qingdao Marine Biotech and Pharmaceutical Industrial Base was established in the HNTIDZ of Qingdao which involves the incubator, science park and technological platforms and gathers hundreds of companies. Besides, a number of industrial associations were established in Qingdao, such as the Qingdao Bioproducts Industrial Association and Innovation Alliance of Marine Biotech and Pharmaceutical Technology, which involves marine firms, local UPRIs, and financial organisations. These industrial associations promote communication between different parties and strengthen the regional marine networks.

Moreover, MBPFs in Qingdao are not only the targets of the regional policy, yet many of them closely interact with the regional government in the formulation and implementation of policies. Government agencies collect firm-level information and opinions through fieldwork, exposure drafts of policies, or relying on the activities organised by the regional industrial associations. According to the interviews with the sample MBPFs in Qingdao, two-thirds of them mentioned that they were solicited by the local government agencies about the comments on the industrial policies to be issued. Most of them believed that their opinions could be reflected in the final version of the policy. As argued by the interviewee from QMBPF4,

> *"The policy may not reflect the opinions of a certain company, or solve the problems faced by a single company. It does reflect the mainstream views shared by the local companies." (I_QMBPF4).*

Nevertheless, a few companies indicated that the regional government of Qingdao has attached more importance to the comments of the leading and large companies. As small private firms, they have been restrictively involved in the policy. Even though most exposure drafts are public, the regional government would still ask for the opinions of the large or state-owned firms in particular. Moreover, even though the regional government in Qingdao has made efforts to characterise the views of small private firms, maintaining the restrictive interaction with the regional government, these firms are not confident that their suggestions could be noticed and valued. As argued by the interviewees,

> *"In most cases, the government agencies would not come to our company to ask for our opinions. They usually communicate more frequently those firms that are large, leading in the region, and having been established for a long time in Qingdao." (I_QMBPF2).*

> *"In the policy drafting stage, the government agencies seldom ask small companies for opinions if the policy was not directly targeting us. The exposure drafts are already mature, and we rarely comment on them. Our parent company engages more actively in the regional policy and represents us." (I_QMBPF6).*

MEFs and the regional government

The majority of MEFs in Qingdao are traditional marine firms. Different from the MBPFs in the same region which expanded the business fields to engage in marine-oriented development, MEFs' interaction with the regional government has limited impacts on their shifts of innovation directions. In such context, most emphases of the business-government relationships have been attached to promote the construction of the regional industrial bases and support the marine industrial development by constructing a supporting environment for the clustering activities.

A number of industrial bases and industrial associations like the Shipbuilding and Marine Engineering Equipment Industrial Association of Qingdao have been established in Qingdao to support the industrial networks. The National High-tech Marine Equipment Industrial Base was built in the HNTIDZ of Qingdao. Besides, relying on the locational advantages, the West Coast Bay Industrial Base of Shipbuilding and Marine Engineering Projects was built. The regional government has made efforts to offer infrastructure facilitates to facilitate the manufacturing activities of MEFs and collaborate with them in building supporting apartments to retain the talents. By collaborating with the central government-owned enterprises, subsidiary companies (e.g., QMEF4) and firm-based research institutes targeting the R&D on high-end marine equipment were built in Qingdao.

Furthermore, nearly half of the ME firms mentioned that the local government often organises trade fairs and helps them to build connections with potential customers. Moreover, as mentioned in Section 5.4, in order to strengthen the supply bases for the companies, MEFs and the regional government agencies collaborate in attracting suppliers to build bases in Qingdao. Their collaboration strengthens the industrial bases, promotes the region-based networks, and facilitates the clustering of marine activities. Nevertheless, by offering these supplying firms preferential policies in different aspects like land use, regional protectionism is likely to happen. As argued by the interviewee from QMEF5,

> *"The government officials often come to us enquiring the situations and information about our suppliers. And we expressed the difficulty we encountered in the lack of local suppliers. The government sought to collaborate with to attract more supplying companies to Qingdao." (I_QMEF5).*

In the interaction in terms of the regional policy in Qingdao, the views of private SMEs have been increasingly valued. However, the regional government has limited energy to ask for each company's opinions or conduct firm-level fieldwork. In such context, those small MEFs with strong innovation capabilities, advanced technologies and top R&D teams like QMEF3 and QMEF8 are involved in the regional policies. Moreover, despite the technological capabilities, companies of large sizes that contribute more to the regional economy, especially those central SOEs are attached to greater importance. On some occasions, their feedback on the policies would be expressed by their parent companies whose opinions are more emphasised and reflected.

> *"Essential comments regarding the key aspect of the policy have been put forward by our parent companies, while we cannot play important roles. However, when the local government agencies did research or fieldwork at our company, we would provide some comments on those specific points relevant to us. (I_QMEF7).*

5.7.4 Regional patterns of business-government relationships in Qingdao

This section analyses the interaction between sample marine firms in Qingdao and the regional government. The illustrations indicate the regionally ***obligational*** pattern of business-government relationships in Qingdao. Table 5.5 summarises the key features of interactions between local marine firms and government agencies. Their interactions mainly happen in the financial support and the construction of supportive regional environments.

Table 5.5. Business-government relationships of marine firms in Qingdao

Dimensions of business-government relationships	Marine firms in Qingdao
Communicating channels	Mainly through official channels, industrial associations have increasingly been engaged
Use of personal relations	Limited
Communicating frequency	Frequent
Intensity of innovation-related interaction	Considerable
- **Information exchange**	High
- **Financial incentives**	Considerable
- **Industrial bases or clusters**	Considerable
- **Policy interaction**	Medium
Trust	Mainly competence and goodwill trust
Relational pattern	**Obligational**

Sources: fieldwork interviews.

According to the fieldwork, the communication between marine firms and the local government is through the official channels offered by government agencies but less on *guanxi*. With their co-efforts to build industrial associations, marine firms and the regional government have formed alternative communication channels. With the increasing disclosure of information to the public and more flexible channels of communication, the information asymmetry between the two parties has been reduced and the credibility of the local government has been enhanced. The business-government interaction seldom influences specific stages of the innovation process but supports the innovation of marine firms by sharing risk and financial resources through government funding programmes, establishing local industrial bases and innovation networks, and communicating in regional policies.

By means of financial incentives, marine firms obtain direct benefits for innovation. Through policy advocacy and, in some cases, policy-affiliated financial incentives, the local government acts as the director guiding the regional industrial development. By coordinating firms in the establishment of industrial associations, organising trade fairs and events, and forging collaboration between firms and UPRIs, the local government acts as the coordinator of industrial development. Through these interactions, the marine firms in Qingdao and the regional government have built mutual trust based upon the enhanced mutual understanding, the "service spirits" of the regional government agencies, and the willingness of the marine firms to participate in the regional marine development. However, problems like regional protectionism also happen. In general, on the regional level, the obligational business-government interaction and their induced benefits have been important in constructing Qingdao as a strong marine cluster in China.

5.8 Summary

This chapter presents the regional institutions in Qingdao including the regional state, the R&E system, the financial system, and the cultural system. Besides, the major analytical focus of this chapter is on the analysis of the innovation behaviours of sample marine firms in Qingdao, especially from the perspective of their relational networks with the vertical and horizontal players. Based upon the evidence from individual firms, this chapter notice the dominant patterns of firm behaviours on the regional level in Qingdao. Specifically, marine firms in Qingdao have generally been committed to innovation by continuously inputting into R&D and building corporate-level innovation platforms. Meanwhile, dominantly, they have forged *obligational* relationships with extra-regional customers, the local UPRIs and the local government agencies, and *arm's-length* interactions with extra-regional suppliers. Limited interaction with competitors has been found in the marine firms in Qingdao.

Furthermore, this chapter characterises the cross-firm diversity in firm-level behaviours in the same regional institutional framework, which indicates that the institutional impacts are contingent upon the reactions within the region, which highlights the importance to conduct the bottom-up analysis. To a region, there are always "outliers" who behave divergently from the regional-level dominant patterns of firm behaviour. As will be analysed in Chapter 7, the dominant regional patterns are structured by the regional institutions. However, to the individual firms, the combination of firm-level factors, and in this research, the innovation commitment and the relational networking, play more determining roles in influencing the innovation performance of a firm.

The differences across firms in the firm-level factors result from the decisions of the firms and different choices in the history. Rather than depending on the effects of a specific factor, it is the combination of factors that generates integrating effects on the marine firms, thereby contributing to the explanation of the firm-level diversity in marine innovation results. By comparing the sample marine firms in Qingdao, it shows the firms with a high level of commitment to innovation, the obligational relationships with customers, the obligational or arm's-length relationships with suppliers, the obligational relationships with the local UPRIs, and the obligational relationships with the local government as exemplified by QMBPF3 and QMEF4 are more likely to perform better in innovation and business by enjoying the benefits of the specific relational pattern evidenced by the fieldwork analysed in above sub-sections. However, firms that have not formed such a pattern, for example, exemplified by QMEF2 with the low level of commitment to innovation and QMBPF7 with the arm's-length interaction with the UPRIs and the local government, can hardly perform as well as the above cases.

Highlighting the dominant patterns of marine firm innovation on the regional level and the regional institutions in Qingdao, this chapter lays the basis for the comparative regional analysis in Chapter 7 which will interpret how the regional patterns of marine innovation influence the innovation of marine firms and the regional innovation, and how the regional institutions structure the dominant regional patterns of firm behaviours and thereby influence the regional innovation development.

Chapter 6. Regional Marine Innovation in Ningbo

Ningbo is the first group of opening-up cities in China. The port advantages significantly connected this coastal city to the global world since the Tang Dynasty. In the Ming Dynasty, Ningbo became the only legitimate port between Chinese trade with Japan. Later in the 1840s, when the government of the Qing Dynasty signed the "Nanjing Treaty" with the British government, Ningbo was opened up as one of the five treaty ports in southeast China. Foreign capital quickly entered this city and built the early modern industries in this port city. Long-term opening-up histories and advantages in the deep-water ports made Ningbo a trade-oriented city closely connected to foreign economies. Entering the era of the new China, due to the geographical proximity, Zhejiang is the other important forefront of China mainland facing Taiwan besides Fujian province. No heavy industries were built in this province initially in the newly established China since 1949. The regional economy depended more on the light industries like textiles, clothing, and stationery industries and the small-scale firms later transformed into collectively owned enterprises and the "underground" private economy. The production scale of the textile and garment industry was once in the leading position in China.

Since the late 1970s, the market economy started to be revitalised in Ningbo. In 1984, Ningbo became one of the 14 Coastal Open Cities and was successively entrenched as a "Municipality with Independent Planning Status under the National Social and Economic Development" and a vice-provincial city, which enabled Ningbo to enjoy a relatively high level of autonomy in economic development and the same administrative position as the capital of Zhejiang Province - Hangzhou. Harbour-dependent sectors such as the iron and steel industry and petrochemical industry were developed, which have become the new pillars of local economic growth. Relying on the port advantages, Ningbo has also strived to develop the marine economy. Since 2013, Ningbo-Zhoushan Port has become the world's largest port measured by cargo throughput. Around 15% of Ningbo's GDP came from the marine industry, which has continuously contributed the most to the provincial GOP (MNR, 2021). Figure 6.1 shows the map of Ningbo.

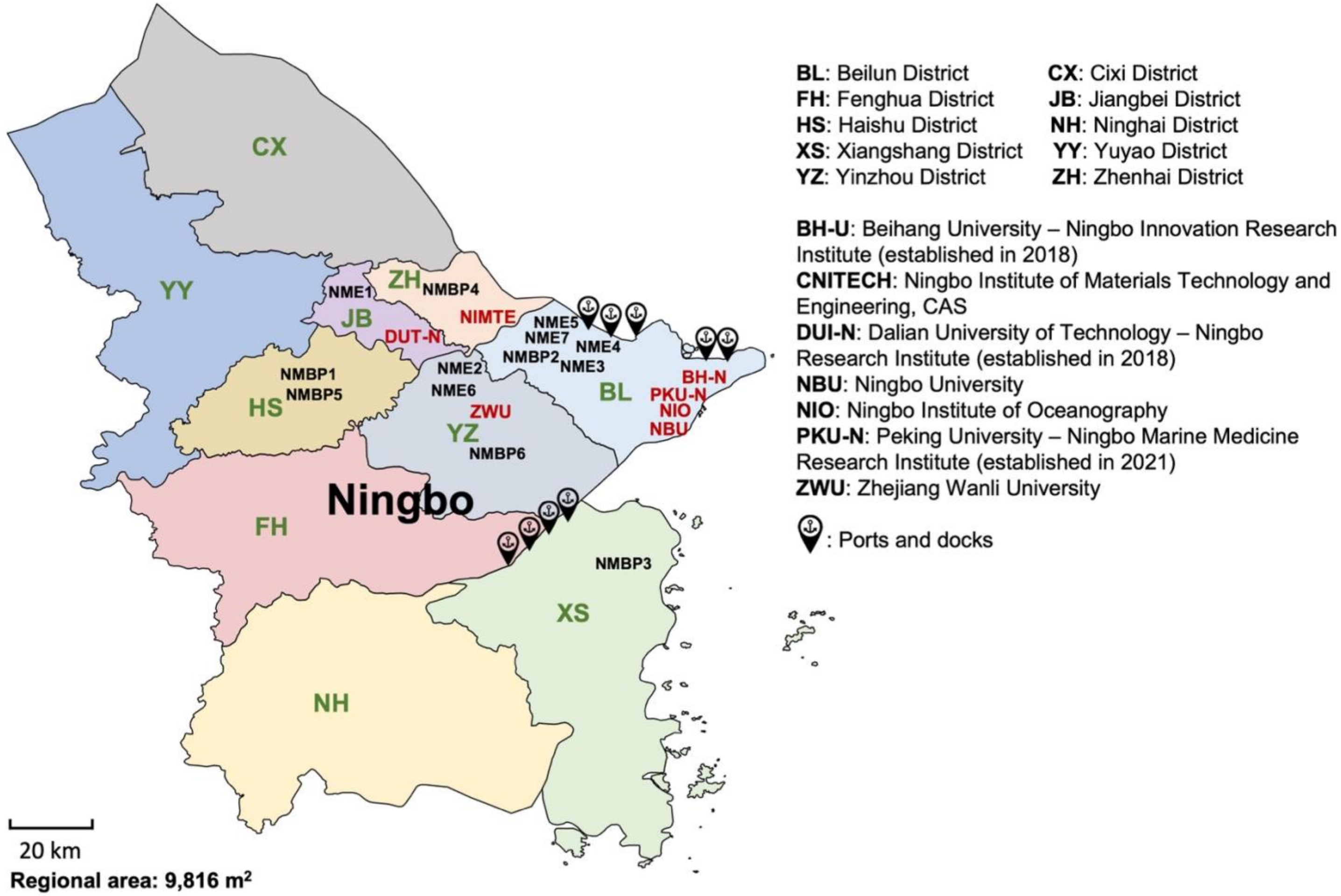

Figure 6.1. Map of Ningbo

This chapter analyses the regional pattern of marine innovation in Ningbo and illustrates the details of the regional institutions (Section 6.1) and follows the bottom-up approach by focusing on the commitment to innovation and the relational networking of marine firms in Ningbo (Section 6.2 to 6.7). Lastly, Section 6.8 summarises the marine firms' behaviours in Ningbo and concludes the regionally dominant pattern of marine innovation. Combined with Chapter 5, it paves the way for the comparative and causal analysis of regional disparities in Chapter 7.

6.1 Regional institutions in Ningbo

Built upon the background knowledge introduced at the beginning of this chapter, this section explores the regional institutions in Ningbo and the characteristics of the core institutions, including the local state, the research and education system, the financial system, and the cultural system which will be demonstrated from the aspects of the regional marine development.

6.1.1 The regional state

The local state of Ningbo maintained a *liberal-developmental* role in the regional economy and innovation by incorporating the liberal features in the Chinese context of the quasi-developmental state model. This phenomenon is also evident in the regional marine development under the general background of the national call for marine development.

Figure 6.2 depicts the major characteristics of the regional state of Ningbo. Specifically, the relationships with the higher-level states, the industrial policies and the regional bureaucracy that influence the marine industrial and innovative development are interpreted combined with the geolocational and historical influences.

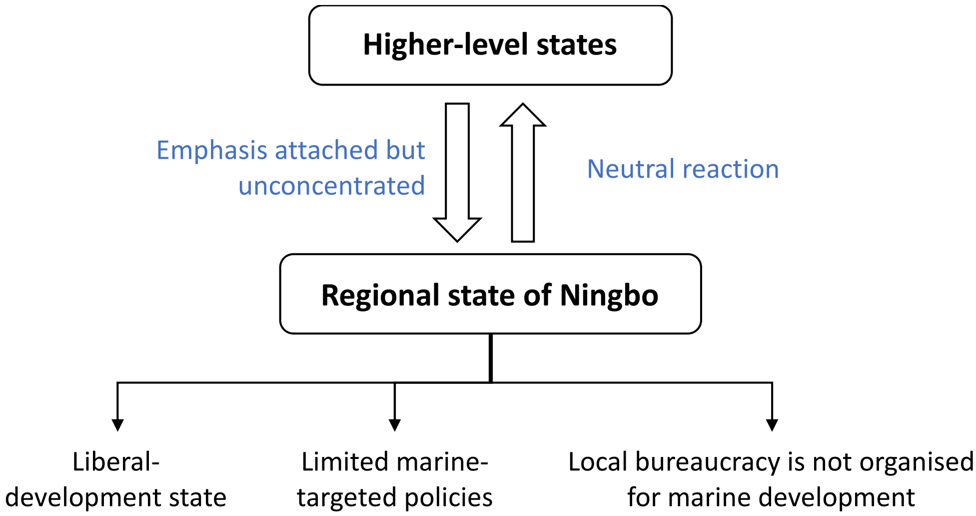

Figure 6.2. Regional state of Ningbo

Limited central (provincial)-local interaction

The state of Zhejiang historically maintained a distant relationship with the central government and a low level of reliance on the support from the central state. This is also evident in the regional case of Ningbo.

(a) Historically distant relationships with the central state

During the Maoist period, the distance from Beijing, the poor natural resources, the Mao's self-reliance policy seeking to reduce the dependence upon trade, and the geographical proximity to Taiwan all made this province be ignored by the central state in the industrialisation plan and investment in transportation like railways (Wei and Ye, 2004). In this case, the state of Zhejiang also played little directing and intervening role in the regional development but made a tacit consent of the private economy. Since the Open-up and Reform in the late 1970s, Zhejiang province became the bridgeheads of the regional experimentation of the open policy. More policy support has been allocated to this province. One of the important reasons that Ningbo was attached great importance by the central government was because of its port advantages and geolocational importance, thus receiving great state investments in infrastructure and port-related and resource-dependent industries. However, in such context, the regional state has spent more efforts in deregulation rather than enhancing the state control (Zhou and Zhou 1997; Wei and Ye, 2004). The local firms and entrepreneurs have been given much freedom.

Built upon the capitalism advantages, Zhejiang province is now a significant coastal province leading China's economic development. Following the national strategy of marine economic development initiated by the central state, the coastal province has been treated as the experimentation region since the late 2000s. In the early 2011, the "Development Plan of Marine Economy Demonstration Area in Zhejiang" was approved by the state council, which was one of the pioneer regional-oriented marine strategies in China and the first plan to develop the demonstration area as the experimentation of the marine economy. This plan sets the "Ningbo-Zhoushan port" sea area, islands and the supporting cities as the core areas of marine economic development in which Ningbo was undoubtfully the central region. Ningbo has also been characterised by the central-oriented regional experimentations as exemplified by the demonstration city of the marine economy and innovation and the industrial demonstration base of S&T-driven development of the marine industry.

(b) Unclear provincial marine centre and competition from proximate cities

Besides the distant central-local relationships, within Zhejiang province, it has been unclear which city is the provincial marine centre to develop marine economy, which leads to the unconcentrated focus. For instance, though the development plan mentioned above characterised the Ningbo-Zhoushan area as the centre, the experimental zone of marine development was set up at Zhoushan - a prefecture-level city in Zhejiang province made up of islands that far lagged behind Ningbo in economic development and industrial foundation. Many key national policies targeting the marine industry also unclearly define the marine centre in Zhejiang province. For instance, the "13th Five-year Development Plan of Marine Economy" mentioned to support the marine equipment manufacturing of the Yangtze Delta Region but only vaguely mentioning eastern Zhejiang. Regions such as Zhoushan, Hangzhou and Hangzhou Bay area were more frequently mentioned than Ningbo. This implies a regional balance strategy of marine development.
Furthermore, because of the proximity to Shanghai, the importance of Hangzhou, the capital city in Zhejiang province leading the provincial economy, in the national economy and the development of new industries[1], and the strong position of other

[1] Zhejiang and Jiangsu provinces in general have been seen as the surrounding regions of Shanghai.

cities within Zhejiang Province underpinned by the flourishing private economy (e.g., Wenzhou), Ningbo has not recognised itself as having the potential to become the regional centre. The regional state has neither been ambitious in become the provincial leader nor active in striving for more resources to support the marine development. When Ningbo started to develop the marine economy in the 2000s following the provincial development plan, the regional state issued the local marine economic development plan for the 12th five-year plan period. Ningbo positioned itself as the core of marine development in Zhejiang. However, it also clearly recognised its weaker position in the national strategy and described its own roles as (i) promoting and supporting the overall development plan of Zhejiang, (ii) supporting the national development strategies targeted at the Yangtze Delta region, and (iii) working as the geographical conjunction city by linking the southern Jiangsu, the northern Zhejiang, and the Fujian areas.

Plain marine policy tools

Received significant but unconcentrated focus on marine development from the higher-level government, the state of Ningbo has made a limited involvement in the regional marine development. In governing and promoting the regional marine economy and industrial innovation, the developmental logics are generally weak. By looking through the regional marine policies as summarised in Figure 6.3, in Ningbo, the industrial or innovation policies directed at the marine field are mainly the following-up strategies associated with the regional-oriented programmes driven by the central state (the upper half of the figure).

Besides, the regional state of in Ningbo characterises the importance of some specific marine fields but as a small section mentioned in other regional policies. For instance, the “246 Industrial Clustering Development” strategy in the bottom half of Figure 6.3 illustrates the building of two trillion-level industrial clusters, four half-trillion-level industrial clusters, and six 100-billion-level industrial clusters, supporting the product development in 13 industrial and technological areas. The high-end equipment manufacturing industry is one of the four five-billion-level industries in which marine equipment is included as a part. However, in general, regional policies and strategies

With Hangzhou’s strong momentum in economic growth, the development of the Yangtze Delta Region now highlights the double-core strategy emphasising both Shanghai and Hangzhou.

targeting the marine industry or sub-sectors are limited in Ningbo. As commented by a firm interviewee,

> *"We don't think the state of Ningbo truly recognises the marine economy as a critical opportunity to this city. Though they are not as strong as the states in other areas that may intervene in the industrial development, their decisions regarding the industrial development, such as how to guide and allocate the state resources, are still important." (I_NMEF7)*

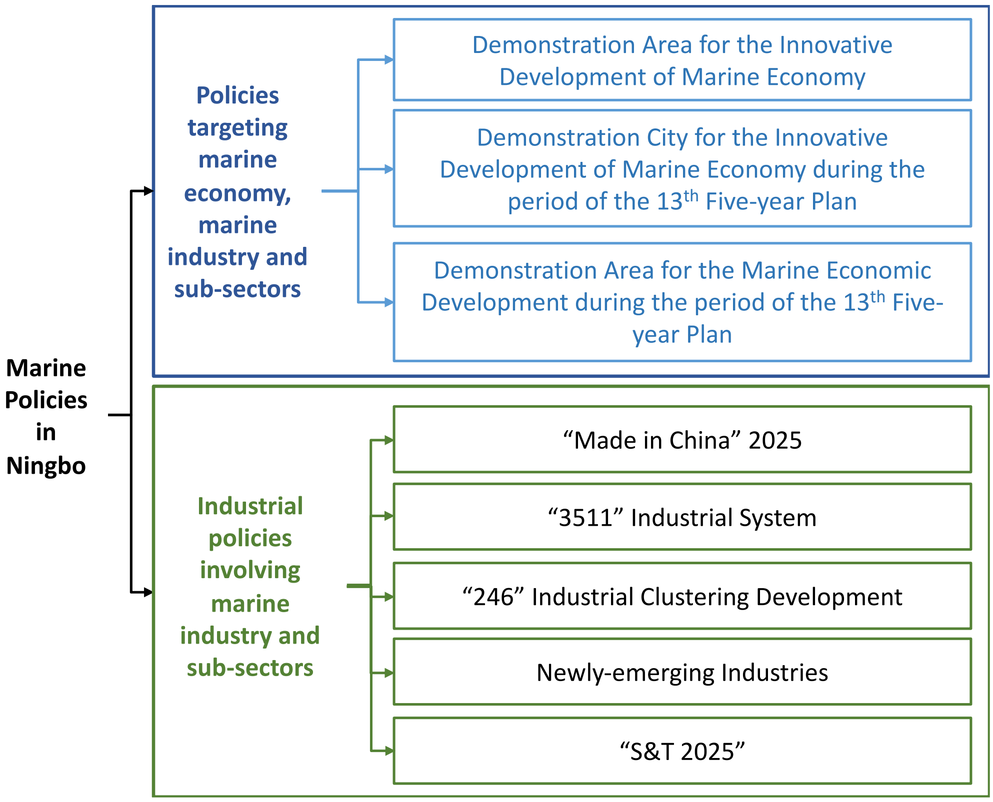

Figure 6.3. Policies in Ningbo targeting or involving marine development

Loosely structured bureaucracy and reduced marine orientation

As an important coastal marine city, Ningbo has established a specific bureaucratical department governing the affairs of marine and fishery since the last century. This role was once played by the Bureau of Marine and Fishery. In the 2000s, an internal department of the Development and Reform Commission - the Marine Economic Development Office was set up and assigned the role of organising and coordinating the regional marine economic activities. It co-existed with the Bureau of Marine and

Fishery to manage marine affairs but the later focused more on the fishery and ocean resources and governance.

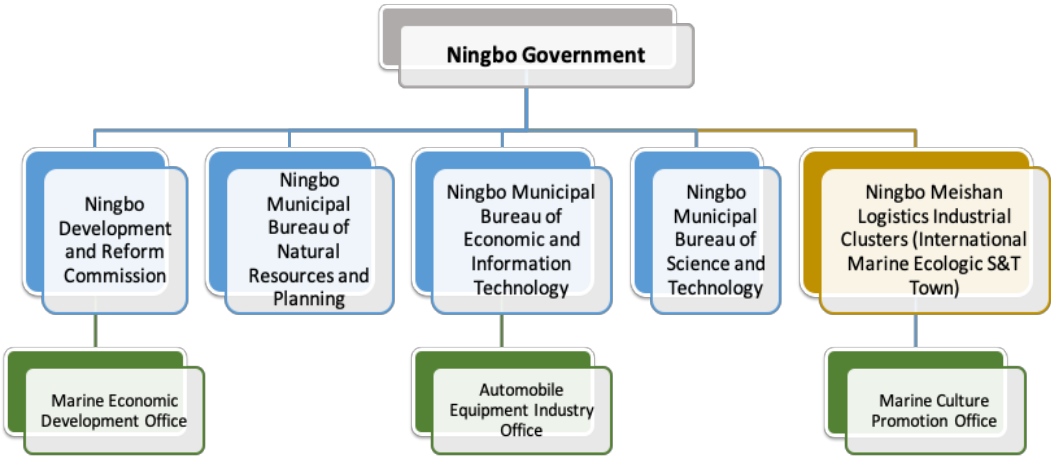

Figure 6.4. Bureaucratical structure for marine development in Ningbo

However, after a series of bureaucratical restructuring reform, the regional attention attached to the marine economy has been reduced. As Figure 6.4 shows, the previous Marine and Fishery Bureau has been incorporated into the Bureau of Natural Resources and Planning and becomes an internal department of the new bureau. Though this follows the national and provincial trend of integrating the management of ocean and the other natural resources, the local interpretations of this reform combining with other actions indicate that the *de facto* reduction of the administrative level of the local marine governance and imply the lower importance of the marine economic development to this region and the wider province.

In the local bureaucracy of Ningbo, no super-bureaucratical agency exists to coordinate the marine economy and innovation despite the complexity and wide coverage of this sector. Furthermore, no internal departments or offices targeting the marine development have been set up within the core key municipal bureaus such as the Bureau of Economic and Information Technology and the Bureau of Science and Technology. Moreover, even though Ningbo has built a functional area - Ningbo Logistics Industrial Cluster and seeks to gather marine industrial firms in “International Marine Ecologic Science and Technology Town”, the cluster is in the initial stage of development and no specific and effective regional clustering strategies or policies have been developed to attract and agglomerate marine firms. And more significantly, there exists a mismatch between the proposed aim of this cluster and the fact. Internal to this functional area, only one marine-relevant department has been built to promote the marine culture rather than for monitoring or supporting the proposed target of building a marine S&T and industrial development.

6.1.2 The research and education system

As mentioned in Section 6.1.1, there exists the unclearness of the provincial marine centres and unconcentrated emphasis on marine development in Zhejiang province. This feature is also evident in the R&E system. Before going into the details of the regional R&E system of Ningbo, it is important to build background knowledge about the provincial context.

Unconcentrated R&E capabilities in Zhejiang province

The marine R&E resources within Zhejiang province are in scattered distribution. There are two UPRIs specialising in the marine R&E in the Zhejiang province located in Hangzhou and Zhoushan, respectively. Specifically, the Second Institute of Oceanography[1] belonging to the MNR as the only national-level ocean PRI in Zhejiang is situated in Hangzhou[2]. The only ocean-specialised university in Zhejiang province - Zhejiang Ocean University, is suited in Zhoushan. Besides the lack of marine R&E organisations, Zhejiang suffers from an insufficiency of the top UPRIs on the national level. In this province, there is only one national-level university - Zhejiang University belonging to the MOE located in Hangzhou. As commented by an interviewee,

> *"Zhejiang province lacks strong higher education institutions except for Zhejiang University. This is a large weakness to the local development compared with other developed provinces." (I_NF1).*

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[1] Though this institute had once moved to Ningbo in the 1960s, it moved back to Hangzhou in the early 1970s. Almost all key laboratories and R&D activities of this institute are currently based in Hangzhou, except the equipment R&D base in Zhoushan.

[2] Due to Hangzhou Bay, Hangzhou is geographically a coastal city. However, it is not a typical marine city because of the lack of sea harbour and marine culture and its short coastal line.

Weak R&E system but with specialised advantages

No marine specialised UPRI exists in Ningbo. Similar to the provincial context, there is a limited number of R&E organisations in Ningbo. The regional R&E system is far from well-structured and comprehensive. As Figure 6.5 shows, there is only one national-level UPRI - the Ningbo Institute of Materials Technology and Engineering (CNITECH), belonging to CAS that has engaged in marine research[1]. Besides, the Ningbo-based UPRIs participate in the marine research and education, which contributes to the development of capacities in specific marine S&T fields and the training of marine skilled labours or talents. As the mainstay of the local R&E system, Ningbo University engage with marine R&E though it is a non-traditional marine-focused organisation. The main marine-relevant school internal to the current Ningbo University - the School of Marine Sciences[2]. Merged with Zhejiang Aquaculture School, the School of Marine Sciences mainly specialised in marine biotechnology and aquaculture, such as the genetic research of marine life, breeding, and biochip. According to a researcher from Ningbo University, they have been strongly encouraged to develop applied research and serve the local economy,

> *"Aquaculture industry is key to Ningbo, driven by the high demand for seafood. We aim to better support local industrial development and build more industrial collaboration. Internal to our university, we have also sought to forge the internal collaboration with the other schools, for example, the department of mechanics, in co-R&D of the influence of the fluid field on marine life." (I_NU2).*

In addition, Zhejiang Wanli University also involves marine education and some marine research. Despite the relatively low level of this university and its limited capability, it provides skilled labour with marine knowledge to this region. Besides, in 2015, the local state of Ningbo collaborated with Ningbo University and the SIO and established

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[1] Its main research is new energy like power storage and power lithium batteries and new materials. Marine materials research and education take place in the internal laboratory of CNITECH., which can be applied to the surface strengthening and resistance to corrosion or abrasion of marine equipment.

[2] It was established through the merger with the Ningbo Institute of Zhejiang Aquaculture School, built upon the common interests of the SOA and Ningbo University to build marine subjects in Ningbo. Similarly, the subjects of shipbuilding and marine engineering, fishery appliances and equipment and ship engineering and dynamics in the School of Maritime and Transportation were mainly transformed from the previous division of machinery in Zhejiang Aquaculture School.

the Ningbo Institute of Oceanography. However, it is not a professional higher education or research organisation but more like an R&D service platform, or a think tank, providing consultancy and service acting as the regional research infrastructure.

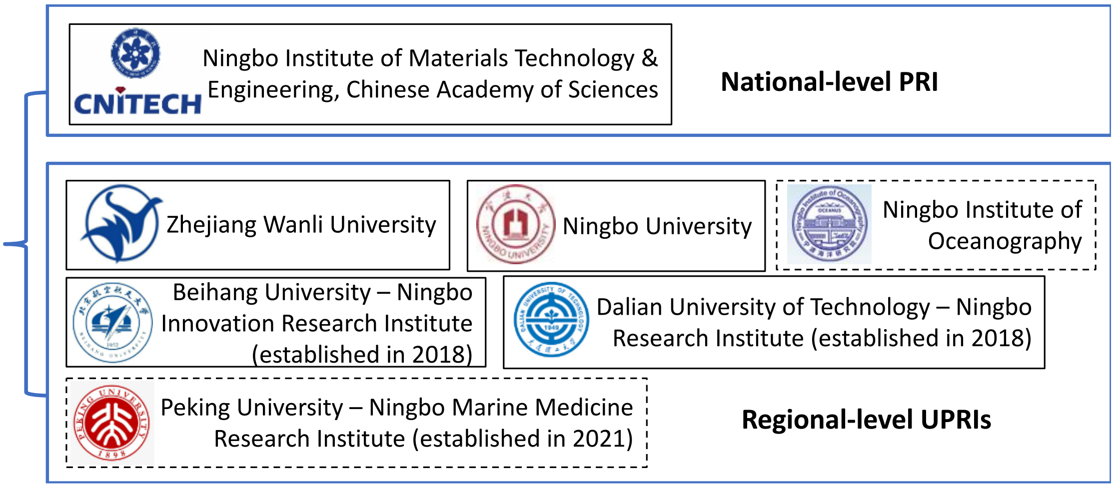

Figure 6.5. Regional R&E system and the composing organisations in Ningbo

Introducing new marine R&E organisations

Despite the efforts of regional-based UPRIs in pursuing marine R&E and application-driven development, the R&E system cannot be regarded as systematic and strong. In recent years, many other R&E organisations in the form of the branch campuses or research schools have been newly established in Ningbo based upon the agreement between the local government and top universities, strengthening the regional R&E system. In this respect, the regional state plays some intervening roles in the regional development.

However, because they are the "immigrants" to Ningbo, their development largely depends on the local state to provide environments, infrastructure and support for their development. Furthermore, because their affiliated universities have own home bases, these universities can neither shift all their development efforts to a new base nor allocate huge resources to the new schools or groups. Therefore, it is difficult to expect that these new schools and research teams can replace the traditional cores of the regional R&E system in Ningbo. And their impacts on the regional development of marine skills and expertise deserve to be observed in the longer time.

6.1.3 The financial system

The development of the marine sector demands the capital sources to facilitate the industrial and innovative development. Benefitting from the well-developed venture capital in the Yangtze Delta Region led by large metropolitans - Shanghai and Hangzhou and the proximity to these cities, firms in Ningbo are more accessible to the risk capital despite the small risk capital market in this city, which could inject some vigour into the local markets. However, this poses high requirements on the innovativeness and business potentials of individual firms. Similarly, even though Ningbo is geographically close to Shanghai - where one of the two stock exchanges in China is situated, the access to capital market is highly dependent upon the corporate capabilities. Most private firms in small scale that account for a large percentage of the regional economy in Ningbo do not possess such capacities. Therefore, like most Chinese regions, the financial system in Ningbo is characterised by the bank dominance. However, resulting from the historical reasons, this financial system of this system maintains some pluralistic feature of the co-existence of formal and informal financial institutions, which offers more choices besides the bank to the large size of private actors.

Bank-centred system

The financial system in Ningbo is bank centred. Even though regional states have been granted more autonomy to allocate the financial resources following the fiscal reform and economic decentralisation, whether firms can easily obtain the bank loans or financial support is contingent upon whether their industries are locally supported. Nevertheless, Ningbo also sought to explore new approaches to support regional marine development financially. For example, in 2015, Ningbo set up China's first marine development fund[1] (fund of funds) to support the local marine economy driven by state capital. The first sub-fund was set up by collaborating with banks and other financial organisations. Also, because of the importance of private economy and small firms in Ningbo, the financial policies and access to bank loans are more friendly

[1] It is known as the "guidance fund" (*yindao jijin* in Chinese) to provide support to strategic and emerging technologies and realise the goals of industrial policy. This way is different from directly allocating resources to specific projects and industries by "*allocating resources to [a] fund of funds, from there reallocating to marketised [sub-]funds, and from there reallocating to specific companies and projects can be regarded as progress or improvement.*" (Luong et al., 2021).

to small firms.

However, the ocean-oriented accesses to capital are still insufficient and premature in general in Ningbo. Besides, as mentioned above, the regional state in Ningbo plays a more liberal role. When the marine sector is still small compared with the other pillar industries, limited resources are allocated to this industry. No banking organisation in Ningbo has launched specific financial products to support the marine economy and innovation. More importantly, also because of the large size of private firms in small scales in Ningbo, the financial resources cannot be evenly distributed, which further reinforces the non-interventionalist logic of the regional state.

Private financing

In Ningbo, an important feature of the financial system is the availability of informal financing. This is partly due to the legacy of the prosperity of money houses (*qianzhuang* in Chinese) in Ningbo built upon the closely linked merchants in this city to obtain financial support when facing the money shortage. As the earliest form of bank in China's history, it once played an important role in supporting the development of commodity economy since the Qing Dynasty and underpinned the financial development in Shanghai in modern China.

The availability of informal financing, mainly in the form of private financing, enables a large group of private SMEs to obtain capital when they fail to access formal financing resources from dominant banks. Compared with the bank loans, the capital access to informal finance facilitates the development of the regional firms by injecting a high degree of flexibility and efficiency. In this process, the historical legacy of the local community culture and networks remains important, which will be discussed in the next section. As argued by the local financier,

> *"The merchants of Ningbo, even though they may now be in other areas, they have a very strong sense of cultural identity and mental connections with other merchants. It is not because we are unwilling to provide them with bank loans. In some cases, many small and private firms turn to private financing for its convenience and quickness." (I_NF2).*

6.1.4 The cultural system

Although the Confucian culture has significantly influenced the Chinese cultural system, many regions are less impacted. Ningbo and its situated Zhejiang Province are typical examples. Zhejiang province was historically famous for the active commercial activities, which is unsupported in traditional Chinese culture. With large mountainous areas, Zhejiang province is inappropriate for land cultivation and is geographically isolated from the interior of China (Wei and Ye, 2004). Self-reliance is a historically important logic in this region's development. At the same time, relying on the advantages in port, foreign trade significantly influenced Ningbo. The merchants of Ningbo accumulated rich commercial experiences and the community-based culture strongly contributed to the business prosperity of the Ningbo. During the Ming Dynasty, business groups started to emerge in Zhejiang. And Ningbo Business Group is one of the most famous.

Besides transforming this city, Ningbo businessmen played important roles in the development of the commodity business and industrial development in modern China. Since the open-up after the First Opium War in the late Qing Dynasty, Shanghai quickly became the most important trade city of China after Guangzhou. Due to the geographical proximity, a large number of businessmen from Ningbo moved to Shanghai seeking new business opportunities. Built upon the associations of fellow businessmen from Ningbo, they have demonstrated a strong sense of unity and created plenty of commercial miracles. The group of merchants from Ningbo, historically known as "Ningbo Bang", became the largest business group in modern China and played a significant role in transforming Shanghai into a modern city and later contributed to the development of Hong Kong.

The cultural system and the industrial organisations

The cultural system in Ningbo based on the integration of the early marketisation, the deeply nested community of Ningbo Bang, and the businessmen geographically dispersed all over the world has led to the prevalence of the capitalism awareness in this city and the low reliance on the state economy. There was a small proportion of the SOEs in the regional industrial development. What have been important to the economic development of Ningbo are the bottom-up paths built upon the initiatives of enterprises rather than the top-down and state-led forces. The lack of strong state economy made this city and the wider Zhejiang Province at the disadvantageous positions in the period from the 1950s to 1970s, which led to the increasingly lower reliance on the state support and the “underground” development of the private economy (Wei and Ye, 2004). The traditional commodity culture further encouraged the spirits of self-reliance of the local population and their strong initiatives to find the means to make a living.

However, since the late 1970s, the relaxation of the regulations on the development of private ownership and the support from the overseas Ningbo businessmen (Hua et al., 2016) led to the revival of the entrepreneurship culture in Ningbo. The experiences of foreign trade and the strong tradition of the commercial activities provide the fertile environment for the market-oriented development of this city. Meanwhile, the port advantages further facilitated the development of the economic development based upon the foreign trade. In such context, the private economy of Ningbo was revitalised and started to take off. In the recent decade, from 2010 to 2019, the private economy contributed over 70% of the regional GDP. Over 90% of the economic entities in Ningbo are privately owned.

As exemplified by the private financing discussed, in the present Ningbo, the cultural legacy of the Ningbo Bang and the community-based networks and trusts still act as the overarching business logics in the regional economy and underpin the reliance on the intra-regional connections. State control is low despite there was some state investment in several heavy industries that built the early heavy manufacturing basis. Bottom-up industrial clusters and integrated value chains have been established in Ningbo. This provides cultural advantageous conditions and experiences of the industrial agglomeration for the marine clusters. Nevertheless, the low dependence on the state company also determines that the marine economic and innovative development depends more on the marine notions and the self-motivations of the local businesses to engage in marine activities.

To summarise, the sections above have explored the regional institutions in Ningbo that are assumed to be important in structuring the regional patterns of economic and innovative development. The further impacts of these institutional elements will be analysed in combination with the firm behaviours based upon the evidence obtained from the firm-level interviews and be in comparison with the regional case of Qingdao in Chapter 7. The following sections of this chapter present the analysis of marine firms in Ningbo by characterising the idiosyncrasy of firms and aim to summarise the dominant regional patterns of marine innovation in Ningbo.

6.2 Innovation commitment of marine firms in Ningbo

This section demonstrates the commitment to the innovation of sample marine firms in Ningbo from multiple perspectives by presenting the numeric and qualitative data. Specifically, commonly adopted indicators of R&D input including the R&D expenditure and R&D employees are interpreted and complemented by the firm-based innovation platforms as a qualitative indicator. Although measurement of R&D input is not the determining factor to marine innovation, it is an important internal dimension of firms that should be characterised in combination with the later interpretations of the external networking.

6.2.1 R&D input of marine firms in Ningbo

Table 6.1 demonstrates the innovation input of the sample marine firms in Ningbo. In the three years from 2017 to 2019, sample marine firms in Ningbo input 5.40% of the sales income into R&D and maintained 12.78% of staff for R&D activities. The inputs measured by the R&D expenses to sales and the R&D personnel to the total headcount were notably higher in the MBPFs in Ningbo than the MEFs in the same region. In addition, in order to control the influence of the sample size and the extreme firm cases, the median is presented to indicate the medium level of marine firms' innovation input. Typically, marine firms in Ningbo spent 4.50% of sales on R&D and kept 12% of R&D staff. Similar to the average, MBPFs in the middle of the industry invested more than the typical MEFs in Ningbo.

Besides, despite the low degree of mobility of the population in Ningbo and the stable growth of the size of the R&D department in marine firms, interviewees mentioned that it was difficult to recruit and retain the high-end marine R&D employees, which are often composed by a higher proportion of the non-locals. In many cases, to attract and retain high-end talents, the private marine firms in Ningbo often use strategies like the high salary or other benefits and make long-term plans.

Table 6.1. The R&D input of sample marine firms in Ningbo from 2017 to 2019

R&D input (three-year average)	TOTAL n = 13	MBPFs n = 6	MEs n = 7
R&D expenses / sales (%)			
Mean	5.40%	6.95%	4.07%
Median	4.50%	7.25%	3.90%
R&D personnel / total personnel (%)			
Mean	12.78%	14.68%	11.16%
Median	12.00%	12.50%	10.00%

Sources: fieldwork interviews and annual reports of companies.

In terms of the R&D spending, in the three years from 2017 to 2019, various kinds of governmental funding account for around 13.51% R&D expenditure of the sample marine firms in Ningbo. Within the same region, MBPFs in Ningbo acquired more financial resources from the government (~15.95%) than their ME counterparts (~11.42%). However, according to the fieldwork interviews, most of the funding in relatively high amounts came from the tax reduction, rewards, and S&T projects associated with national-level programmes. Regional-level financial support accounts for a small proportion. More details about the interaction with the regional government agencies will be illustrated in Section 6.7.

In addition to internal financing and governmental funding, firm interviewees mentioned three main accesses to financial resources that support their capital demand and facilitate the R&D investment. They cover the major types of capital sources of firms including the bank loans, the equity financing (through stock market and venture capital), and the private loans. The following sub-sections will analyse the R&D input data of the sample marine firms in the two sub-sectors in Ningbo.

R&D input of MBPFs

According to the fieldwork interviews in Ningbo, in the three-year duration, the annual inputs into innovation measured by the proportion of R&D expenses to sales and the percentage of the R&D staff to the total headcount has been stable. Viewing the data of MBPFs, no specific extreme firm cases have been identified like QMBPF5 in Qingdao (i.e., no extreme values). The intra-region disparities across the sample MBPFs in Ningbo in terms of the R&D expenditure proportion have been unobvious.

Furthermore, as mentioned in Section 5.2.1, MBPFs often invest a great deal in R&D at the initial launch of the new projects. This is also an evident phenomenon reported by marine firms in Ningbo. Currently, the majority of the MBPFs in this region focus on the innovation of generic drugs, which has contributed to the stable growth of R&D expenditure. However, following the implementation of stricter regulations on the reviewing process of generic drugs and the fiercer competition to bring the generic products on market as soon as possible, most firms have shifted more attention to plan for the R&D of more innovative products and advanced technologies to strength their positions in the niche market, which incurs the higher input in R&D spending. As indicated by the interviewee from NMBPF2 - a traditional generic drug producer,

> *"We are doing a budget plan for the next year. A new project will be launched. And we expect to invest most of the sales income this year into it." (I_NMBPF2).*

R&D input of MEs

As for the sample MEFs in Ningbo, intra-regional cross-firm differences in the ratio of R&D expenditure to sales are small. However, it is worth noting that the sizes of firms are highly influential on the absolute scale of the pecuniary spending on the internal R&D. Cross-firm differences in the percentages of R&D expenditure should be interpreted in combination with the size, the development stages, and the positions of a specific firm. For example, even though the R&D spending of the large-sized companies with a high level of sales income (e.g., NMEF7) has accounted for a small percentage of the sales (around 3%), the amount of money invested into R&D can sometimes exceed the overall sales income of small firms despite their higher proportion of R&D expenses.

As for the commitment measured by the size of R&D staff, sample MEFs in Ningbo demonstrate a more heterogeneous pattern. And the heterogeneity between different firms exists both in the proportion and the composition of the R&D staff. As stated in Section 5.2.1, technicians and skilled workers usually constitute the most significant parts of the R&D staff in MEFs, while research-driven and science-driven staff account for a small percentage. According to the fieldwork interviews in Ningbo, large-sized companies with a higher proportion of R&D staff also offer the R&D employees more spaces and higher freedom to focus on the R&D of emerging technologies and products. A few companies established internal research institutes and a number of the R&D employees work on the analytical design and lab experiment. However, for companies in relatively smaller sizes (e.g., NMEF5 and NMEF6), they often have no specific R&D departments. And their R&D employees contain higher proportions of technicians and engineers. They blur the distinctions of R&D tasks and differentiate the R&D employees only according to their academic background. As argued by the interviewee from NMEF6,

> *"We do not have specialised researchers but maintain a large size of technical employees. This group of people conduct the "R&D activities" you referred to - improving the product design, developing new products, solving the technical problems, and so on." (I_NMEF6).*

6.2.2 Innovation platforms of marine firms in Ningbo

As illustrated in Section 4.5.3, major innovation platforms built upon the firms include the engineering technology centres, enterprise technology centres, and expertise workstations ranging from the city to the national level. Because of the strict criteria to establish the innovation platforms and the regular revisions, this measure works as an effective means to characterise the commitment of marine firms to innovation. In Ningbo, most of the sample marine firms have been qualified for the corporate innovation platforms, including over two-thirds of the sample MBPFs and over half of the MEFs. However, sample marine firms of Ningbo demonstrate different attitudes towards these platforms.

Moreover, as mentioned in Section 5.2.2, despite the wide establishment of company-based innovation platforms across sample firms, the levels of innovation platforms and their types differentiate firms' commitment, capabilities, and the benefits of these platforms. In the case of Ningbo, among the sample MBPFs in Ningbo, only one-third have established the provincial- or national-level innovation platforms. To the rest of them, establishing regional-level platforms means the limited positive impacts associated with the establishment of these platforms in enhancing their brand image, attracting talents and resources to support innovation. However, sample MEFs demonstrate somewhat different attitudes because over half of them have been qualified for the higher-level platforms entitled by the higher-level governments, which means the relatively higher degree of commitment to innovation and internal R&D capabilities.

6.2.3 Regional patterns of innovation commitment in Ningbo

This section demonstrates the commitment to the innovation of marine firms in Ningbo by combining quantitative and qualitative indicators and the narrative illustrations from interviews. The analysis shows that the sample MBPFs in Ningbo have input the higher proportions of the pecuniary and human resources in the internal R&D, though most of their innovation focus are not radicality-oriented. However, MEFs in Ningbo have established the company-based innovation platforms in the higher levels, which indicates their continuous investment in innovation. Moreover, while reviewing the data per se shows little intra-regional disparities across firms, the characteristics of firms highly influence the interpretations of the data and indicator. All in all, on the regional level, marine firms in Ningbo have shared the commonality in being committed to innovation.

6.3 Interaction between marine firms in Ningbo and customers

This section demonstrates the customer relationships of marine firms in Ningbo. Nowadays, market-driven development and innovation are the common characteristics shared by the marine firms with different backgrounds in Ningbo with customers act as the important external sources of innovation ideas, knowledge, and feedbacks. On the regional level, a homogeneous pattern of the close interaction between marine firms in Ningbo and their customers in innovation has formed. Based upon the firm-level evidence, this section summarises the regional patterns of relational interaction of marine firms in Ningbo and their customers in the innovation-related aspects. How the region has influenced their relationships will also be discussed.

6.3.1 Interaction between MBPFs and customers

As demonstrated in Section 5.3.1, this study will not make a strict distinguishment of MBPFs' customer groups between the users, buyers, and doctors. For the sample MBPFs in Ningbo, two third of them are drug or vaccine producers, hospitals and farms are their main trading customers with human patients and ailing animals are the primary users of their products. As for the remaining two companies, NMBPF3 mainly trades with business companies and its main innovation and business field are biotech products (i.e., enzymes extracted from marine life), while NMBPF6 mainly focuses on the medical-used diagnostic products made by marine materials. The primary customer groups of the latter company are hospitals similar to those drug producers. In general, the relationships between MBPFs in Ningbo and their customers is obligational (see Appendix J for details of individual firms).

Geographical sources of customers and the interacting basis

According to the fieldwork interviews, sample MBPFs mainly trade and interact with domestic customers except NMBPF3 that has also built relationships with foreign customers. The interviewees from sample MBPFs in Ningbo mentioned that the sales of products demonstrate regionalised featured. In particular, according to the interviews, the coastal areas (with large sizes of population) and the region where a MBPF is situated are important. From this perspective, being located in Ningbo and the wider Zhejiang province, these MBPFs enjoy geographical advantages to penetrate into the local market and build the brand images in the local and nearby regions. Besides, interviewees also mentioned that the diseases also demonstrate regionalised feature caused by the regional habits. For example, there is a large proportion of people in Changsha - an inner city in China to suffer from the oral cancer. In general, regions with large populations like Henan and Shandong mean the large markets.

The interaction between MBPFs and customers is less determined by their trading agreement. To the interaction in innovation beyond the trade, previous collaborative experiences with hospitals and business companies are crucial. Besides, the personal relations of the marketing and the R&D staff in MBPFs with doctors are important channels to build and maintain the contacts in innovation. In many cases, to the MBPFs in China, *guanxi* with doctors was historically determinant to the marketing and business success. However, with the implementation of policies to regulate the drug circulation, the use of *guanxi* to establish trading relationships has been largely reduced. Due to the centralised procurement in China, many MBPFs now have restricted access to their customer groups, especially those public hospitals in the marketing.

Obligational relationships with customers

(a) Customers as providers of innovation insights and feedbacks

As mentioned in section 5.3.1, because of the industrial characteristics of the biotech and pharmaceutical companies in which the innovation often involves the high uncertainties and risks, their disease-driven innovation has been less influenced by the customers or users in direct means. However, this cannot diminish the importance of MBPFs' interaction with customers. In the initial stage of innovation, interaction and communication with customers are crucial to MBPFs to obtain new thoughts of innovation. And in the after-sales stages, customer opinions are similarly important to the MBPFs in order to continuously improve the products.

According to the fieldwork in Ningbo, sample MBPFs have maintained close relationships with customers in the marketing stages. The MBPFs communicate with the customers to understand their demand and preference about the effectiveness of the existing drugs, the safety, and conveniences in the use of medication. This information offers important insights to the MBPFs in the directions of innovation of new products and is significant to the launch of new R&D projects. However, in the early stage of interaction, the sales department plays more important roles by passing the customer opinions to the internal R&D department, which poses requirements on the internal coordination and understanding within a MBPF. Whether these initial insights can be transferred to the mature innovation concepts is still contingent upon the judgement of the R&D staff. This is especially important for the companies facing great competitions in the innovation of generic drugs. As argued by the interviewee from company NMBPF1,

> *"If our products cannot successfully enter the procurement catalogue of the public hospitals, which is contingent upon the negotiation with the local or national government agencies, we would stop the further innovation, improvement, or even production of that specific product because the profits and costs can hardly be balanced. This determines that we must carefully choose our next direction of innovation according to the market trend and our capabilities and specialised advantages to speed up the innovation process and shift more attention and resources to innovative drugs. This sets up higher criteria for MBPFs - innovate or*

die." (I_NMBPF1).

For the biotech firms or vegetarian drug producers, because they can directly trade with the business customers, collecting insights from customers is crucial to their product innovation, or in some cases, design more targeting products. Furthermore, customers are also important sources of after-sales feedback that are essential for the further improvements of the existing products. MBPFs not only provide products to customers or users but also engage closely with customers by providing customised services surrounding the core products, such as the plan of cultivation, the guidance on the usage of products, and the establishment of communication channels with other users, and so on. These services increase the customer loyalty. Moreover, it builds the communicating basis between MBPFs and customers, which enhance their mutual trust and benefit their long-term relationships.

(b) Customers as external knowledge providers

Moreover, in the regional case of Ningbo, co-R&D projects between MBPFs and customers have been rare. As agreed by the majority of the sample MBPFs in Ningbo, the interactions between the customers concentrate on knowledge exchange. In such circumstance, the customers and users or their representatives (e.g., doctors) are important external knowledge sources and essential participants in their innovation process, especially in the stages of clinical tests and experiments. In this process, they exchange information and knowledge about the specific aspects of the products to obtain the validated data, which is essential to the later industrialisation and obtaining the approval. As mentioned by several interviewees from the sample MBPFs,

"We have maintained collaboration relationships with doctors. Though they are not always the direct customers of our products, at least in the recent few years, they sometimes act as the external "R&D staff" to our company. They are vital because they can help us to validate the feasibility of some of our thoughts and ideas for innovation from the clinical perspective." (I_NMBPF2).

"Customers are involved in our innovation process, particularly in the fieldwork experiment stage after the lab-stage R&D. They offer us valuable insights regarding the products from the perspective of farm managers, which also lays a

foundation for establishing trading relations afterwards." (I_NMBPF6).

6.3.2 Interaction between MEFs and customers

For the MEFs in Ningbo, their customer groups mainly consist of business customers, with only one firm (i.e., NMEF5) that also trades with the individual customers and government agencies such as the Maritime Bureau. As evidenced by the interviews, a regionally obligational pattern of customer relationships can be identified in Ningbo despite the specific differences across firms (Appendix J shows the details of individual firms). Though lacking a regional customer base, the region of Ningbo facilitates MEFs to approach customers in many aspects.

Geographical sources of customers and the locational advantages

According to the fieldwork interviews, over four-fifths of sample MEFs in Ningbo mentioned that they have mainly traded and collaborated with customers from domestic coastal areas, especially in southern China such as Shanghai, cities within Zhejiang provinces like Zhoushan and Taizhou, and nearby provinces such as Jiangsu and Fujian. Even though Ningbo offers no significant customer base to them, being situated in Ningbo provides them advantages in geographical proximity and cultural proximity to customers in nearby coastal regions.

Besides, relying on the port advantages, the regional external-oriented development, and the large size of overseas Ningbo population, MEFs have easier access to foreign companies and have accumulated rich experiences of interacting with them. Even though most of them have maintained the dominant focus on the domestic market with the large domestic demand, previous relationships with overseas customers enable these MEFs to approach extra-regional and even extra-national knowledge, for example, the industrial standardisation in foreign countries and products dominating the overseas market that are unavailable to many of their domestic competitors.

Obligational relationships with customers

According to the fieldwork in Ningbo, sample MEFs in Ningbo have forged close relationships with their customers and maintained the long-term relationships, which benefits their innovation. Even though their interaction is based upon the trading relationships, MEFs improve the product designs according to the customer requirements, strength the process innovation to improve the innovation efficiency and to better satisfy their customers, and exchange information, knowledge, and expertise in the innovation process. These interactions often transcend the trade interaction but involves more frequent communication and interaction and accumulates the mutual trust beyond the trade or projects.

(a) Customers as sources of innovation ideas

In Ningbo, sample MEFs have agreed that customers are important sources of their innovation ideas by proposing specific product requirements and specifications. This is particularly true for firms like NMEF4 whose main products are for specialised use, like the marine scientific expeditions, or their products are highly unstandardised and are subject to further customisation. Besides, even for those standardised products such as the ship-used diesel engine, MEFs may adapt the products to suit the specific contexts of application through communicating with their customers. Based on the core analytical design, MEFs make adjustments to the products. In this respect, the mutual understanding and long-term interaction builds their trusts in each other. Many modifications around the product designs are suggested and judged by the MEFs rather than always being required by the customers' specific requirements. As mentioned by the interviewee from NMEF1,

> *"Customers may order the products at the rated load of 100 horsepower (hp). We can definitely offer them a standard product. However, through communicating with them, we may notice that the most frequent level attained in their actual use is 85 hp. In this case, we would consider how to optimise our products according to their application scenarios and to adjust the products to achieve the best performance at 85 hp (while it can still realise 100hp.)" (I_NMEF1).*

(b) Interaction with customers in the innovation process

Besides guiding and inspiring the innovation of MEFs, customers often participate in the innovation process of MEFs in different ways. Related to the customer-driven nature of innovation, to the majority of the sample MEFs in Ningbo, the most common way of their interaction and communication with customers is seeking feedbacks on the product design and specificities in the different stages of the innovation before the production of the final products. In this process, MEFs accumulate experiences and strengthen their expertise in product design and engineering, which further increases their ability to satisfy different kinds of customers.

Besides focusing on the improvements of existing products, some MEFs in Ningbo treat customers as important sources of expertise and knowledge that facilitate the develop of new technologies and advanced products. These firms usually have some achievements in their specific technical fields. In order to achieve long-term development and keep attracting new customers, they invest in the development of advanced technologies. Some of them have accumulated experiences of participating the innovation projects led by their customers, which involves the sharing of resources in knowledge, expertise, and the innovation outputs such as the IPs. By this means of collaboration, MEFs need to continuously update their internal knowledge base. The project-experience or the star products can strengthen their brand images and sometimes open new business opportunities. As mentioned by the interviewee from the sample company NMEF7,

> *"We are willing to trade with those high-end customers, for example the SOEs, so that we can be involved in important projects on the national level. Technical breakthroughs often generate from these projects. Many of these projects last long and we join in from the product design until the implementation and after-sale maintenance services." (I_NMEF7).*

6.3.3 Regional patterns of business-customer relationships in Ningbo

According to the above analysis, marine firms in Ningbo have generally interacted closely with their customers in innovation, which demonstrates the ***obligational*** pattern on the regional level. Table 6.2 summarises the customer relationships from several key dimensions. The innovation of marine firms in Ningbo has benefitted from the relationships with customers primarily in terms of the innovation insights, either generally inspiring their innovation or proposing specific requirements. Besides, the feedbacks from customers and the expertise of customers constitute external knowledge sources to marine firms. Moreover, in the interaction with customers, the region provides marine firms the local market that they can penetrate in and build the brand image. However, in Ningbo, there lacks a large size of customer groups for the regional marine firms. Ningbo favours the marine firms in the locational advantages of the proximity to nearby regions and the easier access to foreign regions, while there are limited benefits in the industrial agglomeration or regional-based networks that facilitate the marine firms to approach more customers beyond the geographical advantages.

Table 6.2. Business-customers relationships of marine firms in Ningbo

Dimensions of customer relationships	Marine firms in Ningbo
Establishment of innovation interaction	• MBPFs: disease-driven and non-trade-based, interactive basis include the collaborative experiences and personal relationships, the regional and nearby markets are important. • MEFs: trade-based, Ningbo offers locational advantages to nearby customers and access to foreign customers.
Communicating frequency	Frequent
Length	Long-term
Intensity of innovation interaction	High
- **Information exchange**	High
- **Resource sharing**	• MBPFs: limited • MEFs: some (firm dependent)
- **Risk sharing**	Limited
Trust	• MBPFs: goodwill trust • MEFs: competence and goodwill trust
Relational pattern	**Obligational**

Sources: fieldwork interviews.

6.4 Interaction between marine firms in Ningbo and suppliers

This section shifts the focus to the marine firms' relationships with another vertical collaborators - the suppliers - the material and component suppliers and the equipment suppliers. While the first kind of suppliers is expected to be essential to marine firms' product innovation, the latter is more crucial to enhancing the process of innovation. By analysing evidence collected from individual firms, this section evaluates the impacts of supplier relationships on innovation and summarises the regional patterns.

6.4.1 Interaction between MBPFs and suppliers

MBPFs in Ningbo demand the supply of materials and equipment. The interaction between MBPFs and suppliers is embedded in their trading relationships, which seldom contribute new knowledge or expertise to the innovation of MBPFs. On the regional level, MBPFs in Ningbo have demonstrated the arm's-length relationships with suppliers. The positive impacts on their innovation have also been limited (see details of individual firms in Appendix J).

Diverse sources of suppliers

The upstream material suppliers of MBPFs are mainly the chemical firms or raw materials suppliers. As demonstrated in section 5.4.1, MBPFs rely on the natural marine materials in innovation and production. However, most MBPFs in Ningbo mentioned that their reliance on the local supply base of marine materials was limited. The marine life for food and for medical use is different. Ningbo, as the supply base, is more important to the processing of the aquatic products focusing on the marine breeding and cultivation. It can only satisfy a part of the marine material requirements of the regional MBPFs. For most MBPFs in Ningbo, imported materials are more important to their innovation and production.

Regarding other pharmaceutical materials, domestic and overseas suppliers are both important. Zhejiang is an important regionally manufacturing base of APIs and medical intermediates in China. Ningbo also has advantages in the manufacture of APIs and chemical ingredients. Therefore, some requirements of the materials of the MBPFs can be satisfied by the local area. However, as many firms mentioned, due to the stricter regulations on the environmental protection, many chemical materials were not allowed to be manufactured in China. In such circumstance, they have to shift focus to imported materials from India or Southeast Asia.

As for the sources of equipment, the majority of the sample MBPFs in Ningbo would like to choose equipment from foreign companies for the higher quality, performance, and efficiency. However, as will be demonstrated later, MBPFs have started to shift the sources of equipment to the domestic firms due to the lack of convenience to communicate with the equipment and the difficulty to customise the foreign equipment. With the increasing improvement of the equipment made in China, costs and services become the dominant criteria in MBPFs' selection of suppliers. In general, extra-regional interaction dominates the relationships between MBPFs in Ningbo and their suppliers.

Arm's-length relationships with suppliers

According to the fieldwork, sample MBPFs in Ningbo maintain long-term oriented and frequent interaction with material suppliers. However, the relationships of with suppliers have been mainly trading-based. Based on the agreement of purchasing materials, the innovation of MBPFs centres on the stages of processing materials and product design, which imposes lower requirements on the exchange of the resources between the two parties. This does not indicate that the material suppliers are dispensable or unimportant. While their collaboration is less innovation-driven, the quality and performance of supplied materials and the delivery on time are essential to the MBPFs' innovation, without which some specificities and performance of MBPFs' products cannot be realised.

Besides, a few MBPFs in Ningbo mentioned that they have to rely on specific materials for innovation and production. And the access to the materials differentiates these companies from their competitors in the same technical fields. For instance, NMBPF3 mentioned that marine microorganisms from the deep sea or polar regions were necessary materials because their innovation has focused on exploring and exploiting the structure and catalytic effects of special extreme enzymes extracted from the materials. However, because of the dependence upon the foreign suppliers for particular core materials, the relationships between MBPFs in Ningbo and their suppliers are influenced by the regulations and tensions on the international trading. Therefore, besides seeking to maintain the long-term and stable relationships with key material suppliers, the arm's-length relationships have pushed firms like NMBPF6 to plan for the R&D of materials in order to achieve the self-sufficiency and reduce the risks brought by the outsourced materials.

Furthermore, when equipment is regarded as important to firm innovation, especially the process innovation, sample MBPFs in Ningbo agreed on the reliance on the essential equipment in their innovation and production but also admitted that the relationships with the equipment suppliers are featured by the infrequent and discontinuous interactions. The high-end equipment technically enables the innovation realisation of MBPFs in Ningbo, which constitutes a critical aspect of the MBPFs' innovation and production capacities. However, the contribution to innovation depends on the equipment itself rather than the relationships or interactions with the suppliers.

Alongside the development imposing higher demand on the innovation and production, the upgrade of the equipment will happen. However, when the equipment has been implemented in the production line, the large modification of the equipment rarely occurs. After the purchase, the interaction between MBPFs and equipment manufacturers becomes infrequent. Even though the equipment suppliers have often been involved in designing the production lines, this process involves limited exchange of resources and risks around innovation. Moreover, as mentioned at the beginning of this section, a few sample MBPFs have been shifting to domestic equipment. According to the interviewees, this is also out of their requirements on the customisation but the difficulty in interacting with the foreign equipment suppliers. As mentioned by an interviewee,

> *"It is difficult to customise the imported equipment. On some occasions, we even needed to design the production line according to the size and specificities of the imported equipment. This brings more troubles from the test-run of equipment to maintenance and repair - we have to wait for a long time because the suppliers do not often come to China. If the domestic equipment can satisfy our requirements on quality and specificities, we would certainly choose them because they the domestic equipment producers can offer us better and more convenient services." (I_NMBPF2).*

6.4.2 Interaction between MEFs and suppliers

As mentioned in Section 5.4.2, the supplier of MEFs includes the companies that supplying them equipment, materials, and components and parts. To the sample MEFs in Ningbo, the arm's-length relationship with different suppliers is a dominant pattern common to the most firms in this region. This section illustrates their interactions and how the arm's-length relationships have influenced the innovation of MEFs in Ningbo. Details of individual firms are demonstrated in Appendix J.

Limited reliance on the local source of suppliers

Regarding the sources of suppliers, MEFs in Ningbo mentioned that most of their equipment demand could be domestically satisfied. Besides, most of the sample MEFs argued that their demand for materials and components was primarily supplied by domestic companies. With regard to the simple components, Ningbo and the nearby regions in Zhejiang province like Taizhou that have gathered a large number of small firms centred on the low-end manufacturing activities can satisfy their remand. However, in Ningbo, unlike the local integrated industrial chain of the vehicle components, there lacks a supply base which agglomerates different kinds of firms specialising in different kinds of components for the marine equipment.

However, for certain key materials or core components such as the cross-linked polyethylene, the boosters and precise controllers, some MEFs have to rely on the foreign suppliers. In this circumstance, their selection of materials or components from the leading international companies is not only because of the higher quality. These materials or components can increase the overall quality and the level of their products so that they could earn the tickets entering the high-end markets. Some MEFs mentioned they build contacts with new suppliers through trade fairs or exhibitions. However, these events have seldom taken place in Ningbo. As mentioned by the interviewee from NMEF4,

> *"There are several large industrial exhibitions targeting marine equipment firms every one or two years. They act as the great platforms for companies to meet new suppliers and build connections." (I_NMEF4).*

Arm's-length relationships with suppliers

According to the fieldwork in Ningbo, most MEFs have maintained the long-term relationships with their key suppliers. To some extent, because none of the sample

MEFs is state-owned firms, the approaches to suppliers rely less on public tendering, which also reduces the project-based interaction. Many firms at the industrial leading positions with larger sizes like NMEF1 and NMEF7 have built their own supplying pool that enables the stable supply of materials and components. For the other smaller MEFs in Ningbo, restricted by the negotiation power and the limited choices, their selection of suppliers has also been influenced. Some of them are unwilling to switch key suppliers, especially for those irreplaceable materials or components that rely on specific suppliers. Nevertheless, a few cases, for example, NMEF6 mentioned that their relationships with suppliers, especially the material suppliers, have been flexible. They would even not directly interact with suppliers but reach suppliers through the local agents with the resources of more than one supplying company.

However, the interaction between MEFs and suppliers has been restrictive. Most of their communication centres on the negotiation of the delivery time in order to ensure the innovation and production to be finished on time. In general, sample MEFs in Ningbo engage more with component suppliers than the material suppliers in innovation-related aspects. Their interaction often takes place when their products require some changes in the components. However, MEFs rarely innovate based on the improvement of component performance. In some cases, the components constitute the important competitiveness of MEFs' products, especially when they interact with those world leading firms like Yamaha Corporation and Schneider Electric Appliances.

Furthermore, equipment is important to many MEFs to improve the manufacturing and production efficiency and achieve process innovation. However, most MEFs in Ningbo describe their interactions with the equipment suppliers as pure seller-buyer relationships. They have limited communication beyond the use and maintenance of the equipment. Moreover, according to the interviews, over four-fifths of the sample MEFs in Ningbo mentioned that their technological advance and product innovation have rarely been restricted by the specificities of the existing equipment. Therefore, there is a low frequency in upgrading the equipment. To most firms, they only need to organise different kinds of equipment according to the design of their production line or sub-modules in the factory. Nevertheless, it is interesting to find that, for certain MEFs in Ningbo, the selection of equipment suppliers depends on materials. As argued by the interviewee from NMEF7, *"Because the materials we use are imported, the equipment used specifically for processing the white materials - the cross-linked polyethylene is purchased from foreign companies. There exist technical barriers in both materials and equipment." (I_NMEF7).*

6.4.3 Regional patterns of business-supplier relationships in Ningbo

This section has demonstrated the interaction between marine firms in Ningbo and their suppliers. As Table 6.3 summarises, on the regional level, the business-supplier relationships in Ningbo have been dominated by the ***arm's-length*** pattern. According to the analysis, most marine firms in Ningbo have built the contract-based relationships with suppliers and maintained frequent communication around purchasing the materials or components. Ningbo and the neighbouring regions have provided some supply bases of materials and components. However, the dominant business-supplier relationships are across regions.

Table 6.3. Business-supplier relationships of marine firms in Ningbo

Elements of supplier relationships	MBPFs	MEFs
Selection of suppliers	Quality > price > experience	
Communicating frequency	Frequent with material (and component) suppliers, infrequent with equipment suppliers	
Length of relationships	Long-term with material (and component) suppliers, discontinuous with equipment suppliers	
Intensity of innovation collaboration	Low	
- **Information exchange**	Limited	
- **Resource sharing**	Limited	
- **Risk sharing**	Limited	
Trust	Mainly contractual trust	
Local advantages	Local supply base of chemical materials to MBPFs	
Relational pattern	**Arm's-length**	

Sources: fieldwork interviews.

Stable relations with material and component suppliers facilitate their innovation, and a few cases highlight that they rely on specific materials or components to innovate that constitute the important basis of their competitiveness. And specific to the MEFs, their innovation sometimes involves the modification of components. Furthermore, the equipment outsourced from the foreign companies or increasingly the domestic source also ensures the realisation of innovation and production and improve the efficiency. Nevertheless, with limited exchange of resources and information, the trade-based relational interaction with suppliers has restrictively contributed new knowledge to the innovation of marine firms in Ningbo. Because of the low level of commitment, the selection of suppliers may change when the marine firms have better choices.

6.5 Interaction between marine firms in Ningbo and competitors

The section analyses the interaction between marine firms in Ningbo and their competitors. As section 5.5.1 specifies, firms often treat industrial leaders or companies in the same innovation directions with similar capabilities, especially the latter as the main rivals, while most of the firms in the same industrial sector are termed as "so-called" competitors. This also applies to the marine firms in Ningbo in their recognition of competitors. Identifying the rare competitor interactions on the regional scale in Ningbo, the main analytical focus of this section is to explore the sources of their competitors, elaborate on the sample marine firms that have collaborated with competitors in terms of how and why they interact, and the impacts on the innovation compared with other firms in the same region.

6.5.1 Interaction between MBPFs in Ningbo and competitors

According to the fieldwork interviews in Ningbo, most sample MBPFs argued that their main competitors came from other domestic areas. Often-mentioned areas include the eastern coastal regions in China, especially Jiangsu province. Situated in the pharmaceutical and biotech sector despite the marine focus, most MBPFs face competition not only from marine firms but also other companies in the same broad sector. A third of the samples referred to the overseas companies, especially the Japanese firms as competitors of their marine business and innovation. Firms seldom mentioned Ningbo as the geographical sources of their competitors. Besides the "criteria" of how firms identify rivals, many interviewees claimed that the biotech and pharmaceutical industry is generally under-developed in Ningbo. And the marine sub-division has been emerging. Therefore, the regional MBPFs face few competitions from industrial firms in the same region to compete for resources or opportunities in their development.

Interactive sample firms

In Ningbo, collaboration with competitors is not a regional phenomenon. Most MBPFs in this region generally have been reluctant to coordinate with the competitors or "so-called" competitors in the same region as QMEF5 and QMEF8 have done. Only a limited number of companies have forged innovation alliances with competitors though in different patterns. NMBPF2 has formed a project-based collaboration with competitors in clinical tests relying on the enforcement of detailed contracts and agreement. As argued by the interviewee from this company,

> *"We sometimes require expertise or resources in certain fields - mainly relevant to specific diseases. The disease-relevant feedback and knowledge on how to improve the products are essential for passing the clinical test. In this case, we would build a connection with specific companies through third-party intermediaries. The distribution of IP rights and profits are negotiated and written clearly in the contracts." (I_NMBPF2).*

According to the interviewee from NMBPF4, their collaboration with a specific competitor located in a nearby city within Zhejiang province has been highly complementary and in diverse forms. Their relationships were historically forged based on the close personal relationships between the CEOs (i.e., relatives). Thus, the trusts have also been built upon the inter-personal trusts. Through the alliance, they complement each other in innovation and production by exchanging resources and building complementary capabilities. For instance, behind co-R&D in new products, they help each other in the manufacturing aspects. When lack specific production lines or R&D conditions, company NMBPF4 would turn to the collaborator to complete the specific experimenting, testing, or manufacturing tasks for them and vice versa. This kind of interaction saves resources for each other, while firms can be locked in this partnership.

6.5.2 Interaction between MEFs and competitors

According to the fieldwork interviews in Ningbo, most sample MEFs argued that their main competitors came from other domestic coastal areas, especially Jiangsu and Shandong provinces. Unlike the MBPFs or marine firms in Qingdao, a few MEFs in Ningbo also characterised the local competitors but demonstrated a much more friendly attitude towards these firms than the rivals in other regions. Situated in the manufacturing industry that are sensitive to the economic size of firms, large companies in Ningbo usually have more competitive advantages in capital and facilitates, especially compared with the small firms in the same region. However, in the case of Ningbo where a group of small private MEFs have gathered, these small firms face more intensive competition. Horizontal inter-firm collaboration has been regionally widespread to the MEFs in Ningbo. However, as will be demonstrated later, besides simply competing relationships, a few firms have developed the localised ways to build co-opetition interaction with other firms in the same region.

The alliance between MEFs and competitors is customer-oriented but entirely different forms from cases in Qingdao as “required” by customers (section 5.5.2). MEFs in Ningbo have been more positively engaged in the alliance driven by their own initiatives. Common to the two MEFs that have built collaborative relationships with competitors, the important mechanisms underlying their relationships are the regional-based close personal relationships. The interviewee from company NMEF1 mentioned that they have rarely collaborated to conduct product or process innovation but often introduced new customers to each other. Besides the personal relationships and inter-personal trusts, another important prerequisite of their introduction of customers to each other is that the customer demand cannot be fulfilled by the company itself.

Furthermore, the interviewee from company NMEF6 mentioned that they often form alliances with the competitors in the same region to approach new customers. Alliances form because they have limited internal capacity and must rely on joint efforts to increase the possibility of being accepted by new customers. Therefore, instead of complementing each other, this company and its competitors reinforce each other in the same technical field to strengthen their capabilities in innovation and production. The interviewee from NMEF6 was also impressed by the unity of the local merchants and the social networks in Ningbo and Zhejiang province in general. As argued by the interviewee, *"Our boss has close relationships with the CEOs in several local firms that are similar to us. Actually, our competition is intensive. However, when there are opportunities to reach out to new customers with large orders, especially those non-local customers, we would contact each other and naturally forge the alliance to strive for the customers and orders. This often happens." (I_NMEF6).*

6.5.3 Regional patterns of business-competitor relationships in Ningbo

On the regional level, collaboration between marine firms in Ningbo and their competitors has not formed a widespread phenomenon. However, most marine firms in Ningbo hold the positive attitudes towards the potential to collaborate with competitors, especially those in the same region benefiting from the proximity and widespread regional-based social networks. Among the sample, a few marine firms have established collaborative relationships with competitors. Personal relationships between the senior-level managers or founders have been essential to their interaction, which induces the heavy reliance on inter-personal relationships than contracts and determines the obligational pattern. By collaborating with competitors, they two parities complement or reinforce each other in resources, internal innovative and manufacturing capabilities, and access to new business opportunities. Despite the positive impacts of the horizontal inter-firm collaboration, this interaction has not constituted the determining factor to the innovation and business development of marine firms when being observed on the regional scale.

6.6 Interaction between marine firms in Ningbo and UPRIs

Innovation collaboration with UPRIs is significant to marine firms' innovation by offering knowledge, technologies, information, and other tangible or intangible resources. Section 5.6.1 has summarised the major forms of collaboration between firms and different UPRI agencies. Built upon the background knowledge, this section explores the interaction between marine firms in Ningbo and the UPRIs, which often happens beyond the regional scale with a relatively weak regional R&E system has been built as illustrated in 6.1.2.

6.6.1 Interaction between MBPFs in Ningbo and the UPRIs

All the sample MBPFs have built collaborative relationships with UPRI agencies (see Appendix J). However, on the regional level, the collaborative patterns and the geographical sources of the collaborating UPRIs have been highly heterogeneous across various firms. Only one-third of the sample MBPFs preferred to choose the local UPRI, while they have also maintained some degrees of innovation partnership with other non-local ones. For the rest of the sample MBPFs, the firm-UPRI alliances are primarily not embedded in Ningbo, and these more emphasis the extra-regional partners. The reasons driving their choices of non-local UPRIs have been different. Besides the easier access to their collaborating UPRIs based on the inter-personal relationships, the regional lack of marine technical expertise and knowledge they required is an important reason.

Short-term-dominated collaboration with the local UPRIs

The two firms - NMBPF2 and NMBPF4 as traditional pharmaceutical companies mainly collaborated with the local universities. Located in the same region, their interactive relationships are easier to forge by directly contacting the researchers or through the personal relationships built upon the alumni. Despite MBPFs are situated in the more research-driven industry, interviewees from the two companies shared similar attitudes toward the partnerships by arguing that the research conducted by the UPRIs is too far from their practical needs. In such a context, their interaction with the researchers or research groups mainly centres on the project-based technical services and consultancy in which the UPRI agencies, mainly the individual researchers provide external expertise to support their R&D and improve their R&D efficiency. However, these two MBPFs tend to be open-minded towards more intimate collaboration with universities in longer time if there are appropriate opportunities. As argued by the interviewees,

> *"We have once collaborated with universities in exploration-oriented projects. We have several significant R&D projects planned for the next a few years, which should require more collaboration with the high-level UPRIs. Currently, besides the technical services by the universities, we also outsource some specific R&D tasks to the third-party organisations that are purely technical service providers." (I_NMBPF2).*

"In recent years, we have started to build contacts with the local universities. And they also came to us bringing their research outputs or industrial-based R&D project proposals. Nevertheless, we have not established any formal collaboration. After the corporate restructuring, our core R&D team has been merged into the head office. The parent company is seeking to introduce us more non-local university collaborators or research teams." (I_NMBPF4).

Mainly obligational collaboration with the non-local UPRIs

For the majority of the sample MBPFs in Ningbo that mainly collaborated with non-local UPRIs, their interactions are in much more diverse means and have built much more intimate relationships. Their collaborating UPRI agencies range from domestic to overseas ones. In forging the collaborating relationships, personal relationships of the R&D and managing staffs or the founders have been important. Among these sample MBPFs, only NMBPF1 has maintained relatively long-term but discontinuous interactions with its non-local collaborators. Similar to the other MBPFs that built arm's-length but project-based interactions with the UPRIs demonstrated above, NMBPF1 mainly collaborates with the non-local UPRIs in short-term-based technical services.

Besides, as discussed in section 5.6.1, joint R&D often represents a closer innovation alliance involving the higher degrees of exchange of information and resources, which poses higher requirements on their previous experience of collaboration and mutual trusts and understanding of each other's capabilities and advantages. Without denying that project-based collaboration is important, interviewees from several MBPFs in Ningbo argued that the co-R&D was the most essential kind of collaboration with their non-local UPRI collaborators, by which they learnt the most from the researching partners.

Specifically, benefitting from the founder's overseas research background and position in a foreign PRI, NMBPF3 has established direct and close innovation linkages with a few overseas universities. By following the latest research trend, approaching the cutting-edge technologies in the lab, and establishing R&D collaboration with top-level expertise, the internal R&D has been facilitated. This enables this firm to develop advanced products and maintain the position as the industrial leader in the specific technical field and R&D direction. Besides, the joint R&D of NMBPF6 is more traditional by collaborating with universities to apply and undertake S&T or innovation projects. Through these projects, NMBPF6 has obtained access to top-level expertise, which has gradually become the external team of technical consultancy to this company and further reinforces their collaboration in other aspects related to innovation. Besides benefitting from joint R&D, the internal R&D of the MBPFs has also been inspired by the UPRI collaborators, which affects the directions of their new product innovation. As demonstrated by the interviewee from NMBPF5 - an animal drug producer,

> *"Relying on the computational platform of our collaborator - one sub-institute of the CAS, we can conduct more systematic analysis on the progress and future application of our core technologies. This helps us to build a clearer goal in the further research on antigen design." (I_NMBPF5).*

Coordination in talent training on different levels

In addition to those collaboration forms which directly contribute to the innovation process, most sample MBPFs in Ningbo have built collaboration with the UPRIs in talent exchange and training except NMBP1. However, NMBPF2 and NMPBF4 have only built the training and recruitment agreement with the local technical colleges, which rarely contribute them high-end R&D talents but technical workers. Different from them, the other companies that have built collaboration with the non-local UPRIs targeting the postgraduates and undergraduate programmes. This collaboration accumulates human resources for them, especially the postgraduates training programmes that build firm-specific knowledge of the researchers and enhance the possibility to retain them in this company after the graduation. Moreover, NMBPF6 and NMBPF5 have established firm-based academician workstations, which have significantly benefitted their internal R&D innovation and strengthened the training of the internal R&D teams.

6.6.2 Interaction between MEFs in Ningbo and the UPRIs

In Ningbo, MEFs have also behaved differently in their collaboration with the UPRIs. Not all sample MEFs have built collaboration with UPRIs. NMEF5 and NMEF6 have only built partnerships with the local vocational or technical colleges which cannot be classified into higher-education organisations. Restricted by the sizes and capabilities, these MEFs interact with the partners more often in the production-related aspects or very basic technical issues. Several reasons have affected their choices of the local collaborators. For one thing, they do not have high demands on the technical capabilities of the collaborating partners. For another, they have much easier access to the local technical schools that can be approached directly or through the social networks, while they lack the resources and initiatives to approach collaborators. As argued by the interviewee from NMEF6,

> *"We are too small to collaborate with universities and we don't have the urgent need to collaborate with them. Our innovation can be fulfilled on our own according to the customers' requirements. If we meet specific problems in the design or production that the technical staff cannot solve, we sometimes ask the teachers from the local technical colleges for help. On some occasions, when we meet a tight schedule in production but lack staff, we recruit the students from these schools as temporary workers on the short-term basis." (I_NMEF6).*

Only one firm (i.e., NMEF2) has built close interaction with the local UPRIs. Besides maintaining the relationships with the existing local collaborators to obtain technical support and talents training, this company is also open to other opportunities with those newly established universities or schools. An important reason behind the local-based interaction is mainly because of the easier access and communication. As argued, their contacts have been mainly initiated by the local UPRIs, aiming to better support the regional economy. However, the new collaboration has still centred on the exchange of information about innovation ideas and the potential directions of future product development. As argued by the interviewee,

> *"Local UPRIs or research groups, especially those newly established ones, would like to build connections with the local firms. For example, researchers from the innovation college affiliated to Beihang University (established in 2018) often come to us for any collaborating opportunities or asking if we have any S&T problems they can help. We would like to communicate with them. However, our contacts with these new organisations remain in the initial stages. We have not found an appropriate opportunity to build closer cooperation." (I_NMEF2).*

Distinguish innovation collaboration with different UPRIs

Many sample MEFs in Ningbo mainly collaborate with non-local UPRIs. Standing in better positions in their specific industrial fields and with stronger capabilities, they prefer to collaborate with non-local UPRIs with higher R&D capabilities. In other words, they can seldom learn from the local UPRIs, or the research directions of the local ones cannot fit in the needs of these MEFs. Their partners come from areas such as Hangzhou (i.e., the capital city of Zhejiang province where Ningbo is located), Dalian, Qingdao, and Shanghai. These MEFs demonstrated a higher reliance on personal relationships, usually by the graduates, to build collaboration. This is also reflected by their preferred forms of collaboration with UPRIs. Interviewees from these sample MEFs indicated that they were highly proactive in collaborating with UPRIs in talent training. The technical manager of NMEF7 explained their motivations,

> *"It is difficult for private companies like us to recruit high-end talents in relevant majors. We really hope to attract more talents to our firm through building a co-training programme targeting postgraduate research students. If their research projects are company-based, the possibility and their willingness to stay in our company after graduation would be highly increased." (I_NMEF7).*

A distinct feature of these MEFs in Ningbo is that they prefer to distinguish different innovation collaborators from different UPRIs. Among these companies that mainly cooperate with non-local UPRIs, technical services and consultancy are still the mainstream forms. Specifically, for technical problems or experimental and testing tasks, they would look for qualified researchers or groups upon the specific project needs and maintain short-term-based collaboration, which ensures the flexibility and enhances the efficiency.

> *"Different from joint R&D, technical services do not require that we have collaborating basis with the university sides. When we meet problems, we would look for or ask friends to introduce competent researchers or groups to fulfil the tasks, such as doing the Computational Fluid Dynamics simulation and Computed Aided Engineering analysis. This ensures flexibility and efficiency. Also, we do not need to invest time and energy to maintain the relationships." (I_NMEF1)*

Moreover, these firms save the resources and energy to maintain relationships with top universities. As evidenced by the interviews, besides the co-training of talents, many MEFs in Ningbo seek all kinds of opportunities to forge the co-R&D collaboration with the high-level UPRIs, especially by jointly applying the governmental innovation funds or undertake S&T or engineering projects. Because joint-R&D or the government-funded S&T projects often involve a higher level of exchange of information and resources and usually lasts longer, it is a great chance for companies to forge the long-term-oriented relationships with the top UPRIs. As argued by an interviewee from this group of MEFs,

> *"For those top-level universities, we really hope that our relationships can be long time. We often participate in governmental S&T projects, usually national or provincial, such as the 863 Programme. And our project-based communication starts earlier than the official launch of projects. Through these projects, the partnership is further enhanced." (I_NMEF7).*

6.6.3 Regional patterns of business-UPRI relationships in Ningbo

This section explores the collaborative relationships between marine firms in Ningbo and the UPRIs. By synthesising the analysis above, it shows that in Ningbo, a ***heterogeneous*** pattern of innovation collaboration between marine firms and the UPRIs, especially the non-local ones. In establishing the partnerships, personal relations have been the primary channels. Though adopting an open mind towards more interactive relationships with the UPRIs, many small firms in Ningbo focusing on the internal R&D and production treat the UPRIs or technical schools as purely technical service providers that can offer instant and temporary support to their product design and productions. In this case, the regional-based networks and geographical proximity to the local-based researchers can satisfy their demand at least at this stage.

However, by comparing the marine firms, it shows that those firms with stronger capabilities prefer to build obligational relationships with high-level UPRIs. Restricted by the limited regional research and education resources, these firms would turn to the extra-regional organisations or individual researchers, which also determines the widespread use of personal relationships and the preference to further strengthen the resource basis by establishing the training collaboration, especially targeting the high-end talents. At the same time, by building a hierarchy of the UPRI collaborators, some marine firms in Ningbo build the flexible and project-based interaction with certain UPRIs but invest more resources to maintain the long-term relationships with top UPRIs to develop advanced products or cutting-edge knowledges.

6.7 Interaction between marine firms in Ningbo and the government

This section focuses on the interaction between marine firms in Ningbo and the governments, primarily the region one. Specifically, business-government relationships are analysed from two perspectives. For one thing, as demonstrated in Section 6.2, governmental fundings have been important to the R&D input of marine firms. Therefore, the interaction of marine firms and the regional government in financial incentives is demonstrated. For another, the interaction between marine firms and the regional government is important to the regional marine development and the construction of the marine cluster in Ningbo, which will be analysed by exploring their relationships in the regional policies, especially the marine-oriented ones, the efforts to build the regional-based networks either between the industrial firms or between different regional actors. The business-government interactions in Ningbo of individual marine firms have been summarised in Appendix J.

6.7.1 Business-government interaction in Ningbo in financial incentives

As mentioned in section 5.7.1, there are three main forms of financial incentives from the government to support firm innovation, including the tax break, funding for innovation projects, and the rewards or subsidies associated with prizes, titles, and the establishment of platforms. Also, sample marine firms in Ningbo obtained government funding which accounts for 13.51% of the R&D expenditure of the sample marine firms in Ningbo in the free years from 2017 to 2019 as section 6.2.1 demonstrates. Therefore, the interaction in the financial supports constitutes a critical aspect of the business-government relationships.

Access to government financial support

According to the firm-level interviews, sample marine firms in Ningbo obtained the government financial supports through formal approaches and interactions with the governmental agencies. The official channels for communication and information disclosure have been well established in Ningbo. As mentioned in the regional case of Qingdao and the literature review, the use of *guanxi* has increasingly lost its momentum in China. In Ningbo, personal relationships have been restrictively used by firms to obtain resources. As will be discussed below, regional preferential policies have been adopted in many cases. However, this mainly happens in introducing new companies to a region that are potential to contribute to the regional economy by using financial incentive as a kind of regional strategies, rather than using *guanxi* to approach special resources.

Besides, the business development of firms in Ningbo have historically maintained distant relationships with the governments but relied more on the social networks built upon the personal relationships of the extended family like the alumni, regional-based business networks, and business associations of fellow townsmen. However, according to the fieldwork, some interviewees also mentioned that the phenomenon that establishing *guanxi* with the governmental officials would not entirely disappear in China. They argued that some other firms in the same region would still prefer to input resources in strengthening the personal affinity seeking benefits. Nevertheless, this can hardly develop into a widespread phenomenon alongside with the construction of formal institutions in China.

MBPFs and the regional government

According to fieldwork, all the sample MBPFs in Ningbo have been granted the title of High-tech Enterprises, which enables them to enjoy the preferential tax rate targeting the High-tech Enterprises. Combined with the R&D expense super deduction, tax break is the most important kinds of financial incentives supported by the government to the sample MBPFs in Ningbo. As mentioned in the regional case of Qingdao, these preferential policies are implemented by the central government, while the regional government in Ningbo is the regional performer of the central policies.

Besides, some MBPFs also mentioned the tax reductions they enjoyed and obtained from the regional government agencies. As mentioned in 5.7.1, tax incentives are often adopted the regional governments in China to attract new companies to a specific region, which causes the unfair competition between regions and harms the market development. NMPBF3 is a typical example of this kind of firms. The founder of this company is a well-known researcher in the marine biotech field and was born in Ningbo, who was invited by the district-level agency to establish the company in Ningbo. In the first several years of establishment, they also enjoyed the preferential policies. As argued by the interviewee from this company,

> *"As a company brought into Ningbo by the district-level government, we were offered benefits in tax at the starting-up stage. This attracted us to set up the company in Ningbo. As a small firm in the biotech industry, our development requires both technologies and financial impetus to encourage our continuous R&D. Investment in equipment, facilitation, and new product innovation all demand a great deal of money. After the first few years, the local tax bureau continues supporting us in tax claims and interpreting the preferential tax policies we are eligible to enjoy." (I_NMBPF3).*

Besides the tax incentives that support firm innovation without any particular industrial aims, two-thirds of sample MBPFs in Ningbo argued that the governmental funding associated with the S&T or innovation projects is one of the important sources of financial supports to companies. These funds and projects ranging from the regional to national levels. However, according to the fieldwork interviews, most regional-based innovation projects applied by the sample MBPFs have no specific marine preference or focus. Also, projects attached to the marine policy have been scarce in Ningbo with the limited number of marine-oriented policies. According to the interviews, the regional projects that MBPFs in Ningbo have applied are related to the pharmaceutical or biotech industry in general. For instance, NMBPF4 mentioned that they obtained financial support to the specialised projects targeting the development of the biotech and pharmaceutical industry from the regional government. Similar projects also include the "Ningbo 2025 Specialised Science and Technology Projects with Significant Importance", which lists the bio-pharmaceutical and medical appliance industry as one of the ten supporting fields.

Marine-oriented funding obtained by the MBPFs in Ningbo are mainly the national-level projects which often involve a higher amount of money. For example, by undertaking a national project belonging to the initiative of Building the

Demonstration Areas for the "Innovative Development of Marine Economy during 13th Five-year period", the case NMBPF5 received funding of over 10 million yuan. Because these national-level projects are primarily targeting specific marine cities as parts of the regional experimentation, the application goes through the regional government agencies that have the decision power in reviewing and selecting the appropriate projects for submission and further review. In this process, MBPFs and the local government agencies interact closely and communicate the project information. As argued by an interviewee from NMBPF6,

> *"The marine projects we are working on are the national-level projects. But we have limited chance to communicate directly with the higher-level government agencies. We are usually informed by the regional officials about the project information. They would also help us in preparing and reviewing the documents." (I_NMBPF6).*

Moreover, rewards for winning prizes, titles, and S&T progress have been obtained by two-thirds of the sample MBPFs in Ningbo. To encourage the firms to participate in the competitions, for example, the entrepreneurial competition, the regional government of Ningbo also provide additional subsidies or rewards to those firms that win a place in the national final. However, similar to the tax reduction, these *ex post* financial incentives promote the innovation of firms from a general perspective, rather than playing the *ante post* role of directing or guiding the industrial development targeting the marine sector in particular.

MEFs and the regional government

According to the fieldwork, among the sample MEFs in Ningbo, only NMEF6 is not a High-tech Enterprise and has been working on to obtain the title. Therefore, to most MEFs in Ningbo, tax break is the most stable and equal access to the government's financial support. Similar to the findings in the MBPFs in Ningbo, certain districts in Ningbo promise to offer additional tax return. In China, tax payments will partly be handed into the central government and partly retained by the local government. In general, the regional-retained proportions are 50% in VAT, 40% in CIT and 40% in personal income tax. For example, the interviewee from the company NMEF3 sited in Ningbo Free Trade Zone mentioned that they were attracted by this area offering to return part of the local retained CIT and VAT according to the actual ratal.

Besides, a number of the sample MEFs, mainly in large sizes, have also gained funding for participating in S&T projects. It has been mentioned in Section 5.7.1 that there is a lower percentage of MEFs in general that have access to project funding compared with the MBPFs because of the dominant customer-oriented nature of innovation and the higher level of technical maturity. In the regional case of Ningbo, MEFs demonstrate a similar preference for undertaking S&T projects to the MBPFs in the same region. This is partly because of the small sample size, the stronger industrial bases of MEFs than MBPFs in Ningbo, and the specific firm-level characteristics and capabilities that could lead to different kinds of corporate models which is not the major focus of this study focusing on the regional comparison.

Among sample MEFs in Ningbo, besides company NMEF6 that was involved in a marine S&T project undertaken by its customer, the innovation projects conducted by the NMEF1, NMEF4, and NMEF7 are either a direct part of the marine-oriented programmes (e.g., the project of "Building Ningbo a National Demonstration Area of Marine Economic Development") or the exploration-oriented projects (e.g., the 863 Programme and Torch Programme). As indicated by the interviewees from NMF4 and NMEF7 that have accumulated rich project experiences,

> *"We have conducted different kinds of S&T projects. Some are driven by the aim of the industrialisation and commercialisation of the under-researched projects within our company. Some target the S&T advance that are mainly co-conducted in cooperation with universities" (I_NMEF4).*

> *"Our products are used in submarine areas. The explorative innovation usually takes place in the form of the government-funded projects." (I_NMEF7).*

Moreover, over half of the firms also mentioned that they obtained rewards and subsidies. The awards obtained by the MEFs in Ningbo are usually on the national or provincial levels. Besides their achievements and innovation capabilities, for a few firms, their particular technical fields and their relevance to the national strategy or security of their innovation are also important reasons that increase the chances of obtaining higher-level prizes.

6.7.2 Business-government interaction in Ningbo in building marine clusters

The above section demonstrates that marine firms in Ningbo have mainly been influenced by the financial incentives from the high-level government. Regional-specific financial supports are generally insufficient. This section explores the interaction between sample marine firms and the regional government in the industrial building and the construction of marine clusters in Ningbo. The analysis demonstrates that the business-government interactions in Ningbo often concentrate on specific issues, which has restrictively facilitated the regional marine development in coordinating ways.

MBPFs and the regional government

In the context of the national strategy to develop the marine economy and the increasing importance to of the emerging marine sub-sectors, such as the marine biomedicine, one-third of the sample MBPFs in Ningbo have been motivated. They have treated the marine fields as new opportunities to their development, especially when they enjoyed great regional advantages in Ningbo which is seen as an important marine city in China and a regional target of the industrial experimentation highlighted by the central state and thereby enjoying more preferential policies. Therefore, they started to engage involve more marine characteristics in their business and innovation. Nonetheless, to most of the others, traditionally focusing on the marine fields, the implementation of the national or regional policies has limited impacts on the shift of the business and innovation directions. However, the increasing emphasis on the marine orientation offers them better environments and greater momentum to plough the marine field. Also, as traditional marine firms, they have enjoyed more first-mover advantages. As argued by the interviewees from these two kinds of MBPFs,

> *"We are not traditional marine firms. However, we were attracted by the national strategy to develop the marine economy and innovation, and in particular, the emphasis attached to Ningbo, especially the funding and projects aspects. It broadens our product lines and offers us chances to explore new innovation areas based on the policy support." (I_NMBPF5)*

> *"In such a highly competitive industry, the ocean-oriented strategy allows us to*

stand out. Compared with transition businesses, we were born in this field. It is also easier for us to access the resources allocated to the marine sector in this region, especially at the early stage." (I_NMBPF3).

However, most sample MBPFs in Ningbo have indicated that their shift in the innovation focus was mainly driven by their own initiatives. The regional government has neither advocated the national strategy among the local firms nor cared about whether firms would engage in the marine areas. When the marine strategy was implemented in Ningbo, the regional government would just notice the regional firms rather than persuading firms to shift product focus or directing or intervening the regional industrial development. According to the fieldwork, the entire biotech and pharmaceutical industry stands in a weak position in Ningbo compared with those industries with much integrated industrial chain and companies in numerous numbers. In such context, the regional government also pays little attention to this industry and much less to the marine field. As commented by the interviewees from NMBPF2 and NMBPF4,

"The private economy focusing on the foreign trade is too strong in Ningbo. And the regional economic growth has no need to rely on the biotech and pharmaceutical sector. Having this industrial part is only for "ornamenting" the regional industrial layout." (I_NMBPF2).

"The local government provided restricted support to the biotech and pharmaceutical industry, and most of their attention and resources have been put on the foreign trade and petrochemical sectors. Until recent years, there started to be some support to the pharmaceutical sector." (I_NMBPF4).

In such a background, the interaction between the local MBPFs and the regional government agencies rarely involves the construction and integration of the industry in the local area but is mainly problem-driven restricted to the specific daily matters. Agreed by the firm interviewees, the government agencies in Ningbo have been keen to provide better services to the local firms by improving the governmental efficiency in dealing with clerical work and seeking to simplifying the administrative procedures. For example, many interviewees mentioned the implementation of the "maximum once" reform (*zuiduo pao yici* in Chinese) by the regional government of Ningbo that in most cases, firms only need to present once to get things done. Besides, when firms meet any difficulties and turn to the regional government, the officials are also enthusiastic about offering help.

Furthermore, a few interviewees mentioned that the regional government sought to bridge the collaboration with firms and local universities by collecting the technical problems from firms though without a specific industrial focus. However, as mentioned in section 6.6.1, the sample firms rarely relied on the coordinating roles of the regional government in building or maintaining relationships with the UPRIs, especially in the context that their collaborating UPRIs are mainly outside Ningbo. In general, there lacks a regionally industrial-oriented focus towards the MBPFs in Ningbo by the regional government. More significantly, there is no other channel established jointly by the efforts of the regional government and MBPFs in order to enhance the interaction among the MBPFs in the same region or between the marine firms and the regional government. In 2015, Ningbo established the Marine Biotech Alliance. However, since its establishment, this alliance has played limited roles in coordinating regional firms, building the networks and communications, or organisation industrial-specific activities.

Moreover, the interviewees of the sample MBPFs reported the limited interaction with the regional government agencies in industrial policy. Only NMBPF3 have argued that their interaction with the regional government on the district level is intimate and mutually beneficial to each other in terms of the marine development. As mentioned in the above section, this company was brought to Ningbo as the regional brand of marine firms by the district-level government and the founder of this is a professional researcher in the marine biotechnology. As a rare biotech firm in this district with the strong R&D background, it plays an important role in guiding and influencing the regional industrial policies and strategies, at least on the district level. As argued by the interviewee,

> *"We interacted closely with the government on the district level. Because we were invited by the district government to build the company in Ningbo, it laid a foundation for our intimate relationships and frequent communication with the government. This district is positioned to develop into an ocean-characterised area with the marine industry as the pillar of the local economy. Because of our*

positions and marine S&T background, we would naturally be able to attract more attention from the regional government on district and city levels." (I_NMBPF3).

Except for this firm, policy interaction is limited. In general, the regional government would issue draft policies and post online for comments. Their ordinary communication can seldom be transferred to the industrial policy targeting the regional MBPFs. Therefore, without effective industrial policies and supportive environments, the resources or services from the regional government are not exclusive to the MBPFs. The positive impacts of the business-government interaction have also been limited to the support the business and innovation development of MBPFs in Ningbo, which further reinforces the fact that the marine orientation of firms is mainly out of their own initiatives and strategic decisions.

MEFs and the regional government

According to the fieldwork interviews, most sample MEFs in Ningbo referred to the limited attention attached to the marine sector by the regional government, despite the national government's emphasis on it. They have maintained limited interaction with the regional government agencies in strengthening the development of the regional marine equipment industry. Some of them have highlighted the roles of national marine strategies in motivating and encouraging marine innovation. For example, NMEF7 was not a traditional marine firm, but the current main business and technical fields have transferred to the marine fields. Referring to the shift of their innovation directions, the marine strategy and policy guidance pursued by the higher-level governments were characterised. As argued by the interviewee,

"We do not think the local government of Ningbo has paid special attention to developing the marine sector or the marine equipment sector. Our development and innovation strategies are mainly reacting to the national. Though we attracted attention from the local government and officials sometimes come to our company for fieldwork, this is mainly because of our performance and contributions to the regional economy rather than the marine focus. We do not want to maintain too close relationships with the local government." (I_NMEF7)

To the majority of sample MEFs in Ningbo, their innovation and business directions depend mainly on their internal innovation capabilities and production capacity and are rarely intervened or influenced by the regional government. In the interaction with the regional government, these firms mentioned that they would exchange information about the undergoing projects and the development about their firms. However, most interviewees also mentioned that in such an area strong in the private economy with a very high proportion of SMEs, it would be hard for the local government agencies to pay sufficient attention to each individual firms and be familiar with their specific conditions. This also leads to their lower reliance on the government. As argued by the interviewee from NMEF5,

> *"The local government is helpful when we meet problems. However, there are numerous small firms like us in Ningbo. Without strong innovation capabilities, we cannot expect the local government to spare specific resources or attention to us. This is understandable. The government seems to be more like the informant and service provider, less than a director or governor." (I_NMEF5).*

Furthermore, a few sample MEFs in Ningbo mentioned that they had some interaction with government agencies in the industrial policy. For instance, the interviewee from company NMEF1 (a P-SOE) mentioned that the local government agencies (mainly the S&T Bureau) often organise policy interpretation activities or gather professionals from different areas, including firms, to discuss policies through seminars. The government agencies also release the application guidance for significant projects each year and notify the local companies. These activities encourage interaction and communication between the regional government and firms. Yet, their interaction with the government agencies is rarely relevant to the marine policies but concentrates in the general aspect targeted at the manufacturing industry, such as the high-end equipment manufacturing.

Moreover, limited efforts have been made jointly by the regional government and the MEFs to agglomerate the industrial firms or establish the industrial bases or industrial associations on the regional scale. In 2016, the Marine Electronic Equipment Industry Alliance was built upon an internal research institute of the China Electronics Technology Group Corporation - a central SOE focusing on the R&D of marine electric equipment and marine new materials, which has made some guiding roles in the marine equipment development in Ningbo. However, it targets a very specific aspect of the marine equipment industry around the regional R&D advantages in the marine materials and the well-developed large company. Restricted number of firms in the traditional marine equipment field have been covered.

6.7.3 Regional patterns of business-local government relationships in Ningbo

This section has shown the relationships between marine firms in Ningbo and the regional government and illustrated their interaction by specific firm cases and interview evidence. The analysis indicates the regionally ***arm's-length*** pattern of business-government relationships have been prevalent in Ningbo. Table 6.4 summarises the major characteristics of the dominant patterns of the interaction between marine firms and the regional government agencies from several key dimensions.

Table 6.4. Business-government relationships of marine firms in Ningbo

Dimensions of business-government relationships	Marine firms in Ningbo
Communicating channels	Mainly through official channels
Use of personal relations	Limited
Communicating frequency	Generally infrequent
Intensity of innovation-related interaction	Limited
- **Information exchange**	Medium
- **Financial incentives**	Limited, some regional-specific supports but are not directly targeting the marine sector
- **Industrial bases or clusters**	Low
- **Policy interaction**	Low
Trust	Mainly competence trust
Relational pattern	**Arm's-length**

Sources: fieldwork interviews.

Regarding the communicating channels between marine firms and the regional government, most firms rely on the direct and official channels provided by the government. Intermediaries like industrial associations and informal social networks built upon *guanxi* have been rarely adopted. Marine firms have generally recognised the efficiency and the services provided by the regional government offer them assistance on many issues. However, their communication generally concentrates on specific issues, which implies the project-based nature. Therefore, the trusts between firms and the regional government rely more on the competences. Besides, in Ningbo, the innovation development of marine firms and their choices of the marine development as the new directions are mainly because of the corporate advantages, their historical paths, and the strategies to develop into a new field especially in the context of the national guidance of marine development. A number of well-developed firms closely follow the national strategies and obtained great resources in capital and innovation projects supported by the high-level government. The regional government plays limited roles in intervening or directing the regional marine development.

Therefore, in the interaction between marine firms and the regional government in Ningbo, a major characteristic lies in the limited marine orientation. Financial incentives targeting the marine sector obtained by the marine firms are mainly from the higher-level governments. Regional-initiated innovation projects and financial supports rarely direct the marine industry but focus on the broadly industries like the biotech, pharmaceutical, and equipment manufacturing industries. Though there are a few firms, especially the MEFs that have built relationships with the local government in regional policy, most of their interactions are not relevant to the marine area either. Therefore, the common vision to build a strong marine cluster or industry base is absent in the interactions between marine firms and the regional government in Ningbo.

6.8 Summary

This chapter presents the regional institutions in Ningbo, demonstrates the commitment to innovation of marine firms, and illustrates the relational networks between marine firms and vertical and horizontal partners. Evidenced by the firm-level interviews, this chapter summarises the regional patterns of marine firm behaviours in Ningbo. In summary, marine firms in Ningbo have been committed to innovation. From the relational perspective, marine firms in Ningbo have demonstrated similar patterns by forging the *obligational* patterns of interaction with extra-regional customers, and *arm's-length* interactions with extra-regional suppliers and the local government agencies. Restricted interaction with competitors has been found across the sample marine firms in Ningbo. Furthermore, marine firms in this region demonstrate a *heterogeneous* pattern in their relationships with the UPRIs mainly from other regions outside of Ningbo. This regional dominant pattern is structured by the regional institutions, which will be interpreted in chapter 7.

Besides, this chapter characterises the intra-regional differences across marine firms. As Chapter 5 mentions, the combining effects of these factors on marine innovation facilitate the explanation of the performing differences across the marine firms. By comparing sample firms in this region, the results indicate that the combination of the high-level of commitment to innovation, the obligational interactions with customers and the non-local UPRIs, the arm's-length business-supplier relationships, as well as the obligational relationships with the regional government like NMBPF3 - an obvious divergent firm case to this region or the arm's-length business-government relations yet the positive reactions to the marine guidance of the higher-level governments like NMEF7 are more likely to contribute to the innovation and business of marine firms. Despite the similarities in inter-firm collaboration, marine firms that innovate without the close interaction with non-local UPRIs and maintaining the distant relationship with the government like NMBPF2 and NMEF6 face more constraints in their innovation and business development. How these factors influence the performance have been interpreted in detail in the above sub-sections.

Based upon the concluded regional dominant patterns of marine innovation and the knowledge of the regionally marine-related institutions in Ningbo in this chapter, Chapter 7 will compare the two regional case of Ningbo with Qingdao, by which to synthesise the analysis of regional-level institutional factors and firm-level factors, especially the relational networking, and explore the causes pathways through which these factors explain the regional disparities of marine innovation in Qingdao and Ningbo.

Chapter 7. Comparative analysis of two Chinese regions

Proceeding chapters 5 and 6 have explored the regional case of Qingdao and Ningbo separately by elaborating on the regional institutions and analysing the regional dominant patterns of marine firm innovation, particularly from the relational perspective, despite that there are some intra-regional differences across firms. The aim of this chapter is to synthesise the empirical analysis and answer the last sub-research question, i.e., how the regional institutions and relational networks of firms explain the regional marine innovation.

7.1 Relational networking of marine firms in Qingdao and Ningbo

This section compares the similarities and differences of corporate factors - the dominant patterns of relational networking and innovation commitment. On this basis, the main aim of this section is to explain how the two dominant patterns of marine innovation in Qingdao and Ningbo influence the performances of the marine firms and the regions.

7.1.1 Comparing the two regions

Evidenced by the firm-level interviews in the two regions, this research summarises the dominant regional patterns of marine firm innovation in Table 7.1. Following the bottom-up approach, the combination of the similarities and differences in the firm-level factors including the innovation commitment and the vertical and horizontal relational networks construct two regional patterns of marine innovation in Qingdao and Ningbo.

Table 7.1. Comparison of the regional patterns of marine innovation

	Qingdao	**Ningbo**
Regional patterns of innovation	Regionally coordinated	Firm-oriented
Innovation commitment	Considerably committed	Considerably committed
Relational patterns of innovation collaboration		
- With customers	Cross-regional and obligational	Cross-regional and obligational

- With suppliers	Cross-regional and arm's-length	Cross-regional and arm's-length
- With competitors	Limited	Limited
- With UPRIs	Regional-based, Obligational	Firm-dependent Heterogeneous
- With local government	Obligational, Active government supports and positive corporate efforts	Arm's-length Little involvement of government and self-dependent firms

Sources: author summarised.

Similarities

Two major similarities can be identified by comparing the innovation patterns of the two regional cases - the commitment to innovation and the patterns of inter-firm relationships. On the regional level, the similarities in these factors are assumed to generate similar impacts on the innovation of marine firms in the two regions. Specifically, marine firms in both areas have been willing to commit to innovation as measured by the R&D input and the firm-level innovation platforms. In China's transition towards the innovation-driven development, the similar levels of commitment to innovation of firms indicate that marine firms in the two regions have generally acknowledged the importance to strengthen their internal innovation capabilities. This commitment can hardly be substituted by other factors.

Besides, evidenced by the firm-level interviews, marine firms in both regions have shared similarities in the dominant patterns of cross-regional inter-firm relationships with customers and suppliers. Both regions provide the local marine firms with locational advantages in the closeness to the regional and nearby markets, material resources, and industrial infrastructures to attract the vertical collaborators. However, the local marine bases of customers and suppliers are too small to satisfy the needs of marine firms, which demands extensive construction and heavy reliance on the cross-regional relationships with vertical partners from other regions.

Firstly, marine firms in both regions have primarily forged obligational relationships with customers, which contributes to their innovation and business development by inspiring the innovation, collecting feedbacks on the new product development or the existing products, and in some cases obtaining external sources of knowledge and collaborating in the development of advanced technologies and products which opens new business opportunities of marine firms. Frequent communication, long-term interaction, and accumulated trust in goodwill and competence enhance the stability of the business-customer relationships and facilitate the sharing of information, knowledge, and expertise beyond the simply trade-based interaction guaranteed by the written contracts.

Furthermore, most firms in the two regions have formed arm's-length relationships with suppliers. Their collaborations concentrate on aspects related to their trading relationships, such as the delivery time. Even though marine firms have some interactions with certain suppliers in product design, the knowledge mainly flows from marine firms to suppliers. The trust between them is mainly contract-based that marine firms could consider changing suppliers when they have better choices. In general, the arm's-length interactions ensure the completion of innovative and manufacturing tasks yet make limited contributions to the innovation of marine firms in knowledge. Marine firms seldom learn from suppliers. Compared with the relationships with customers, the positive impacts of arm's-length business-supplier relationships on innovation are much weaker.

Differences

Differences in the relational pattern of marine firms in the two regions centre on the business-government and business-university relationships. In Qingdao, firms preferred to forge innovation alliances with local UPRIs, and they interacted closely in the process of innovation and related aspects such as training. However, collaboration between marine firms in Ningbo and UPRIs is not as popular as in Qingdao. The partners of marine firms are mostly from non-local areas.

Furthermore, considerable differences exist between marine firms in Qingdao and Ningbo in their relationships with the regional government. While most marine companies in Qingdao have forged interdependent and obligational relationships with the local government, their counterparts in Ningbo are more self-reliant by maintaining more arm's-length and atomist relationships with the local government agencies. Although their interaction does not concentrate on the particular stages of the innovation process, their innovation-related collaboration generates indirect and all-round effects on the firm innovation and regional innovation. Considering the similarities, the two factors are seen as important to distinguish and explain the different patterns of innovation in the regions.

Therefore, this research labels the two regional patterns of marine innovation. The model of Qingdao is labelled as the *regionally coordinated* pattern, while Ningbo representants the *firm-oriented* model. Despite the similarities or differences in specific factor, the integration of various factors generates combining impacts on the performance of marine firms in the two regions and the performance of regional innovation.

7.1.2 The influence of relational networking in firm innovation

By synthesising the analysis in Chapter 5 and Chapter 6, the *regionally coordinated* pattern of marine innovation in Qingdao are more likely to generate positive impacts on the innovation and business development of marine firms and thereby better performance than the *firm-centred* model in Ningbo.

Firstly, the regional-based obligational interactions with the UPRIs support the innovation of marine firms by contributing external knowledge, expertise, and technology in both formal and informal ways. For SMEs with limited innovation capacities, easier access to the local UPRIs enables them to obtain technical supports and improves innovation efficiency. For those leading marine firms with strong internal innovation capabilities, the high-level local UPRIs enables them to participate the joint R&D projects and develop advanced technologies, which brings new business opportunities to apply the emerging technologies and strengthens their brand images in the relevant marine fields. The training interaction accumulates marine human resources to the marine firms. The technology transfer saves marine firms time in preliminary research and speeds up their development of new products. Furthermore, through long-term interaction, marine firms have internalised the non-project-based cooperation in technical services, consultancy, and information exchange into their regular communication.

Secondly, the obligational interaction with the regional government in Qingdao largely contribute to firm innovation by reducing the information asymmetry between the political and business actors within the same region. The close business-government connections enable the local marine companies to obtain easier access to information about the financial schemes and the marine industrial policies, which has contributed to the R&D expenditure of marine firms and guides the innovation and business directions of many marine firms as evidenced by the MBPFs in Qingdao. Besides, through the interaction with the regional government in regional policies, the comments of marine firms can be characterised and reflected, which further facilitates the development of the local marine firms. Furthermore, through the interaction in the construction of marine industrial bases and industrial associations, marine firms in Qingdao are more likely to enjoy the externalities that will brought by the agglomeration of supplier and customer base in the future.

In the current stage, the regionally coordinated models in Qingdao by maintaining the extra-regional relationships with customers and suppliers strongly support the innovation of regional marine firms. On the one hand, when the regional market and supplying bases are still small, the cross-regional relationships support the innovation and business development of the regional marine firms without merely relying on the regional market. On the other hand, with the pursuit of globalisation and domestic integration, innovation and business development are no longer regional-constrained activities. Maintaining part of the extra-regional connections enables the local marine firms to avoid the locked-in problems in innovation, expand their knowledge boundaries, and approach more business opportunities.

In the regional case of Ningbo, marine firms have maintained extra-regional vertical relationships with customers and suppliers. However, with the firm-dominated approach of marine innovation in this region, the outperformances of marine firms are less likely to happen than in Qingdao due to the differences from Qingdao in other perspectives. Firstly, the lack of easy access to UPRIs increases the search costs of local marine firms to approach appropriate UPRI. This also increases the thresholds to build intimate collaboration with the UPRIs on the daily basis and excludes a large number of SEMs concentrating more on the exploitation of mature technologies, especially considering the context of Ningbo where the local economy is composed by the large size of small private firms. Therefore, marine firms in Ningbo can hardly enjoy the benefits from UPRIs as external sources of knowledge, expertise, and technologies that are important to innovation and sometimes brings new business opportunities.

Besides, the extra-regional collaboration with UPRIs reduces frequent, face-to-face interaction. Marine firms in Ningbo often have to invest more resources to maintain their interaction with the non-local UPRIs. Though the arm's-length interaction increases flexibility by rejecting the bounding relationships, it also restricts informal interaction and communication beyond projects or agreements.

Furthermore, marine firms in Ningbo prefer to maintain a lower level of interaction with the government. The limited business-government interaction enables the local marine firms to enjoy a high level of freedom in their business and innovation development. However, this also reduces the chances of the regional marine firms to influence regional marine policies and obtain more marine-oriented benefits. This can be evidenced by the limited regional innovation projects in the marine fields. In this case, those firms that have stronger capabilities and follow the national directions of marine development are able to obtain more resources from the higher-level government. However, because of the limited financial and support from the regional government, and the lack of industrial atmosphere in the local area, the development of the majority of the marine firms in Ningbo have not benefitted from being located in this region. Therefore, the marine firms' development has to be more self-reliant. And the innovation and business performances of marine firms are thereby largely contingent upon the firm-specific factors such as the internal R&D capabilities, the development strategies, and the willingness and capabilities to approach collaborators, develop new technologies and products, and find new business opportunities.

According to the above analysis, this research argues that compared with the *firm-dominated* model in Ningbo, the *regionally coordinated* kind of relational networking in Qingdao generates more positive impacts on the innovation and business development of the regional marine firms, and thereby, is more likely to contribute to the innovative and business performance of marine firms.

7.1.3 The influence of relational networking in regional marine innovation

Besides influencing the innovation and business development of the marine firms in the two regions, the *regionally coordinated* pattern in Qingdao creates more advantages to facilitate the regional innovation development and the regional economy compared with the *firm-oriented* one. The relational networking patterns influence regional performance from several major aspects.

Firstly, the Qingdao model facilitates regional innovation and economy by enhancing the knowledge flow and diffusion and configuring the synergy of marine knowledge on the regional level. By the diverse means of connections between marine firms and the local marine UPRIs built upon the frequent and face-to-face interaction, the theoretical and academic knowledge in the marine field is spillovered from the local UPRIs to the regional firms. The advanced technologies are transferred from the local UPRIs to local marine firms, which creates opportunities for marine firms to develop novel products and the expand to new business fields. Reversely, the industrial knowledge is diffused from marine firms to the local UPRIs, which facilitates the applied research of UPRIs to better support the regional economic development. The bidirectional interaction enhances the interdependency between the marine research sector and the marine industrial sector on the regional level, which strengthens the marine research prominence and capabilities in Qingdao, configures the regional marine knowledge bases, and enhances the regional innovation capabilities in Qingdao compared with Ningbo.

Secondly, the *regionally coordinated* pattern in Qingdao with extensive networks on the regional level generate clustering effects. Besides the marine business-UPRIs interactions on the regional level, the interaction between marine firms and regional government facilitates the construction of marine clusters. Through policy interaction, the industrial parties and the regional authorities reached a common vision of the regional marine-oriented development. Through the joint efforts of marine business and the regional government, industrial bases and agglomerations started to emerge in Qingdao. Then, combining the locational advantages like the marine industrial infrastructure, natural marine materials, and port advantages, and the relationships between marine firms in Qingdao and extra-regional vertical partners, the marine industrial chain with Qingdao as the centre is more likely to be generated.

However, in the *firm-dominated* pattern in Ningbo, limited joint efforts have been formed on the regional level to cluster the marine economic and innovative activities in this city, which makes it difficult to agglomerate the regional resources to support the marine industrial development and generate clustering effects. Even though the marine firms in Ningbo have built cross-regional industrial relationships like their counterparts in Qingdao, without the strong regional marine base and the combining forces of marine development on the regional level, integrating the marine industrial chain that is regionally centred on Ningbo by relying only on the efforts of individual marine firms would be hampered.

In addition, with the increasing clustering of regional marine activities in Qingdao, marine start-ups and subsidiaries evidenced by the subsidiaries of centra-SOEs in this research are more likely to be attracted to Qingdao than to Ningbo, which leads to possibilities of opening new marine markets. Compared with Ningbo, the integration of different marine-related organisations through relational networking further strengthens the region-specific relational capabilities in Qingdao that are hard to be imitated by other regions on the one hand. It also facilitates this region to strive for more resources from the higher-level governments targeting the marine sector and build the regional image as the leading marine city in China on the other hand.

Lastly, the *regionally coordinated* development of the marine economy generates more positive impacts on the regional innovative and economic development in Qingdao than Ningbo. The marine sector becomes a new pillar of the regional economy in Qingdao. The strengthening innovative capabilities and the innovation-driven development in Qingdao enhance the competitiveness and resilience of the region. Moreover, as demonstrated in Chapter 2, the wide coverage of the marine industry in China by incorporating various sectors and economic activities generates new opportunities for growth and innovation for the related sectors in the same region, which opens new markets on the one hand and creates plenty of employment opportunities on the other hand to facilitate the regional economy.

Therefore, built upon the causal analysis, this research concludes that the *regionally coordinated* pattern of relational networking in Qingdao generates more positive impacts on the regional innovation development and the regional economy and thereby contributes to the regional innovation performance and economic performance than the firm-centred model in Ningbo.

7.1.4 The importance of proximity in regional innovation

Through the two regional cases and the analysis of the relational networking, this research contributes to the regional innovation literature by demonstrating the importance of firm-level factors in explaining the regional differences of marine innovation. This complements the existing frameworks in explaining regional innovation. Besides, in addition to the region-constrained focus on the geographical proximity as highlighted by the mainstream regional innovation literature, this research contributes to the explanation of regional innovation by stressing the various kinds of proximity through the networking analysis.

Even though geographical distance is no longer seen as an essential problem obstructing the establishment of relationships and collaboration, the findings of this research suggest the continuous importance of the geographical proximity in regional innovation with reference to the regional innovation literature highlighting the geographical proximity (Boschma, 2005; Bathelt et al., 2004). As demonstrated by the empirical analysis, the co-location of marine UPRIs and marine firms endows marine firms in Qingdao with more advantages in reaching research partners and maintaining the collaborative relationships through frequent face-to-face interaction. However, for marine firms in Ningbo, the distance between them and the extra-regional UPRIs not only impedes many marine firms to forge collaboration with UPRIs but also increases the costs and investment to find appropriate UPRIs and maintain collaborative relationships.

More importantly, this research highlights technological proximity and social proximity. The importance of the technological proximity is reflected in two main aspects. On the one hand, even though the local areas of Qingdao and Ningbo provide some customer and supplier bases to the marine firms, the local availability of more customer and supplier resources has been restricted. However, the marine innovation and business development require not just the natural marine resources and the geographical advantages of being situated in the coastal regions. Marine firms in both regions require non-local sources of customers and suppliers as external sources of knowledge, information, and business opportunities. The vertical interdependence between firms in the marine industrial chain specifies the importance of technological proximity.

On the other hand, the technological proximity reflects on the marine business-UPRI interactions. In Qingdao, the extensive collaboration between marine firms and the local UPRIs is mainly because of the fit between the innovation directions of the regional marine firms and the diverse R&D capabilities and expertise in the regional UPRIs. In such case, the marine firms in Qingdao in diverse innovation and business marine fields can find suitable UPRIs with diversified marine research focuses and learn from them. However, the competencies of local UPRIs in Ningbo concentrate on specific subjects, for instance, marine fishery research. Marine firms in Ningbo are less likely to approach matching UPRIs from the local region.

Moreover, this research contributes to the regional innovation literature by characterising the importance of social proximity. The use of personal relationships in forging interactions with customers and UPRIs by many firms in the two regions reflects the extensive existence of the extended family relationships in China mainly in the forms of school cohorts and alumni. For example, to marine firms in Qingdao, the social proximity combines with the geographical proximity in reaching the local UPRI collaborators, while in Ningbo, the social proximity built upon the graduates makes up the weak physical proximity. However, with the increasing institutionalisation, the improper use of *guanxi* has significantly reduced. Furthermore, the obligational pattern of relationships with the high-level trust in goodwill and long-term collaborative experiences highlight the relational embeddedness. Limited reliance on formal contracts and well-written agreements enables the flexible collaboration and frequent communication on a daily basis.

7.2 Mediated institutional influences in Qingdao and Ningbo

The above section indicates that there exist at least two kinds of paths of regional marine innovation in China. And the *regionally coordinated* model is more likely to lead to better innovative and economic performance of marine firms and the regions than the *firm-oriented* one. Reflecting on the regional innovation literature stressing the institutional explanations, the different regional marine innovation patterns are underpinned by the different institutional settings in the two regions. However, as demonstrated in Chapters 5 and 6, there exists intra-regional diversity of firms. Recognising that not all firms react positively to the institutional impacts, the results of this research highlight the importance of institutional factors in structuring the dominant patterns of firm behaviours in a region, through which the institutional impacts on the regional innovation performance are mediated.

In Qingdao, because of the strong development-oriented state and well-structured and comprehensive R&E system, marine firms are promoted to develop close interaction with the regional government agencies and the local UPRIs, and to be committed to marine innovation by accessing marine human resources on the one hand and financial support from the government on the other hand. The bank-based financial system further supports their innovation commitment by providing the easier access to patient capital. Furthermore, the cultural system strengthens the business-government interaction on the regional level and promotes the existing reliance on the extra-regional inter-firm relationships. In such kind of institutional environment, the *regionally coordinated* pattern became the dominant model of marine innovation in Qingdao.

In Ningbo, the regional state and the financial system also encourage the commitment of marine firms to innovation. However, the liberal-developmental state and the cultural system stressing firms' initiatives and networks reduce the reliance on business-government relationships to support marine innovation. Combined with the lack of local marine industrial bases, marine firms are promoted to establish the firm-oriented relationships with other firms not certainly restricted to the local area rather than relying on the regionally coordinated efforts of firms, government, and relevant organisations. The R&E system further pushes the local marine firms in Ningbo to search for extra-regional partners and marine human resources. This kind of institutional environment determines the limited institutional advantages for marine innovation in Ningbo and leads to the *firm-dependent* pattern on the regional scale. The following sub-sections explicate the institutional impacts.

7.2.1 Influences of regional states

Proceeding Sections 5.1.1 and 6.1.1 described the regional state institutions in Qingdao and Ningbo in detail. The regional states generate different impacts on the marine innovation in the two regions by structuring the different regional patterns of marine business-government relationships and indirectly influencing marine firms' commitment to innovation (i.e., the R&D expenditure) and business-UPRI relationships. Figure 7.1 illustrates the causal linkages.

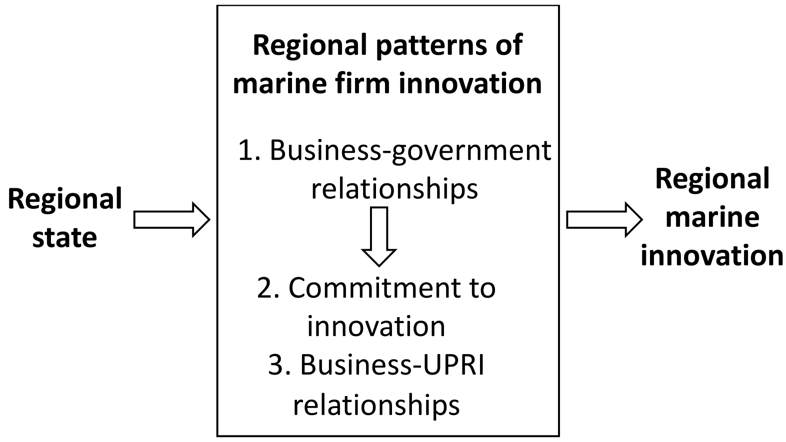

Figure 7.1. Regional state, marine innovation, and the causalities

Primarily, the regional differences of the marine business-government relationships in Qingdao and Ningbo are structured by the regional states. As demonstrated in Sections 5.7 and 6.7, an important kind of interaction between marine firms and the regional government is financial support. Initiated by the central state to pursue marine development, both regions are important coastal cities for regional experimentation of marine development and enjoyed the first-mover advantages. This can be reflected by the national-level marine innovation projects conducted by many marine firms in Qingdao and Ningbo and the associated financial support. However, the implementation of the national marine strategy relies on the reactions of the regional states. Qingdao has closely followed the footsteps of the central government and seeking the provincial leading marine city by implementing regional-specific marine policies and offering financial support to facilitate the innovation of the local marine firms as reflected by the interviewees. Nevertheless, due to the neutral reaction towards the national guidance, the regional competition with the Zhejiang province, and the restricted number of regional-initiated marine policies in Ningbo, local marine firms in this city have limited interaction with the regional government in terms of the regional marine financial schemes.

Besides, the state ideology and the regional marine policies influence the marine business-government interaction in the construction of the regional marine clusters. The state of Qingdao embraces the characteristics of a developmental state by maintaining both intervening and interacting ideologies to direct, guide, and support regional marine development and has implemented wide scope of regional policies and initiatives to support regional marine development. The regional ideology of the developmental state equips the government agencies in Qingdao to direct industrial development and support marine firms in multiple ways. As illustrated in Section 5.7, marine firms and the regional government in Qingdao interact closely in regional policies through which passing the practical demand of firms to the formulation and perfection of regional policies. Besides, driven by the regional government, they interact in forming the regional industrial associations and establishing supply bases, which contributes to the construction of marine clusters in Qingdao and generates indirect impacts on the innovation commitment of marine firms and region-based business-UPRI relationships.

However, for the local marine firms in Ningbo, due to the insufficient policies targeting the marine field, their relationships with the local government lack a marine-specific interacting basis. Also, adopting a more liberal-oriented ideology, the regional government agencies in Ningbo have played limited leading roles in the regional marine development. The synthesising efforts of the local government and the marine firms through close interaction can hardly be achieved. In such conditions, marine firms in Ningbo maintain arm's-length relationships with the local government and interact mainly on specific issues. Though there are some clues that the regional government agencies seek to bridge the local-based business-UPRI relationships, there is generally a missing linkage in the coordination between marine firms and the local UPRIs in Ningbo like the government-coordinated establishment of relationships in Qingdao.

Moreover, the business-government relationships are structured by the state bureaucratical arrangements in the two regions. The different local bureaucracies in the two regions influence the efficiency and capability of the government officials in coordinating and supporting the marine firms. In Qingdao, the existence of the super-bureaucratical organisation coordinates the fragmented offices on significant affairs in regional marine development. Setting up marine offices internal to the local bureaus with clarified duties and responsibilities enables the local marine firms to find and communicate with particular departments or officials regarding specific marine issues. Compared with Qingdao, not only did the regional state of Ningbo lack an internal super-bureaucratic organisation, but also lacked a specific department in charge of marine development at the bureau level. “Blue” departments and offices within the important bureaus in Ningbo are not as common as in Qingdao, which causes a lack of specialised officials and focuses dedicated to the marine affairs. Therefore, the business-government communication on specific marine issues is discouraged.

7.2.2 Influences of regional research and education systems

Section 5.1.2 and Section 6.1.2 presented the R&E systems in the two regional cases from different dimensions. By comparison, large differences can be identified between the two regions. The differences in the regional R&E institutions have structured the dominant regional patterns of the marine business-UPRI relationships and the innovation commitment of marine firms in the input of the R&D staff, which influences the regional innovation. And the R&E system creates more institutional advantages for firms in Qingdao than in Ningbo.

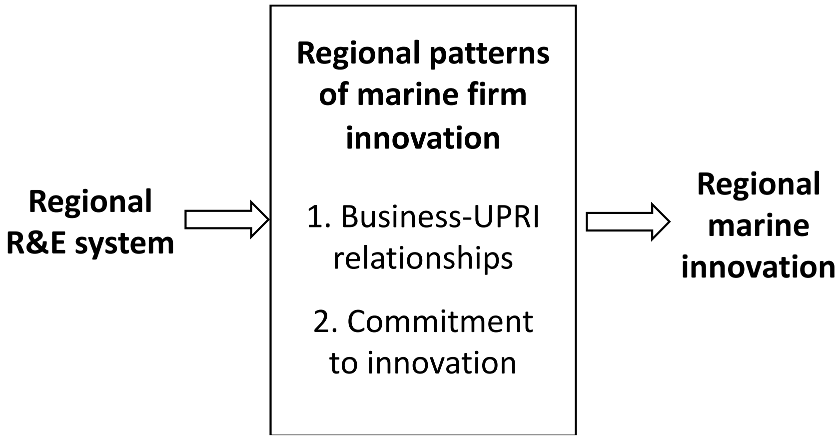

Figure 7.2. Regional R&E system, marine innovation, and the causalities

Regional R&E institutions and marine business-UPRI relationships

The establishment of marine R&E system started early in Qingdao. After decades of development, it has become one of the brands of this city and laid solid foundations for the regional marine innovation by creating a well-established knowledge base, gathering marine research expertise, and accumulating marine research and education resources. Thanks to this advantage, the marine research environments and atmosphere are more evident in Qingdao. The well-structured and comprehensive regional R&E system in Qingdao provides different kinds of research organisations, expertise, and knowledge in diverse marine fields to the local marine firms, which encourages the regional-based marine business-UPRI interactions.

Though Ningbo has started catching up in these years by enriching and strengthening the regional R&E system by introducing new research schools and groups in the marine field, the catch-up is not a short-term process. It is also hard to relocate the national marine research resources concentrated in cities like Qingdao, Beijing, and Shanghai to other coastal marine cities. Surrounded by a weak R&E system with restricted numbers of local UPRIs and uneven research expertise and capabilities across various marine fields, the business-UPRI interaction has been discouraged on the regional level in Ningbo, which further reinforces the extra-regional-oriented relationships.

Regional R&E institutions and marine firms' innovation commitment

Besides relying on the UPRIs as the external sources of knowledge and expertise, the innovation of marine firms demands skilled people and R&D staff with marine-related knowledge accumulation. Different institutional settings of regional R&E systems impose different impacts on the regional marine firms in their human resources investment, and thereby the commitment to innovation and the internal innovative capabilities.

In the two regional cases, the regional R&E institutions in Qingdao generate more favourable influences on the marine firms in the investment of R&D staff than Ningbo. Both as non-first-tier cities, the two regions have low levels of movement in population, which makes the regional human resources pools more crucial to the continuous supply of R&D talents to the local firms. In Qingdao, the strong marine educational system is pooled with marine labours. Marine UPRIs on different levels have been established in Qingdao. Besides those traditional marine UPRIs, many local universities set up marine majors in combination with their traditional advantages. Thus, marine firms in this region have less trouble in finding suitable employees.

However, in Ningbo, the regional educational institutions have been weak in general not just in the marine-specialised capabilities, which contributed limited skilled human resources to the local labour market. Therefore, marine firms in this region face more difficulties to attract and retain marine employees and have to spend more time and energy considering how to attract and retain marine employees and high-level talents. As demonstrated by the firm examples in Ningbo, aiming to accumulate firm-specific knowledge to retain potential employees, many marine firms have sought to save more resources for maintaining relationships with the extra-regional high-end UPRIs and are enthusiastic to build collaborations in talent co-training. However, without a strong sense of regional belonging, these employees are not always willing to stay in Ningbo for a long time, which causes more instability to firms.

7.2.3 Influences of regional financial systems

As Sections 5.1.3 and 6.1.3 demonstrate, the financial institutions in the two regional cases have shared similarities in the bank-centred system and the insufficiency of venture capital. However, Ningbo demonstrates a higher level of popularity in using private loans to access capital, while Qingdao has well-developed blue financing targeting the marine sector. As Figure 7.3 illustrates, the financial systems in the two regions structure the regional patterns of innovation commitment in the R&D spending of marine firms and their pursuits of innovation with higher or lower risks. By influencing marine firms' approaches to raising capital, the financial institutions influence the regional marine innovation.

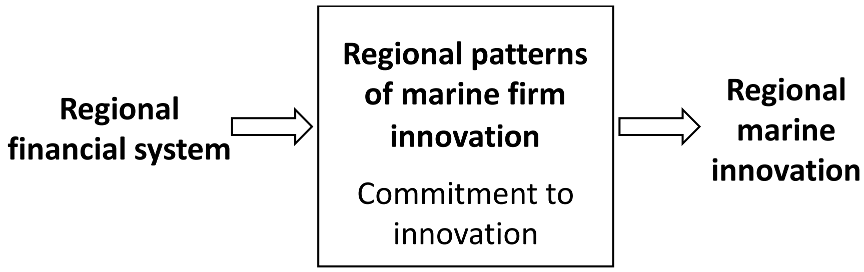

Figure 7.3. Regional financial system, marine innovation, and the causalities

For marine firms in both regions, besides using the internal financing and government funding to sustain the R&D expenditure, the empirical evidence in Qingdao and Ningbo have demonstrated bank loans as the primary external sources of finance, which fits in the context of the major bank-based nature of the regional financial systems in the two regions. The empirical analysis also shows the effectiveness of the eased restrictions on SMEs and private firms to obtain bank loans, which provides the regional marine firms with easier access to patient capital. Besides, the under-developed risk capital markets in the two regions constrain the local marine firms to pursue high-risk and highly uncertain R&D. As evidenced by the empirical analysis, innovation of marine firms in the two regions generally demonstrates limited engagement in the highly risky activities. Though for most MBPFs situated in an R&D-intensive industry, R&D of innovative drugs is not the primary focus.

Moreover, despite the multiple blue financing products (especially in Qingdao), the evidence collected from the regional marine firms has not characterised the broad use of marine financial products or services to access capital. The industrial-oriented regional financial institutional arrangements are demonstrated to be ineffective at the existing stage. Differently, in Ningbo, where marine financial products are less prevalent than in Qingdao, the regional financial system supports regional marine innovation by fewer regulations on private loans which are not exclusive to marine firms. Evidenced by the interviews in Ningbo, the prevalence of private loans encourages the local marine firms to use this kind of external financial source. However, because of the informal and unstable nature of private loans, the possibility of firms' pursuing high-risk R&D by relying on this source of finance is also restricted.

7.2.4 Influences of regional cultural systems

The cultural systems in the two regions demonstrated in Sections 5.1.4 and 6.1.4 have significant differences. Highlighting the regional norms, the cultural systems are assumed to structure the relational networks of marine firms with different actors, especially the regional government and the industrial collaborators as Figure 7.4 illustrates. Specifically, in Ningbo, the community-based culture and the reliance on the business networks further influences the commitment to innovation by causing the popularity of informal financing.

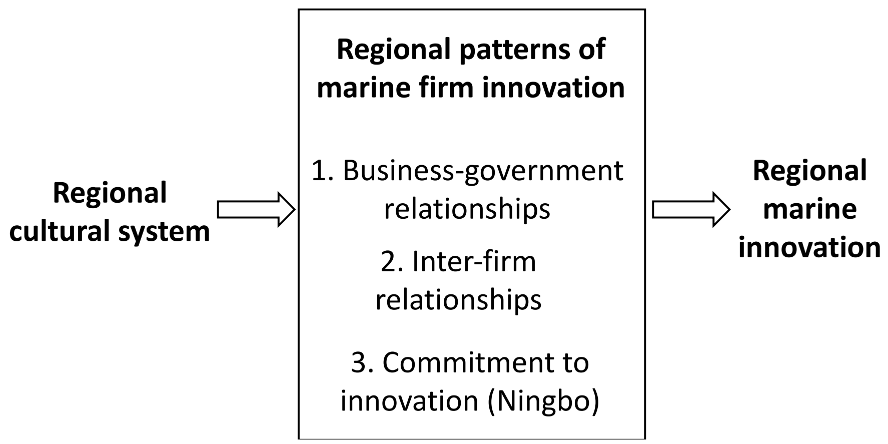

Figure 7.4. Regional cultural system, marine innovation, and the causalities

On the one hand, the state-dominated logic in Qingdao strengthens the business-government interactions in which the regional firms are willing to follow the guidance of the regional government and maintain close relationships with the government. However, in the case of Ningbo, the cultural system highlighting the business culture has led to the traditionally low reliance on the regional state, which further restricts the formation of close relationships between the local firms and the regional government agencies. In this way, the differences in the regional cultural systems lead to the different patterns of business-government relationships in the two regional cases.

On the other hand, the cultural systems influence the extra-regional interaction with vertical players of marine firms in the two regions, though in different ways. In Qingdao, the industrial structure traditionally highlights the roles of SOEs and encourages the formation of marine clusters by the co-efforts of the regional government and the firms, especially by the initiatives of the regional government. The marine firms are less likely to agglomerate initiatively and gather supplying and customer bases. Therefore, at the existing stage, marine firms in Qingdao have to rely more on the extra-regional vertical relationships before the formation of the top-down-oriented industrial agglomerations. In establishing relationships with vertical collaborators, the regional benefits of Qingdao concentrate more on the industrial infrastructures or natural endowments. And the dispersed technological focuses of marine firms in Qingdao discourage the intra-regional competition and horizontal interaction by reducing the fits between different marine firms.

In the case of Ningbo, the cultural system highlights the business networks within a region and encourages the wide development of the private economy, which should more facilitate the bottom-up agglomerations of marine firms in specialised technical fields and is more important to this region. However, this kind of agglomeration requires a strong common vision and norms shared across the regional firms to recognise the importance of the marine-oriented development, which is obviously sufficient in Ningbo. Furthermore, combined with the higher entry level of some marine sectors where the innovation not only requires the large investment, especially in the early stage, but also involves concerns about national security, and the lack of state involvement and efforts to build the industrial infrastructures or promote the agglomeration following a top-down means, the formation of the marine cluster on the regional scale is hard to achieve by relying on the efforts of a small group of marine firms. In such conditions, marine firms in Ningbo are more likely to forge cross-regional inter-firm relationships.

7.2.5 Hierarchical institutional complementarities in two regions

The above sub-sections highlight the structuring roles of institutions in regional innovation. Besides focusing on the impacts of a single institution, this section explores the interdependent relationships between different institutions in the same region. In contrast to the VoC theory that assumes the rigid complementarity between institutions within an economy, the analysis of the regional cases of Qingdao and Ningbo with different kinds of institutional constitutions and structures refutes the direct application of the VoC framework in the Chinese context. The findings of this research highlight the hierarchical interdependency of institutions. Figure 7.5 visualises the institutional structures in Qingdao and Ningbo.

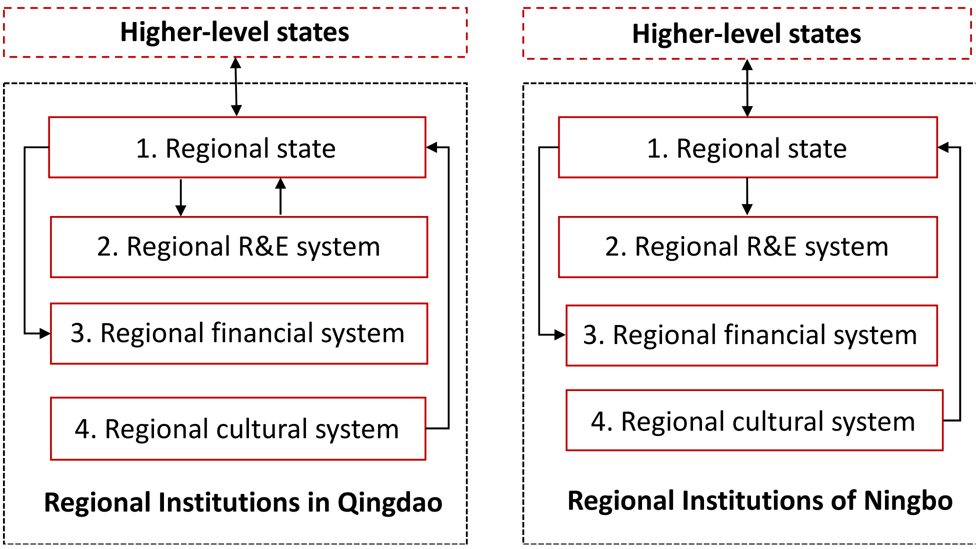

Figure 7.5. Regional institutional structures in Qingdao and Ningbo

Situated in China's regionally decentralised political system that is structured by the central-local relationships, the state is dominant in the regional settings of institutions. For example, regional states in both regions are capable of structuring the financial systems by influencing the availability of marine-driven financial services in Qingdao or allowing the existence of informal finance in Ningbo, through which mobilising the financial resources and directing the capital to targeted industries in the regional development. Besides, the regional states structure the regional R&E systems by mobilising the local UPRIs' shift to marine research and education in Qingdao and the introduction of new marine schools and groups in Ningbo. However, in Qingdao, the regional R&E system also holds the central position that defines the marine image specific to Qingdao and attracts attention from the higher-level states. In this way, the R&E system is able to impact the regional state. Moreover, in both regions, the logic of the regional states in governing the regional economy has been significantly impacted by the regional culture embedded in the regional histories, which has been institutionalised in the long time. However, generally speaking, in the Chinese context, the state still maintains the central position and have stronger strengths and initiatives to react upon the cultural impacts.

7.3 Summary

This chapter addresses the fourth sub-research question by comparing the two regions and explaining the causal paths through the firm-level factors - in particular the relational networking of marine firms, and the regional-level institutional factors that influence the marine innovation in Qingdao and Ningbo. Figures 7.6 and 7.7 illustrated the causalities.

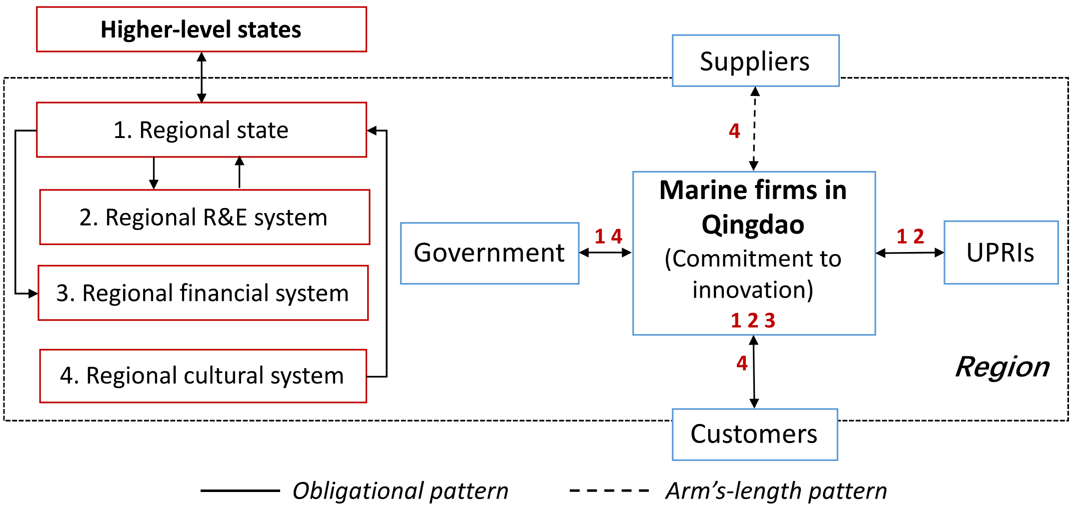

Figure 7.6. Regional marine innovation and causal networks in Qingdao

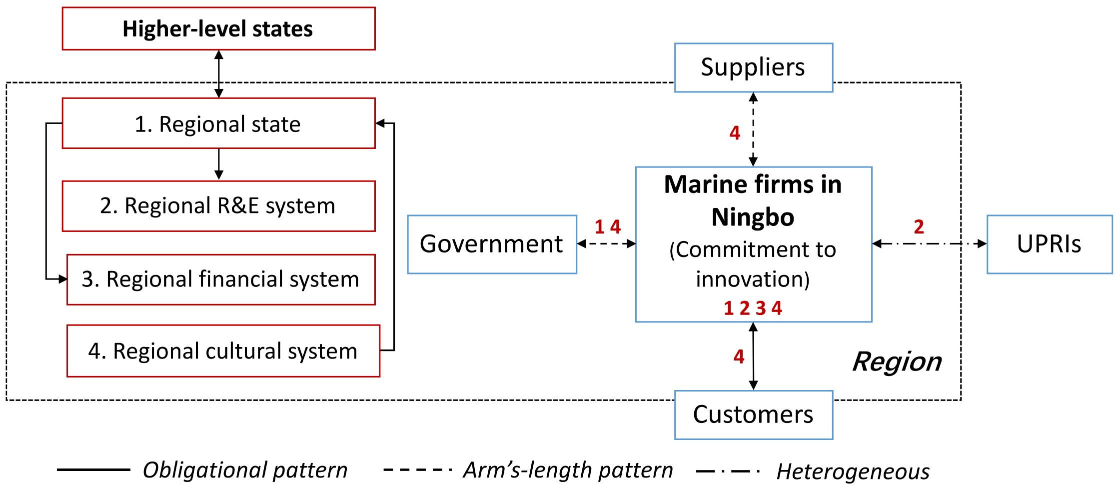

Figure 7.7. Regional marine innovation and causal networks in Ningbo

Specifically, the regional comparison in Section 7.1 highlights the cruciality of relational networks in innovation. By the regional comparison, this study concludes that the *regionally coordinated* pattern of marine innovation, as exemplified by the case of Qingdao, is more likely to generate positive impacts leading to the innovative and economic outperformance of marine firms and the region than the *firm-oriented* pattern in Ningbo without a strong regional basis of networks, especially the horizontal networks. By the analysis, this research echoes the literature on regional innovation and marine cluster which highlight the importance of networking interaction as the key factors to the clustering emergence and competitiveness. Besides, the analysis in Section 7.1.4 characterises the different kinds of proximity. In addition to the physical proximity, technological proximity and cultural proximity are defining factors structuring the establishment of relationships.

Furthermore, through the bottom-up analysis in Chapters 5 and 6, this research complements the insufficiency of traditional RIS analysis by rejecting the institutional determinism. However, by synthesising the institutional analysis and firm-level analysis, this section validates the significant importance of institutional factors, which has been characterised by the prior studies of regional innovation, especially those following the top-down approach. The comparison and analysis show that the *regionally coordinated* pattern in Qingdao and the *firm-centred* pattern in Ningbo are embedded in the regional institutional environments. In line with the literature on regional innovation in China the institutional analysis stresses the importance of the regional state playing some extent of developmental roles and the industrial-oriented

R&E system in China's regional innovation. It also characterises the historically inherited culture that is important in influencing the firm and organisational behaviours. Moreover, reflecting on the VoC literature, the findings of this research highlight the hybrid complementarities and the hierarchical arrangements of institutions - the state dominance that has been stressed in various theoretical discussions on China.

Chapter 8. Conclusions

This chapter summarises this thesis, outlines the key findings and presents the contributions and limitations of this research. Specifically, Section 8.1 reviews the whole thesis. Section 8.2 discusses the major findings for answering the research questions. Section 8.3 discusses the theoretical contributions to existing literature, which is followed by the practical implications for policy and management in Section 8.4. Lastly, Section 8.5 ends this chapter and the whole thesis by discussing the limitations and potential directions and topics for future work.

8.1 Review of the study

Driven by China's pursuit of becoming a marine power yet the under-investigated marine industrial and innovation development, and the paradoxical fact that firms have been treated as the central actors in the regional innovation, yet the firm-level factors have been poorly characterised in the existing analytical frameworks of regional innovation focusing on the structural elements and mechanisms, this thesis sets out the aim to explore the marine innovation of in Chinese regions following a firm-centred, bottom-up approach, and explain the regional disparities of marine innovation by integrating the firm-level and regional-level factors.

The development of a conceptual framework is an essential step to address the gap. Based upon the literature review of four strands of literature, namely the regional innovation systems (Section 3.1), the varieties of capitalism (Section 3.2), the relational networks of firms (Section 3.3), and marine clusters (Section 3.4), Section 4.1 proposes a tentative framework to conceptualise the regional innovation and explain the regional disparities. Built upon the basic understanding of China's marine strategy and the fact of regional disparities (Chapter 2), four sub-research questions (articulated in Section 4.2) have been developed around the central research question **"How can the regional differences of marine innovation be explained in the context of China?"**.

Employing the method of multiple case studies (justified in Section 4.4), the conceptual framework has been applied to the empirical analysis of two regional cases, i.e., Qingdao and Ningbo in Chapters 5 and 6. Based upon the bottom-up analysis of marine firms, especially their relational networks in innovation, and the investigation of regional institutions, a synthetic and comparative analysis between the two regions is made in Chapter 7, which explains how the firm behaviours and institutional factors co-shape the regional marine innovation and contribute to the regional differences in performance.

8.2 Key findings

8.2.1 Chinese contexts for regional marine innovation

This thesis analyses the contexts of Chinese regional marine innovation in Chapter 2. In the global trend to develop the blue economy, the marine development strategy in China has been driven by the increasing inter-dependence between China and the oceans. By covering numerous industrial fields, the marine economy has been treated as a new source of economic growth and an important aspect of Chinese transition towards the innovation-oriented economic development. Plenty of policies and programmes have been implemented in the historical process of China's marine development and made many achievements.

However, regional unbalance common in China's development is also an evident feature in Chinese marine economy and innovation. Among Chinese coastal provinces and cities, regional disparities exist not only in their natural resources and locational properties but also in the socio-economic and political conditions for the marine development. These coastal regions cover the most economically developed areas in China like Guangdong and Shandong but also those underdeveloped areas like Guangxi. Even among the developed regions with similar foundations, the marine industrial development has been heavily different as exemplified by the comparison of well-known marine cities in China (Section 2.3.2), including the focused regions of this research - Qingdao and Ningbo (Section 4.5.1).

8.2.2 Firms' relational networks for marine innovation

This thesis thoroughly explores the relational networks of marine firms in two Chinese coastal cities - Qingdao and Ningbo (Chapter 5 and Chapter 6). Firms' relationships with customers, suppliers, competitors, UPRIs, and the government are analysed. Though the main focus of this research is not to explain the firm-level diversity, the idiosyncrasy of individual firms is characterised. By comparing firms, it has found that the combinations of commitment to innovation, obligational business-customer relationships, obligational business-local UPRI relationships, and obligational business-government relationships (or arm's-length relationships, yet positive reactions upon the policy guidance of higher-level governments) are more likely to support the innovation of individual marine firms.

Through the bottom-up analysis, this study identifies the two dominant patterns of regional marine innovation labelled as the *regionally coordinated* model in Qingdao and the *firm-oriented* model in Ningbo. In the former model, marine firms have been committed to innovation, forged obligational relationships with customers, local UPRIs and local government, and maintained arm's-length relationships with suppliers. In the Ningbo pattern, marine firms have been committed to innovation and established obligational relationships with customers, but arm's-length relationships with suppliers and the local government, and highly heterogeneous with UPRIs.

This research finds that the *regionally coordinated* model is more likely to contribute to the innovation of marine firms (Section 7.1.2). Besides maintaining close relationships with customers to access external sources of innovation ideas and knowledge and interacting with suppliers for stability of innovation and production, the local UPRIs provide marine firms easier access to marine knowledge, technologies, and human resources, which facilitates their innovation and production efficiency and opens new business opportunities to develop new products and advanced technologies. In addition, the local government provides multiple guidance and support to marine firms' development in finance, directions of development, involvement in marine policies, and the construction of the regional marine clusters.

However, for the marine firms in Ningbo, despite the similar patterns in business-customer and business-supplier relationships, without the local foundations of UPRIs and close connections with the regional government, their innovation is more reliant upon the strategies and the capabilities of individual companies in approaching external resources. This makes the essence of the *firm-oriented* model. Thus, the findings drawn from empirical analysis and comparison indicate the importance of positively coordinating with relevant actors in firm's innovation.

8.2.3 Regional institutional contexts for marine innovation

This thesis systematically investigates the regional institutions in Qingdao and Ningbo (Section 5.1 and Section 6.1). Four regional institutional elements, including the regional states, the research and education system, the financial system, and the cultural system are analysed. Through the analysis in Section 7.2.5, this research identifies the hybrid and hierarchical complementarity of institutions in Chinese regions with the state holding the dominating position in influencing the arrangement of other institutions.

In the two regions, the institutions are observed from the marine-related aspects. The institutions in Qingdao with the quasi-developmental regional state, the well-organised research and education system with comprehensive capabilities in various marine fields, the bank-centred financial system in marine features, and the cultural system underpinning the state-centred logic generate more institutional advantages to the regional marine development. The institutions in Ningbo can also be supportive by maintaining a more liberal-oriented state logic compared with Qingdao, constructing research and education bases for certain marine fields, facilitating the easier access to capital, and supporting the networking culture for the industrial agglomerations built on numerous small firms. However, marine-oriented institutional arrangements are generally weak and not suitable for the state-initiated marine strategy in China.

8.2.4 Different marine development in Chinese coastal regions

Through the comparative analysis, this research finds that the *regionally coordinated* model is more likely to contribute to the regional marine innovation (Section 7.1.3) and demonstrates the importance of proximity beyond the geographical one (Section 7.1.4). And the different two patterns of firm behaviours have been underpinned by the different regional institutions (Section 7.2). They have generated integrated effects contributing to the explanation of the regional differences in marine innovation performances.

Specifically, the *regionally coordinated* pattern in Qingdao can better facilitate regional marine innovation than the *firm-oriented* model by promoting the marine knowledge flow, diffusion, and synergy in the local area, generating, and intensifying marine clustering effects through integrating the efforts of actors in the same region, and sustaining the marine economic development and supporting the regional economy. The *firm-centred* patten in Ningbo lacking both the large marine industrial base and the regional coordinated efforts can hardly form the marine cluster in the short term. This finding indicates that to support regional innovation and economy, it is critical to develop the regional coordination by unifying regional resources.

The analysis in Section 7.1.4 indicates the importance of geographical proximity in building collaborations. However, the widespread existence of extra-regional relationships with vertical partners and the non-local UPRIs in Ningbo also highlights that to marine firms, technological proximity and social proximity are also crucial factors directly influencing the establishment and maintenance of relationships with relevant actors. This finding highlights the importance to observe the micro-level agents of innovation and the underlying basis of coordinating relationships in the meso- or macro-level innovation research beyond the pre-assumed internal mechanisms of geographical closeness or localisation.

Moreover, the different regional institutions have structured the dominant firm-level behaviours in the two regions. The regional institutions in Qingdao facilitate the formation of the *regionally coordinated* patterns of marine firm innovation by promoting the regional-based triple-helix collaboration among firms, UPRIs, and government agencies. However, in Ningbo, the regional institutions have underpinned the *firm-oriented* marine development, which discourages the regional coordination between different marine-related actors and lays a lack of cultural foundation to form the regional-featured firm-driven agglomeration. Therefore, based on the rich qualitative data collected from the case studies, the research concludes that institutional differences are important factors causing the regional disparities in marine innovation.

8.3 Theoretical contributions

By investigating various marine firms in two Chinese coastal cities, the firms' networks, regional institutions, and regional innovation, and based upon the main research findings, this thesis makes several contributions to the existing literature and theoretical discussions and fulfils the research gaps from the following perspectives.

Firstly, this thesis contributes to the literature on regional innovation. Prior studies of regional innovation discussed the conflicts between the assumptions of homogeneous firms and the fact of firm-level diversity (Uyarra, 2010; Werker and Athreye, 2004). However, there is a lack of in-depth understanding of the initiatives of firms and how the firm-level factors could influence regional innovation. This thesis addresses this gap by presenting a conceptual framework that integrates the regional- and micro-level analysis and the bottom-up and top-down approach in investigating regional innovation. Furthermore, based on the firm-level interviews, this research examines the causal relationships between the regional patterns of innovation (i.e., the *regionally coordinated* one and the f*irm-dominated* one) and regional innovation performance, and between the regional institutions and the regional innovation performance, and finds that the relational networks are important to explain the regional disparities in innovation, and the mediated institutional impacts. In this way, this research reconciles the conflicts between the impacts of regional factors and the intra-regional firm-level diversity.

Also, the regional case studies in this research provide an example of applying this framework to the Chinese regions. However, because of the generalised causes in explaining the regional innovation, this conceptual framework can be easily applied to the theoretical studies and policymaking targeting different regional contexts and various industries. It can be used for both single case study and also comparative studies. In addition to the qualitative analysis as conducted by this research, quantitative methods and measurements could also be adopted by quantitising the firm-level and regional-level factors constituting the conceptual framework to explain the regional innovation.

Besides, this study contributes to the discussion on marine clusters. Previous studies on marine clusters based upon the empirical cases in Western economies like Canada, Norway, and Japan, and has reported different definitions of marine industry (e.g., Doloreux and Shearmur, 2009; Jenssen, 2003; Shinohara, 2010; Silver et al., 2015). They highlight the networking effects, the formation of marine clusters, and the clustering benefits. However, there is little understanding about Chinese marine clusters. This study addresses this gap by conducting a comparative regional analysis of two marine cities in China. The analysis indicates the top-down and state-driven formation of marine clusters in the Chinese context where the central and regional authorities play significant roles. Besides, this study confirms the importance of clustering the marine economic, innovative, research, and education resources, which highlights the significant roles of networks to stimulate and consolidate the regional-based coordination. However, this study also identifies the extra-regional relational networks, which are linked to the third contributions.

This research adds to the discussion of proximity in regional innovation and the openness or closeness of a region. Previous regional studies highlight the regional-based agglomeration with the geographical proximity as an important condition. There is some discussion on the increasing importance of extra-regional relationships to avoid locked-in problems (Laranja et al., 2008; Coenen et al. 2017). However, this is little understanding of what determines a firm's selection of collaborators and the establishment of relationships, and how this is linked to the regional conditions. This research addresses this gap by recognising the importance of geographical proximity, but also highlighting the technological and social closeness, especially the former, which tends to be more important to the innovative and business activities of marine firms and to the sustainability of marine clusters in the long-term.

Fourthly, this study contributes to the networking theory. Previous networking literature characterises the importance of relationships with different actors as external sources causing the firm-level heterogeneity (e.g., Gulati, 1999) and captures the significance of networks in regional studies (e.g., Saxenian, 1994; Nee and Opper, 2012). However, there is a lack of an operationalised way to observe firms' networks composed of the relationships with vertical and horizontal players and how these relationships combined to influence the innovation of firms either by directly participating in the innovation process or indirectly impacting on their innovation. This research addresses this gap by the in-depth analysis of how the relationships with external actors influence firms' innovation. Besides, by the firm-based analysis, this research finds that the differences of firms in innovation are dependent upon the combination of different relationships rather than determined by the relationships with a specific kind of players. The findings of this research indicate that compared with the ease of building vertical relationships embedded in trading interactions, horizontal relationships are more critical and differentiating factors that influence the innovation of firms. Though the industrial comparison is not the focus of this research, the sub-sectoral-based analysis contributes to the industrial debate of networks by identifying the different forms and bases of innovation relationships of firms in different sub-sectors.

Furthermore, this research contributes to the institutionalism theory, especially the VoC and general comparative capitalism theory. The VoC theory holds an institution-determinist view and assumes the pure institutional complementarity (Hall and Soskice, 2001). This research makes contributions to the institutional theory by identifying that institutions can explain the dominant regional patterns of firm behaviours (similar to the business system theory proposed by Richard Whitley), namely, the institutional impacts are mediated. In other words, the institutional effects are contingent upon the reaction of individual firms, and hence in many cases, firms can substitute institutional factors and generate different innovation performance. More significantly, by exploring the Chinese regions as hybrid cases, this research finds the hierarchies of institutions in the institutional system. Specifically, Chinese regions highlight the dominance of the state which has the capacities to influence the development of other institutions.

Last but not least, this thesis contributes to the literature on innovation in China. Previous research in explaining China's regional differences highlights the political structure behind the regional decentralisation and the networking capitalism (McNally, 2012; Xu, 2011; Peck and Zhang, 2013). Dominated by the state-centred view or the *guanxi* perspective, there is little understanding of how firms innovate in China's transition towards the innovation-driven development. Regional studies on China focus on the different models of regional development like SEZs and high-tech zones or concentrate on the first-tier cities, especially Shanghai, Shenzhen, and Beijing. There is a lack of understanding of second-tier cities. This study addresses these gaps by focusing on two important (economically, geographically, and politically) but under-explored coastal cities and conducting a bottom-up analysis and deeply exploring and analysing the innovation networks of marine firms, which restates the crucial roles of firms and the continuing importance of the state in contemporary China and the business-government interaction in facilitating the innovation of firms, regions, and even the nation. The findings refute the importance of using improper *guanxi* to access resources but confirm the importance of social closeness in forging collaborative relationships in many cases.

8.4 Practical implications

8.4.1 Policy implications

Built upon the bottom-up analysis of marine firms' innovation in Chinese coastal regions, this research offers practical insights to policymakers that could be utilised in adjusting the regional and innovative policies. In the context of the multi-level governance and multi-domain policy mix like in China, the implications are proposed for the policymakers on both the central and regional levels to facilitate the development of the RISs in China and support the national pursuit of being a maritime power in economy and innovation starting from the construction of the regional marine clusters.

For the central-level policymakers, the first implication is to balance the national resources relevant to the development of a specific sector and differentiate the regional focuses. As this research shows, even between the economically developed regions, there still exist disparities in regional resources and institutions that can generate different impacts on innovation. For example, Qingdao has gathered the top marine research and education resources in China far more than Ningbo. When Ningbo and widely the Zhejiang province have been well developed in the commercial activities, the lack of research resources could restrict the long-term development in the innovation-driven strategy. The regional unbalanced development has been a longstanding issue, especially since the economic reform in the late 1970s. A number of policies like the Great Western Development Strategy to reduce the regional unbalance have been implemented in China. Instead of pursuing the strategy of national homogeneity as in the Maoist period, encouraging the cross-regional sharing of resources and the regional experimentation of under-developed regions could also be good solutions to deal with the unbalanced distributions of resources.

Besides, as identified in this research, regional protectionism still occurs in China. Regional governments often use tax break or other preferential policies to invite new firms to a region. However, this is harmful to the fair competition between regions and creates burdens for firms when they make decisions. The central government could implement formal regulations to avoid the protectionism by strengthening the tax and financial governance and guide the sustainable regional competition. In addition, considering the GDPism and the close linkages between the career paths of the officials and the regional economic performance, the central government could consider including other ways to manage the regional officials, for example enhancing the cross-regional rotation of officials, and diversifying the cadre assessment criteria beyond rarely depending on the regional economic growth.

For regional policymakers, the findings of this research imply the importance of strengthening the regional institutional system and paying close attention to the effectiveness of institutional elements and the reactions of the regional industrial firms. In the short term, this research generates insights to regional policymakers resolve the regional failures by mobilising the extra-region resources, for example, to strive for policy support and resources from the higher-level governments. More significantly, to build the marine clusters, regional policymakers should attach more emphasis to the construction of intra-regional networks.

Firstly, the regional-level associations between industrial firms in the same industry or related industries should be established and strengthened. Industrial alliances can not only act as the effective channels of communication between the firms in the same region, but also facilitate the interaction between the regional government and the firms, or between firms and different organisations in the region. Also, these alliances should focus more on the SMEs. When large firms have strong capabilities and bargaining power on many issues, the demand and difficulties could require more support from external actors.

Secondly, the “industry-education-research” interaction should be further strengthened and promoted. As demonstrated by this research, in China, the rules and regulations for university researchers to participate in the industrial activities have been relaxed. However, how to balance the universities’ pursuits of academic achievements and the industrial and practical achievements and how to reduce the burdens of researchers in undertaking the teaching, researching, and industrial tasks are still urgent issues to be solved. This research suggests modifying the criteria to evaluate both the researchers and the UPRIs.

Lastly, in China’s transition towards the innovative economy seeking to upgrade the manufacturing firms in the global production chain and the pursuit of the marine strategy, financial resources are critical to the innovation-orientation development of the marine firms. Besides enhancing the governmental financial incentives, publicising the existing resources, and offering better services to the regional firms, especially targeting the SMEs, the regional policymakers should also involve the participation of other financial resources, like the risk capital, and create the accommodative environments to enable much more diverse sources of capital available to the regional firms. In the general background of the developmental-like state, the regional policymakers should combine both the developmental and liberal measures to direct, manage, and support the regional development.

8.4.2 Managerial implications

Based on the discussion of marine firms' relational networking and the regional institutions, the findings of this research could generate managerial implications for the managers of marine firms in the pursuit of innovative and business development. The first implication for the managers refers to the importance of the regional conditions, especially the regional institutions, the institutional advantages, and disadvantages. Firms should not only care about the internal characteristics or firm-specific resources and capabilities but also pay close attention to the regional context. Depending on the regional conditions, two major suggestions are proposed.

For one thing, in the regional institutional environments that are supportive to the innovation and development of specific sector, firms could consider shifting their innovation focus and adopting strategies to better utilise the regional advantages and coordinate the firm-level pursuits with the institutional orientation. For example, many MBPFs in Qingdao followed the regional marine orientation of development and obtained the regional financial support associated with the industrial policies and marine innovation projects, which enables them to expand to new business fields. When the marine universities have strong capabilities, marine firms in Qingdao could enhance their innovation capabilities and strengthen the internal R&D department by utilising the regional research and education resources.

For another, when the regional institutional environments lack the benefiting conditions, firms should seek extra-regional resources and opportunities to avoid the institutional determinism or be locked into the region. For example, when the region lacks a large customer or supply base, besides penetrating into the local market, marine firms have successfully built the cross-regional connections starting from the nearby regions. Also, when marine-oriented support and institutional environments have been disadvantageous in Ningbo, many marine firms have sought to obtain higher-level resources by applying for national projects or building cross-regional or transnational collaborations to make use of the resources and institutional advantages in other regions.

The second implication for marine firms in China is that they should enhance the innovation networks and strengthen the innovative capabilities to facilitate the innovation and business development. Three suggestions can be summarised. Firstly, firms should maintain close interactions with their customers which are crucial external sources of knowledge. The requirements and feedbacks from customers are important to inspire the product design and improvement of marine firms. However, managers should be aware of the operational risks of the over-reliance on specific customers and the locked-in problems. Besides maintaining the existing customers, keep expanding the customer groups are crucial.

Besides, firms should collaborate closely with the UPRIs. Technical services and consultancy by the UPRI agencies can solve the technical problems and improve the innovation efficiency of firms. If firms want to develop advanced technologies and explore new areas, the co-R&D collaboration will be the better approach. In addition, firms could learn from the UPRIs and accumulate human resources through the talent training. By maintaining the long-term interaction with UPRIs in different forms, firms are enabled to obtain access to the information on cutting-edge technologies, the research trend in the specific field, the scientific outputs that are possible to be commercialised and industrialised, and various kinds of resources.

Furthermore, firms should frequently communicate with regional government agencies and pay close attention to industrial policies and financial schemes. As demonstrated in this research, policies can help firms grasp the latest development focus in this country or in the region. And financial support from the government can provide additional capital to support the R&D of marine firms. Even though the governments have become more proactive in sharing information with firms, the focus of the government cannot be distributed evenly with a large number of firms in a region. Therefore, firms should take more initiatives to obtain information and resources from the government.

Moreover, committing to innovation by keeping strengthening the R&D input is important to marine firms. As discussed in this research, investment in the R&D expenditure and the R&D team is the necessary conditions for firm innovation. Talents, as the fundamental resources to the innovation of firms, besides their own capabilities, the associated connections with researchers and R&D staff in other organisations can bring in new opportunities to the firms. Also, by committing to innovation, many marine firms have been able to establish firm-level innovation platforms which further attract resources that are important to their business and innovative development and help to build brand images. And the development of the internal innovative capacities also determines the capabilities of firms to identify and seize new opportunities.

8.5 Limitations and future work

This research has several limitations. Firstly, this research aims to build a tentative framework to explain the causes of regional disparities in innovation. Only a limited number of factors are characterised, potentially excluding other possible factors and their impacts. Especially on the firm level, this research focuses on the relational networks and characterises the internal commitment to innovation. In future research, a more systematic analysis of the impacts of corporate factors, such as the innovation and business strategies, the organisational capabilities, the ownership structures, sizes, and so on could be important to generate valuable insights into the firm-level conditions of innovation performance. Besides, this research focuses on the qualitative analysis and the explanation of causalities of regionally different performance of marine innovation. More detailed and quantitatively robust measures of firm-level differences in innovation and business performance by involving more indicators could be added in the future research.

Secondly, this research explores two different marine sub-industries with the medium-to-high level of technical intensities and are strategically important in China, which makes it difficult to generalise the findings of this research on the industries with lower technical intensities like the fishery and marine agriculture. Besides, even though this research characterises the sectoral differences to some extent, the primary aim of this research is to generalise the conceptualisation and explanation of regional innovation, rather than industrial comparison. Therefore, the industrial and technological impacts on the firm innovation and regional innovation have not been examined. Considering the wide coverage of the Chinese marine sector (discussed in Chapter 2) and the influences of industrial characterises, future research could involve or control the industrial factors in analysis in order to seek further insights into regional innovation or generate industrial implications by the industrial comparison.

Moreover, to gain an in-depth understanding of regional marine innovation in China, the multiple-case study method is adopted by focusing on two regional cases ranked high in China in terms of the regional economic performances and administrative positions. Future research could consider extending the research regions of marine innovation to other less developed coastal areas in China, for instance, the Guangxi and Hainan provinces. The cross-national comparison of regional marine innovation between coastal regions in China and the Western marine clusters like the Quebec region in Canada, Tromsø in Norway, the Algarve region in Portugal and the Southwest England could generate more valuable insights into the theories of marine clusters.

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Appendices

Appendix A. National Marine Innovation Index, Sub-indices, Indicators, and Scores in 2016

Sub-Indices	Meaning	Indicators and scores
Marine innovation resources (Score: 215)	The intensity of marine input	1. Intensity of R&D expenditure (298), 2. Intensify of R&D personnel (373), 3. The percentage of senior-level professionals in the S&T staff (117), 4. The percentage of S&T staff in the headcounts of marine research institutes' staff (121), 5. The number of projects undertaken by every 10,000 R&D staff (166). Average: 215
Marine knowledge creation (Score: 457)	The capability to generate S&T outputs and diffuse marine knowledge	1. The number of granted invention patents obtained by every 100 million USD inputs (302), 2. The number of granted invention patents held by every 10,000 R&D staff (965), 3. The number of marine S&T works published this year (509), 4. The number of marine S&T papers published by 10,000 S&T staff (157), 5. The percentage of marine S&T papers published on international journals in the total number of marine S&T papers (353). Average: 457
Marine innovation achievements (Score: 185)	The efficiency and impacts of marine innovation activities	1. The conversion rate of marine S&T innovation achievements (i.e., from S&T outputs of commercialised products) (137), 2. The contribution rate of marine S&T progress to marine economy (111), 3. The rate of marine labour productivity (i.e., GOP generated by every marine-related employee) (399), 4. The contribution of marine education, management and service industry to GOP (105), 5. The amount of marine economic output generated by every unit consumption of energy (i.e., measures how marine innovation reduces the resource consumption) (249),

		6. The contribution of marine economy to GDP (GOP / GDP) (108). Average: 185
Marine innovation environments (Score: 371)	The external environments where marine innovation activities take place (e.g., marine institutional environments)	1. GOP per capita (of coastal regions) (544), 2. The percentage of expenditure spent on equipment procurement in the total R&D expenditure (110), 3. The percentage of governmental funds in the R&D funds of marine research institutes (62), 4. The number of graduates from marine major (767). Average: 371
Marine firm innovation (Data available until 2015) (Score: 2454)	The innovation capability of marine firms	1. The percentage of granted invention patents in the total number of granted invention patents (786), 2. The proportion of corporate R&D expenditure to the added values of marine major industries (2698), 3. The number of granted invention patents held by every 10,000 corporate R&D personnel (8336), 4. The rate of indigenous marine S&T (i.e., the percentage of S&T income from firms in the total S&T income of marine research institutes, and the proportion of the number of domestic granted patents to the total number of granted patents) (96), 5. The percentage of corporate R&D staff in the headcounts of R&D staff (352).

Source: The First Institute of Oceanography (2017, 2018), Liu and He (2020).

Appendix B. Granted marine patents in major marine fields of major ocean-related cities in China by organisations between 2009 and 2019

City	Enterprises		Public research institutes		Universities		Individuals and others	
Beijing	1704	56.49%	434	14.5%	616	20.6%	242	8.08%
Qingdao	648	30.1%	663	30.8%	632	29.4%	209	9.71%
Shanghai	890	52.9%	494	29.3%	199	11.8%	101	6.00%
Hangzhou	480	38.4%	527	42.2%	179	14.3%	63	5.04%
Tianjin	685	56.5%	291	24.0%	149	12.3%	87	7.18%
Guangzhou	477	38.6%	321	25.9%	277	22.4%	162	13.10%
Nanjing	318	33.4%	484	50.8%	100	10.5%	50	5.25%
Wuhan	429	50.2%	294	34.4%	68	8.0%	64	7.49%
Shenzhen	586	75.7%	83	10.7%	26	3.4%	79	10.21%
Harbin	115	14.4%	606	75.8%	14	1.8%	65	8.13%
Dalian	220	31.6%	354	50.8%	37	5.3%	86	12.34%
Wuxi	411	85.6%	38	7.9%	9	1.9%	22	4.58%
Chengdu	235	52.0%	154	34.1%	19	4.2%	44	9.73%
Xi'an	153	34.6%	234	52.9%	28	6.3%	27	6.11%
Zhoushan	112	26.9%	202	48.6%	86	20.7%	16	3.85%

Collaborating applications were counted once for each application type.

Source: Qingdao Research Institute of S&T Information (2019).

Appendix C. Studies of Chinese RISs

Authors	Regions	Aims	Findings
Zhu and Tann (2005)	Zhongguancun Science Park (ZSP) in Beijing	Presents a “cluster” (perceived as network) model at the system-level to depict and analyse ZSP.	ZSP’s RIS comprises five sets of networks comprising high-tech enterprises, institutions, support endowments, government, and intermediaries, which interact systematically to enhance the localised learning and regional competitive capabilities
Sternberg and Müller (2005)	Shanghai	Explore and understand the role of return migrants in the RIS of China.	Return migrants are significant for the Shanghai RIS, which is in the transition from a manufacturing site to a metropolitan region comprising a range of high-tech industries and services.
Chen (2006)	Shanghai	Explain the interaction between the RIS and the knowledge intensive type of FDI.	The localisation of MNCs’ R&D centers result in the technology spillover in the form of new spin-offs, the mobility of trained engineers between MNCs and local firms, and the creation of new research fields through MNCs-University joint research labs, which enriches and restructures Shanghai’s RIS.
Chen and Kenney (2007)	Beijing and Shenzhen	Explore the role of universities and research institutes (URIs) in China’s economic development by comparing the development of the Beijing and Shenzhen technology clusters.	In Beijing, URIs have played important roles in developing the largest high technology cluster in China. In Shenzhen, has in the last twenty years policymakers have consciously worked to establish and attract higher education institutions. With different endowments, local officials are important in developing the evolutionary trajectories of their regional technology clusters following different methods.
Li (2009)	30 regions in China	Estimates a stochastic frontier model to explain the increasing disparity in regional innovation	Government support, the constitution of the R&D performers, and the industrial innovation environment are significant determinants of regional innovation efficiency.

		performance in China.	The gaps in regional innovation performance are widen with the difference in firm innovation performance across the regions and the transformation of regional innovation modes from university and research institute-dominant to firm-dominant.
Breznitz and Murphree (2011)	Beijiang, Shanghai, and Pearl River Delta (PRD) (represented by Shenzhen)	Explore the regional innovation models in China.	High-tech zones have become the local organs of China's development path. Each region has taken a different approach to the management and use of their high-tech zones.
Chen and Guan (2011)	30 provinces in China	Construct a complete measurement framework characterising the RISs' production framework from S&T investment to final commercial outputs and measure the RISs' efficiency in China.	Only 1/5 of China's RISs are operating on the empirical best-practice frontier during the process from technological development to commercialisation. Inconsistencies exist between technological development capacity and commercialisation capacity in most RISs, and downstream commercialisation capacity is more important in the innovation performance of RISs.
Yang et al. (2012)	30 provinces in China	The role of RISs on the different regional innovative capability in China.	A region with higher ratios of private R&D and foreign-owned enterprise production, and closer interactions among industry, universities and academia, demonstrate higher innovative capability. A higher ratio of state-owned enterprise R&D to total R&D lowers a region's innovative capability.
Su and Sohn (2012)	Beijing	Provide insight into the relationships between universities and RIS in Beijing.	Beijing universities have significantly affected the RIS in terms of academic resources, industrial resources, political resources, geographical proximity and academic entrepreneurship.
Bai (2013)	30 Chinese provinces in the	Estimate the regional innovation efficiency in China and to	Innovation efficiency in China remained at a lower level and had much room for improvement. RIS has an imperfect internal

	eastern, central, and western areas	investigate major factors affecting efficiency scores.	construction. The innovation efficiency in the eastern regions was higher than that in other areas.
Huggins et al. (2014)	The PRD, the Yangtze River Delta, and the Bohai Gulf Region	Benchmark the competitiveness of these regions to explore which region is best positioned to be the most dominant knowledge-based economy over time.	Each region has increased the competitiveness through improving the capacity to absorb and diffuse knowledge. Yangtze River Delta with multi-dimensional advantages is best positioned to be the dominant hub of China's future knowledge economy.
Zhang (2015)	Shanghai Zhangjiang High-tech Park (biotech)	Examine the development of biotech in Shanghai using the RIS perspective and its three components: the land, human capital, and the regional base.	The role of the state is mediated through the "construction process" of innovation spaces, which involves many actors such as the national state, the local state, overseas returnees and the skilled labour force, investors together to expand biotech innovation.
Fu (2015)	The PRD (electronics)	Explore the external channels that trigger the local-scale knowledge spillover, expand the understanding of informality and the spatial differences in innovation patterns.	FDI have generates triggering effect on the regional innovation performance. Informal relationships have promoted the innovation of electronics firms, while they are unstable. The absence of supported institutions and related organisations restrict complex and risky innovation activities.
Zhao et al. (2015)	30 Chinese regions	Analyse the emerging patterns of regional collaboration for innovation projects.	Regional innovation and collaboration capabilities are developed by a better use of available resources (input), a better focus on the generation of innovation and research outputs (output), and the role of an organisational mindset (culture).
Yang (2015)	Shenzhen (LED industry)	Draw upon the institutional evolution perspective on the RIS to examine the impacts of policy change on the evolution of RISs in	Foreign-invested LED firms have engaged in innovation for increasing domestic demand, while domestic firms have developed driven by government subsidies. The role played by government is arguably in the transformation of RISs through

		China.	developing strategic emerging industries, while the changing role of states in the changing dynamics and institutional evolution of innovation systems demands better understanding.
Fu ang Jiang (2019)	31 provinces in China	Explore the mechanism of triple helix in China (i.e., how multiple participants affect regional innovation efficiency).	There is a large degree of heterogeneity in the innovation efficiency and regional cooperation in China. A multiple-participant governance of the innovation process can increase the regional innovation efficiency. In China, central and local governments are complementary in motivating regional radical innovation.
Heindl (2020)	Chongqing	Understand how RIS frameworks can be conceptualised in Chinese regions, and what the institutional specificities are in driving regional innovation processes.	Different RIS-frameworks matter for different actors who engage in different kinds of innovation. The notion of separate RIS acknowledges the co-existence of different structures and trajectories, which is helpful to understand the regional innovation dynamics in China in the transformation from state-control to an open system of innovation.
Li et al. (2022)	31 provinces in China	Explore the RISs' effects on emerging industries in China.	RISs have generally contributed to the growth of emerging industries, while different components of RISs have varied impacts on different emerging industries. Well-designed policies that leverage RIS formation and regional industry specific characteristics are vitally important for development of emerging industries.

Source: author summarises.

Appendix D. Data collection methods - documentation and interviews

	Forms	Strengths	Weaknesses
Document-ation	• Letters, memoranda, emails, and other personal documents • Agendas, announcements and minutes of meetings, and other written reports or events • Administrative documents • Formal studies or evaluations related to the case • News clippings and other articles in mass media or newspapers	• Stable - can be reviewed repeatedly • Unobtrusive - not created as a result of the case study • Specific - can contain the exact names, references, and details of an event • Broad - can cover a long span of time, many events, and many settings	• Retrievability - can be difficult to find • Biased selectivity if the collection is incomplete • Reporting bias - reflects the (unknown) bias of any given document's author • Access - may be deliberately withheld
Interviews	One to one • Face-to-face • Telephone • Internet-mediated (electronic) interviews One to many • Focus groups	• Targeted - focuses directly on case study topics • Insightful - provides explanations as well as personal views (e.g., perceptions, attitudes, and meanings)	• Bias due to poorly articulated questions • Response bias • Inaccuracies due to poor recall • Reflexivity - interviewee gives what the interviewer wants to hear

Source: author developed from Yin (2014) and Saunders et al. (2016).

Appendix E. Profiles of sample marine firms

QMBPF1

Established in 1968, QMBPF1 achieved high-speed growth in recent years following the national strategy of marine development. It is a high-tech marine biotech company and has 2,300 employees by the end of 2017. As the previously state-owned firm, QMBPF1 was restructured into a Sino-Japanese joint venture company following the Chinese trend of reforming state-owned companies in the 1990s. Through the joint venture, it strengthens the technological and production capacities. The main products cover marine bioactive substances products, ocean biomedical materials, alginate, functional sugar alcohol, marine biological fertilizer, etc. It is also expanding the business fields into cosmetics, functional food, and so on. With marine algae as the main material, it was the world's largest biotech firm in this industrial field.

QMBPF1 has strong internal R&D capacities. Besides maintaining the advantages in the existing technological fields, it is a proactive innovator seeking the development of advanced technologies and novel products. In addition to the "to business" products, it is making efforts to expand the high value-added product lines targeting individual customers. Based upon the multiple disciplinary knowledge and expertise, QMBPF1 actively seek external partners in R&D collaboration and established several top innovation platforms. It is a star company in Qingdao's marine industry. Through continuously expanding the business fields, the sales income of QMBPF1 has exceeded 3 billion yuan since 2017. The R&D expenditure accounts for 6% of the sales. From 2017 to 2019, 61 pieces of invention patents were applied by QMBPF1.

QMBPF2

Established by the interviewee in 2009 after graduating from a top medical university in China, QMBPF2 is a private-owned and high-tech biotech firm focusing on the innovation and development of animal drugs, animal vaccines, and antibodies. A large number of its products are used in the aquatic industry. Marine natural resources are important materials. The interviewee mentioned, "coming from the ocean, going back to the ocean". The number of employees was reduced from 100 to 60 due to the company's strategy to cut the non-R&D team. The R&D employees account for about one-third of the total headcount.

The competition in generic drugs is competitive, so QMBPF2 decides to enlarge the investment in innovative products. In collaboration with researchers in the US, QMBPF2 has internal capacities and grew steadily in recent years. However, due to the focus on the development of novel products, the development is also slow. No patent was applied from 2017 to 2019. Its sales income is around 200 million yuan in 2019. The gross margin is around 50%. Each year, about 12% of the sales revenue was input into R&D. It successfully developed a highly innovative product in the last few years. Many new products are under R&D.

QMBPF3

Established in 2003, QMBPF3 is a state-owned company in the marine biotech industry. It is a high-tech enterprise belonging to a long-established local distillery. Following the marine strategy, this firm undertakes the mission to transform the upgrade of the traditional distillery into high-tech, innovation-led development. The core R&D capabilities of QMBPF3 lie in biotech fermentation technologies. Its main products include marine microalgae, functional sugars and organic fertilizer extracted from marine natural materials, and so on. Their products are for medical use and health care.

It has developed very well entering the 2010s. By the end of 2019, it has 650 employees with over 1/3 being R&D staff. It is now one of the top suppliers in its niche market occupying over 75% of the global market share. To maintain the lead position, it has continuously widened the industrial layout (e.g., it established a new factory for marine fermentation equipment manufacturing in Jiangsu Province) and improved the innovation capabilities through collaboration with high-end UPRIs such as the institutes belonging to the CAS. Many technological breakthroughs have been achieved.
The annual sales income in these years is over 100 million yuan. 5% of the annual sales income was reinvested into R&D. From 2017 to 2019, 24 pieces of invention patents were applied by QMBPF3.

QMBPF4

Established in 1994, QMBPF4 is a state-owned Chinese medicine company famous in Qingdao. Its main products are Chinese medicines, with Chinese marine medicines as important constitutions. It has 600 employees with 15% of them being R&D staff. It was merged into a large state-owned pharmaceutical company in China. Marine health products are also new product lines to QMBPF4. Because land resources have reached the limits of exploration, marine materials become important to its innovation. Besides producing drugs, its business also covers the drug retail, particularly targeting the local area.

Its innovation focuses on Chinese medicines but also increasingly involves the R&D of generic chemical drugs. The R&D of Chinese medicines is complicated. Most Chinese medicines are compounds made of several ingredients (*fufang* in Chinese), which is difficult to clarify the targets. Many Chinese medicine products are developed based on traditional prescriptions. Thus, the review process is less strict than chemical drugs, focusing more on the toxicology test. The annual sales income was over 1 billion yuan in recent years. Partly because of the relatively large size and the innovation focus on Chinese medicines and generic products, R&D expenditure is lower than many other MBPFs, accounting for 1 of the sales income. From 2017 to 2019, 22 pieces of invention patents were applied by this firm.

QMBPF5

QMBPF5 is a university spin-off company established in 2013. One of the most well-known marine medicines was innovated by its affiliated university. It was founded based on the research team led by a famous academician in the marine biopharmaceutical field. Because of its strong research background, QMBPF5 has strong innovation capacities in marine drug innovation (chemical drugs). Its main products cover marine macromolecular drugs, preparations, small molecular marine drugs, and marine functional products. The innovation focuses mainly on innovative drugs.

The innovation of QMBPF5 concentrates on the cutting-edge knowledge and seeks to transfer the S&T outputs from the university to industrialised and commercialised products. Its affiliated university has collaboration with many pharmaceutical companies in Qingdao, which accumulates plenty of industrial experience for this company. QMBPF5 shares the R&D facilitates and the R&D team with the affiliated university and received government guidance funds. It now has 150 employees and most of them are R&D staff. Its annual sales income is over 50 million yuan and most of the sales income has been reinput into R&D. From 2017 to 2019, 72 pieces of invention patents were newly applied by it.

QMBPF6

Established in 1998, QMBPF6 is a subsidiary of a large, listed marine biotech company focusing on enzymes and probiotics in Qingdao. It is a small private-owned firm having 200 employees with over the R&D staff accounting for about 10% of the total number. It focuses on the innovation and production of animal-used products. This company has 30 main products, mainly including animal vaccines, antibodies, and animal health products. The products are often used in the marine aquatic industry. As an important business field of its parent company, QMBPF6 grew steadily.

This company does not pursue big leaps in technology and business strategies. Most innovation is based on the industrial demand to improve the existing products. The innovation of QMBPF6 focuses on generic products because of the difficulty to innovate entirely new drugs and obtain quick approvals. The innovation process is also shorter. The annual sales income from 2017 to 2019 is around 100 million yuan. The gross margin is very high reaching 90%. Each year, about 9% of the sales were reinvested in innovation. From 2017 to 2019, 18 pieces of invention patents were applied by QMBPF6.

QMBPF7

QMBPF7 is a small private-owned firm whose main business is Chinese medicines. Established in 2005, it used to be a state-owned company in Qingdao and was transferred into private ownership. It has 322 employees. Its main products are Chinese medicines. It has made some attempts in the innovation of chemical products, but most of the projects failed. Most of the sales revenue comes from traditional Chinese medicines. Its financial performance was not satisfying. It was in loss and only started to make profits since 2017.

Focusing on the traditional product areas of Chinese medicines for over 20 years, the growth of the company was slow in recent years. On the one hand, the input in the R&D of Chinese medicines was reduced. On the other hand, it lacks the capability and knowledge in chemical drug innovation. Facing the competition from other companies, the growth of this company has been heavily influenced. It relies heavily on marketing strategies to sell products. The sales revenue is around 100 million yuan in recent years, but most of its revenue was spent on marketing investments. 8% of the sales were input into R&D, most of which was invested in upgrading the equipment and the production line. From 2017 to 2019, only one piece of invention patent was applied by QMBPF7.

QMBPF8

Established in 1994, QMBPF8 is a foreign-owned pharmaceutical firm. It was one of the first several marine pharmaceutical companies in China. Two of the first marine drugs in China were innovated and produced by QMBPF8 in collaboration with well-known universities. Marine products are the main products of this company. Its product catalogues are diverse, also involving other chemical drugs and Chinese medicines. It has 450 employees, 16% of which are R&D employees. The innovation team was led by a famous academician in the field of marine medicine.

QMBPF8 has strong R&D capabilities and industrialisation experiences. Its innovation strategy involves both innovative drugs and high-end generic drugs. As a leading marine pharmaceutical company, it has actively participated in marine innovation projects and invested a lot in constructing the blue medicine base and accelerating the industrialisation of marine technical outputs. It seeks advanced product development. The sales income was about 1.2 billion yuan in 2019, with around 80% gross margin.

8% of the sales income was invested in R&D each year. From 2017 to 2019, 121 pieces of invention products were applied by QMBPF8.

QMBPF9

Established in 1982, QMBPF9 is a large traditional pharmaceutical company based in Qingdao. It is a private-owned company and a famous brand in Qingdao transformed from state ownership. It has 1100 employees with over 15% of them being R&D staff. The core technologies of QMBPF9 were the slow-releasing and controlled-releasing technologies. The main products of QMBPF9 are generic chemical drugs. Development and innovation of marine drugs started late but have become important parts of its business.

As a large company, QMBPF9 pursues the stability. The innovation focuses on the generic drugs. In particular, it pursues to be the first one to bring the under-researched generic drug on to Chinese market to obtain the pricing power. It seldom involves R&D projects for innovative drugs. The competition in generic drug innovation is fierce in China. As a long-established pharmaceutical company, it has rich experiences in product innovation and development. The sales revenue was over 1.3 billion yuan. However, because of the intense competition, the gross margin was low compared with other firms in this industry (35%). Investment in R&D was over 100 million yuan each year. From 2017 to 2019, 16 pieces of invention patents were applied by QMBPF9.

QMEF1

QMEF1 is a company that has a long history of around 200 years. It used to be a state-owned firm and transformed into a private-owned company in the early 2000s. The main products are functional and special cables and relevant products. The key technological capabilities lie in the woven technologies and designing capabilities. It often participated in the ocean scientific expedition activities, from which it strengthened the technological capabilities and opened new business fields. It has nearly 500 employees, with over 10% being R&D staff.

It is the top company in China in the niche market. Its products can bear harsh temperatures and achieve high accuracy and intensity. Starting from the deep-sea expedition use, it has also extended to other areas like the space. Besides maintaining the core technological capabilities, the innovation of QMEF1 focuses on applying the cutting-edge technologies into new scenarios and new product development. It has continuously opened to new business fields. The sales income was around 200 million yuan with around 6% to 7% invested into R&D. From 2017 to 2019, 24 pieces of patents were applied by this company with 6 of them being invention patents.

QMEF2

Established in 2005, QMEF2 is a private-owned firm. The main products are ship distribution systems and ship automation control systems. The innovation capacities lie in the product design of the power distribution and use on ships. There are 100 employees. The proportion of pure R&D staff is low, accounting for 3% of the total number of employees.

For this company, the product innovation takes place in the form of developing new applications of the existing products. Most products are unstandardised, requiring engagement with the customers. However, the R&D intensity is low. Sales revenue is about 50 million yuan with an annual growth of 30%. R&D investment has been enlarged in recent years. Most were spent on process innovation - by enhancing the extent of automation of the manufacturing process to improve efficiency. From 2017 to 2019, no patent was applied by this company. Other patents obtained by this company in the past several years were all utility patents.

QMEF3

QMEF3 was founded by the interviewee - an oversea returnee from the US in 2017. The idea of entrepreneurship was developed by the interviewee during his PhD at Columbia University. It is a Sino-Singapore joint venture. It is a marine equipment manufacturer. The main products include the equipment and the nanofiber materials. Ocean-used products are important parts. The key technologies are nanofiber technologies It obtained a government guidance fund and appointed a Singaporean top researcher in the technological field as the primary scientist. The number of employees kept growing from 10 in 2017 to 60 in 2019. There are around 30% R&D staff.

The innovation of QMEF3 focuses on the development of new products based on existing technologies. Because of its R&D background, it seeks to accelerate the industrialisation of leading S&T achievements achieved in the lab. Besides product innovation, aiming to become a reliable supplier, it focuses on providing the solution for its customers by integrating the supply of raw materials and equipment. This company has developed well since its establishment. The sales revenue increased from 0.5 million in the first year of establishment to 53 million in 2019. Over 10% has been invested into R&D. From 2017 to 2019, this company applied for 19 pieces of patents, including 6 invention ones.

QMEF4

QMEF4 is a state-owned company belonging to a large central state-owned corporation. Established in 2005, QMEF4 has 2000 employees and maintains 12% of them are R&D staff. As for some projects, temporary workers are required. The main products of QMEF4 are drilling platforms, including the Floating Production Storage and Offloading (FPSO), deep-water floating platforms, and jacket offshore platforms. The key capacities of QMEF4 lie in the technological capabilities and the professional manufacturing space for marine engineering products.

Its innovation now focuses on the deep-water floating platforms and FPSOs rather than the jacket offshore platforms with lower entrance barriers. Many projects have been completed in recent years with great technological achievements. It also seeks to build the first modular factory in China and integrate the marine engineering industry. The sales revenues depend on the projects. Some projects last long. The sales revenue in 2017 was about 5 billion yuan but in 2018 was only 1.8 billion. 5% of the sales revenue was invested into R&D. From 2017 to 2019, 257 pieces of patents were applied by QMEF4. 148 are invention patents.

QMEF5

QMEF5 is a subsidiary company of a central state-owned enterprise. Established in 2002, its history can be traced back to the late 19th century. The main products are boats and ship-used machinery. It has 2400 employees, including 460 R&D staff. Due to the industrial transformation from the traditional heavily polluted and low value-added shipbuilding based on cheap labour to the high-tech and innovation-driven development, the financial performance of QMEF5 was not satisfying in recent years. Even though controlled by the central state, this company can also feel a sense of nervousness.

The annual sales income has been unstable but fluctuating at around 4.5 billion yuan. 3% of it has been input into R&D to reach the bottom limit for high-tech enterprises. Because of the rich industrial experience, manufacturing capacity, and the large size of the R&D team, this company successfully survived during the hard time. Facing competition from other large shipbuilding companies, QMEF5 is seeking to develop new products with more sophisticated designss and higher added value. Speedboats in speciality materials, high-speed boats in aluminium alloy, and unpiloted boats are newly developed products. From 2017 to 2019, 37 pieces of patents were applied by this company. 17 are invention patents.

QMEF6

QMEF6 was established in 2012. It is a private-owned company obtaining the “high-tech enterprise” title. It is a shipbuilding firm. The main products of this company are boats made of aluminium alloy. There are 10 product series and 31 different products.

It has 50 employees. The R&D team only accounts for 3% of the total number of employees. Facing stricter regulations on environmental protection, the performance of this company was hampered.

The innovation concentrates on the modification of product design according to the customer demand - mainly foreign customers. New product development seldom involves new technology beyond the existing scope of knowledge and expertise. Technological intensity is not very high. This company has no plan to develop into new business fields. The sales income was about 20 million yuan, and about 5% of it was input into R&D - mainly to improve the manufacturing capacity and buy finished designs from collaborating universities. From 2017 to 2019, this company applied for 11 pieces of patents. None of them is the invention patent.

QMEF7

QMEF7 is a subsidiary of a central state-owned company. Focusing on non-ship marine products, it constitutes an important part of the parent company's business. Established in 2005, it has been granted the title of high-tech enterprise. It has 494 employees with about 10% of them is R&D staff. However, each year, it requires a large size of temporary workers (over 1000). The main products of QMEF7 include port handling machinery, ship lifting equipment, and functional offshore platforms.

Compared with the larger size companies, the professional levels of QMEF7's products are higher. Focusing on the offshore service platforms in smaller sizes avoids the competition with other large firms. The innovation of QMEF7 pursues specialisation. It is one of the leaders in the niche market and has obtained a large number of orders and successfully delivered the products. The sales income is over 1.5 billion yuan. About 3 - 4% of the sales revenue has been invested into R&D. From 2017 to 2019, 16 pieces of patents were applied by QMEF4. 6 are invention patents.

QMEF8

Established in 2013, QMEF8 is the first of several marine high-tech companies in Qingdao's marine cluster. It is a private-owned firm. The main products are underwater equipment such as the sensors, discovering, and monitoring equipment. The products can be used for different marine fields including deep-sea fishing, marine platforms, and undersea cable maintenance. It has nearly 60 employees by the end of 2019. Over 20% of them are R&D staff.

QMEF8 is proactively seeking new business fields and the R&D of cutting-edge knowledge. Cross-disciplinary collaboration is important. It has a detailed plan for technological breakthroughs and industrial chain integration and invested a lot into the innovation. Besides product innovation, the company also stresses service innovation. It provides a whole plan of solution for the customers including both products and services. After years of input, the financial performance of QMEF8 has been growing in recent years. In 2015, the sales revenue was only 10 million yuan. In 2018, the sales revenue exceeded 100 million. The proportion of R&D expenses has maintained at around 10%. From 2017 to 2019, 51 pieces of patents were applied. 14 of them are inventing patents.

QMEF9

Established in 1989, QMEF9 is a private-owned company listed on the market. It used to be a collectively owned company. Main products include the subsea cables, achieving a wide coverage from low-end to high-end products. It is the first of several companies in China doing the R&D of subsea cables. It has built a national-level platform for technological innovation and appointed several professionals to lead the internal R&D. It has 2485 employees. Nearly 5% are R&D staff.

It is now the leading firm in the niche market in China. Entering foreign markets is difficult. Most of the business of QMEF9 is domestically based. However, innovation focuses on the reverse imitation. The cable industry is relatively mature. The major technological capacities of QMEF9 lie in the application in different scenarios. Its innovation is closely associated with the national strategy - whether the government allows the company to reach certain sea areas or degrees of depth. Benefitting from the rich experiences, it obtained more access and resources to develop new products and advanced technologies. The sales income is about 4.5 billion yuan. Over 4% has been input into R&D. From 2017 to 2019, QMEF9 applied 42 pieces of patents with 14 pieces being inventive ones.

QMEF10

Established in 2005, QMEF10 was a private-owned, small shipbuilding company. It is a high-tech enterprise. The main products of this company are fishing boats and pleasure boats made of glass fibre. Despite its small size, it is one of the leading companies in its niche market (i.e., shipbuilding using glass fibre). It has 80 employees. The R&D team is small, and only accounts for no more than 3% of the total number of employees. As a small ship builder, QMEF10 avoids the direct competition with large shipbuilding companies. It grows steadily by maintaining the existing customers and gradually enlarging the customer group.

The innovation of QMEF10 focuses on the modification and new application of existing technology and main products according to customer demand. New products (blueprints) and technologies are mainly bought from other companies or research organisations. The sales income grew steadily from 70 million yuan before 2017 to 100 million in 2019. It applied for 14 pieces of patent from 2017 to 2019 with 8 of them being invention patents. QMEF10 now has over 20 kinds of boats and can make one boat per day.

QMEF11

QMEF11 is a subsidiary of the central state-owned company. Established in 2017 by merging several different firms in the same industry, this firm has achieved rapid growth since its establishment. It has around 500 employees and about 15% are R&D staff. The main products are ship-used engines at low speeds (for large ships) and energy products. Besides setting up an industrial base in Qingdao focusing on the R&D and manufacturing activities, it also has other bases for the test and experiment, and the main parts and products supporting the main products.

The main products occupy nearly 50% of the domestic market and over 15 of the global market. The establishment of this company is to integrate the industrial development and reduce the repeated resource allocation and homogeneous competition. Its innovation focuses on the diversification of existing products for different applications and the development of environment-friendly products. The sales revenue is about 1.2 billion yuan. 7% has been reinvested into R&D. From 2017 to 2019, QMEF11 applied for 69 new patents including 43 invention patents.

NMBPF1

Established in 1993, NMBPF1 used to be a state-owned firm before the transformation. It is now a subsidiary of a foreign pharmaceutical company. There are 450 employees in this company with over 10% of them are R&D staff. The main products are Chinese medicines with some of them using marine materials, and marine health products, but also involve a small proportion of chemical drugs. Because of some negative news, the growth of this company was influenced in research years.

After the acquisition, the parent company has invested plenty of resources in this firm. After several years of recovery, the innovation focuses of this company are perfecting the process of Chinese medicine R&D and manufacturing (process innovation) and trying to break the barriers between Chinese medicines and Western drugs. In 2019, the sales income was nearly 500 million yuan, most of which came from a star product. About 4% of the sales income was invested into R&D. From 2017 to 2019, 11 pieces of invention patents

NMBPF2

NMBPF2 is a pharmaceutical company in Ningbo having a long history. Established in the mid of the last century, it used to be a state-owned company. After a series of transformations, it turned into a private-owned company following being purchased by a large pharmaceutical company. The parent company allocated more resources to support NMBPF2's development. Major products are chemical drugs with increasing involvement in marine medicines and health products. There are 230 employees. The R&D staff account for over 7% of the total number of employees and have been increasing.

This company lacks strong R&D capabilities. Facing competition in the market, the existing focus of this company has been put on marketing to maintain the advantages of the existing products, rather than innovation. Besides investing in the R&D of generic drugs, introducing foreign products into the domestic markets by buying out foreign companies or technological imports are the key strategies. Innovative drugs are not the R&D focus of this company. Sales income is over 200 million yuan, no more than 300 million in 2019. R&D expenditure accounts for over 7% of the sales income. There are 6 under-developed products and one of them has obtained approval. From 2017 to 2019, 5 pieces of invention patents were applied by NMBPF2.

NMBPF3

NMBPF3 is a small, private-owned, high-tech marine biotech firm. Established by a Ningbo-born researcher who held a position at a US top university and was professional in the marine biotechnology field. He was invited by the local government (specifically the district government) to build the firm in Ningbo following the trend of marine strategy. Established in 2013, this company has received great attention from the local government. It has over 50 employees with a large size of the R&D team. Its main technologies focus on the synthetic biology based on marine materials. The main products include marine polysaccharides, marine enzyme preparations, and antibodies.

Relying on the founder's research background and industrial experiences, this company has grown rapidly since its establishment. It received round-A venture capital in 2017 and aims to go public. Its innovation focuses on the cutting-edge technologies. It targets the high-end overseas customers and is now one of the top suppliers in the field of marine enzyme preparations. Its sales income was over 100 million yuan. From 2017 to 2019, 14 pieces of invention patents were applied by this company. It also pursued to apply for patents and obtain patenting approvals in the US.

NMBPF4

Established in 1992, NMBPF4 is a private pharmaceutical company. It used to be a township and village enterprise. Core products are chemical drugs and active pharmaceutical ingredients. Marine products are key parts of the products. After the failure of going public, this company was purchased by a large listed pharmaceutical company. There are about 500 employees. The R&D staff accounts for over 10% of the total number of employees. The innovation used to be based on the internal medicine research institutes located in Beijing and Ningbo separately. After the acquisition, the research institutes were incorporated into the group company.

The parent company has allocated R&D resources and investment to NMBPF4. Its innovation concentrates on the generic drugs - seeking to be the first producer in China of new generic drugs. There are several products that obtained approvals in recent few years. Innovative drugs are not the R&D focus. The main aim of this company at this stage is to make profits rather than seek indigenous innovation. Sales income has kept growing. In 2019, it reached 700 million yuan. R&D investment accounts for about 4% of the sales income. Most R&D expenditure has been invested in those projects that are assumed to have returns in the short term. From 2017 to 2019, this company applied 6 pieces of invention patents.

NMBPF5

Established in 2012, NMBPF5 is a biotech company focusing on the innovation and manufacturing of animal drugs. It has a longer historical legacy and is not a private-owned firm. Major products are animal hormones for fishery and veterinary use, and marine health products. It has 215 employees with around 20% of them being R&D staff. Besides maintaining a large internal department, it appointed several top scientists in the fields of animal science and drug research as the external consultants.

Since the development, it maintains a growing momentum and received venture capital investment in recent years. It focuses on establishing stable collaboration with large customers and expanding the customer groups. Besides increasing the market share of the existing products, it is a proactive innovator. By participating in S&T projects, it seeks new opportunities for technological development and has achieved some breakthroughs. Its sales income was nearly 300 million yuan. Each year, about 10% of the sales revenue has been invested in R&D activities. From 2017 to 2019, 27 pieces of invention patents were applied by this company.

NMBPF6

Established in 2003, NMBPF6 is a large, private-owned and listed biotech company in Ningbo. The main products of this company include the diagnostic preparations and products. Marin-related products (mainly by using marine materials) are new product lines of this company. There are nearly 1100 employees in this company. The size of the internal R&D group is large for a company on such a scale and has been growing. Currently, there are about 300 R&D employees within this company. It also set up R&D centres in other cities in China and in the US.

NMBPF6 aims to be the leader in the diagnostic preparation industry. Beside keeping diversifying the existing product lines, it seeks new business opportunities by investing in marine innovation. It has undertaken several national-level marine S&T projects aiming to apply marine resources to its product innovation. In order to reduce the reliance on material suppliers, investment into the R&D of core materials is one of the key innovation focuses of NMBP6. Furthermore, surrounding the core products, NMBP6 has invested in service innovation aiming to be a provider of diagnostic services. Motivated by the continuous innovation in product development and service, the financial performance of NMBPF6 has kept growing. In 2019, the sales income was over 3 billion yuan. Investment into R&D has accounted for about 3.5% to 4% of the sales revenue. From 2017 to 2019, 33 pieces of invention patents were applied by this company.

NMEF1

Established in 1992, NMEF1 used to be a state-owned firm and has a long historical legacy. After the transformation, it is now a Chinese-foreign joint venture company. It is a marine equipment firm. The main products are ship-used engines at moderate speeds and sets of engines. It has 450 employees with over 70 R&D staff. It set up an internal research institute for R&D only. The kinds of products and the coverage of power are at the leading level.

It is one of the top domestic suppliers of engines in the niche market. The innovation focuses more on modifying the products (e.g., shapes and specificities) based on the existing technologies - diversifying the existing products. Entirely new product development is rare. Due to the poor performance of the shipbuilding firms, the financial performance of NMEF1 - as a key supplier has also been influenced. Over nearly one decade, its sales income has reduced from 2 billion yuan in 2010 to 1 billion yuan in 2019. R&D expenditure accounts for around 4% of the sales income. From 2017 to 2019, 16 new patents were developed by NMEF1. And 9 of them are invention patents.

NMEF2

Established in 2003, NMEF2 is a private-owned company in the marine engineering equipment manufacturing industry. The main products are marine cranes, ship-used lifting equipment, and stainless-steel products for specialised vessels. The technological capabilities are mainly around the specialised vessels-used products.

There are 16 series of main products. It has about 200 employees. The number of pure R&D employees accounts for nearly 10% of the total number of employees.

As a very early domestic manufacturer of the parts for a specific kind of vessel (with high technological intensity and high added value) used for extremely low temperatures, NMF2 fill in the gap of the lack of this kind of product in China. After over 20 years of development, NMEF2 has accumulated rich experiences in innovation and production. As a leading supplier, the innovation of NMEF2 focuses on strengthening the technological capabilities of new energy products and developing new applications for marine engineering equipment. NMEF2 grows quickly in recent years. The sales revenue is over 200 million yuan. Input into R&D accounts for nearly 5% of the sales income. From 2017 to 2019, 38 pieces of patents were applied, including 20 pieces of invention patents.

NMEF3

NMEF3 is a marine instrument manufacturing company. It was founded by a group of oversea returnees from the United States in 2002, based on a world-leading technology of oil and gas separation and water treatment. It is a provider of oil and gas equipment and also provides services associated with its core products and technologies. The main products include water content analysers, separation modules, water treatment modules, etc. Its core R&D team are PhDs graduated from top US universities. It once participated in the 863 project and earned the marine engineering S&T award.

It has strong capabilities and rich experiences in product design and the total solution of product manufacturing. Because of the different application scenarios, innovation in the products and technologies according to the customer requirements is important. NMEF3 targets high-end customers in overseas markets. However, its development in recent years has been stagnating due to the complicated corporate structures and ownership. The financial and innovation performance was influenced. No new patents (invention patents) have been applied from 2017 to 2019. Most technological innovation concentrates on the improvement of the existing 6 main products. New product development is slow.

NMEF4

Established in 1997, NMEF4 is a leading marine equipment manufacturer in Ningbo. It is a private-owned company. The core products cover fishery-used products (e.g., cage systems) and scientific expedition products and manufacturing, especially the former. It also involves marine engineering equipment and glass fibber shipbuilding, but they are not the main focus compared with fishery products. There are about 180 employees in NMEF4, with over 16% of them being R&D staff. Besides, this company appoints many domestic and foreign professionals as technological consultants.

NMEF4 pursues the innovation-driven development. Besides maintaining the leading position in the fishery-used products and involving in the S&T projects, it expands the R&D to the scientific expedition equipment. The innovation starts from the reverse imitation of imported technologies. On this basis, it accumulates industrial and technological experiences. More focus has been shifted to indigenous innovation. Through collaboration with marine equipment firms and participation in national S&T projects, the capacities of NMEF4 have been enhanced. This company has developed well entering the 2010s. It received venture capital in recent years. The financial performance has kept growing. The annual sales income is over 100 million yuan, reaching 200 million yuan. Investment in R&D accounts for nearly 5.5% of the sales revenue. From 2017 to 2019, 37 pieces of patents were applied by this company. 8 of them are invention patents.

NMEF5

Established in 2016, NMEF5 is a small shipbuilding company. It is privately owned. The main products are boats and high-speed boats in glass fibber, for the fishing use, public service, and pleasure use. There are over 100 employees with 3% of them R&D staff. It faces competition from not only large companies, but also other shipbuilding firms of similar sizes based in other Chinese areas. Therefore, it mainly relies on the local customer base in Zhejiang and is now seeking to reach new customers in nearby regions in southern China.

The innovation of this company mainly concentrates on imitating the boats of foreign brands, especially the Italian and British ones. Internal innovative designing capabilities are restrictive. Besides shipbuilding, it seeks to offer integrated products for customers, for example, by involving the trawls, cold storage, and cover enclosures in their fishing boats, or designing fishing boats targeting different species of marine life. The sales income is below 100 million yuan. 4% was input into R&D - focusing on the applications and improvements of the existing technology. From 2017 to 2019, this company applied 8 pieces of patents. None of them is an invention patent.

NMEF6

NMEF6 is a newly established company. Established in 2018, this small private-owned company is a supplier of undersea cables. The main products include the protection parts for the cables. Key technological capabilities of this company are in the product design based on polyurethane materials. Due to the specificity of undersea cables, maintenance is crucial. Therefore, services are important selling points of NMEF6.

There are just over 10 employees. Alongside the development, the number of employees has kept growing with an annual increase of 20 people in the past few years. However, the R&D team is very small, mainly led by two of the co-founders.

Most innovation of NMEF6 comes from the new applications - to satisfy the customer need. The product design capabilities are core to this firm. Besides maintaining the relationships with core customers, the main task of NMEF6 is to expand the customer groups. It seeks to be a core supplier for the undersea cable manufacturers. It is investing in the R&D of cable materials, but only in the very early stage. From 2017 to 2019 (actually since 2018), this company applied 6 pieces of patents. None of them is an invention patent.

NMEF7

Established in 1998, NMEF7 is a high-tech enterprise. It is a private-owned firm listed on the market. Its marine-oriented development started early in the 2000s when China started the marine economic development. The main products of NMEF7 are subsea cables, including seabed cables, umbilical cables, and marine cables. They are the first several companies in China which have indigenous innovation capabilities in designing subsea cable products. It provides a whole set of systems of intercontinental power transmission based on subsea cable. It now has 1200 employees, most of whom are young people. R&D staff occupy over 20% of the total number of employees. They belong to the internal research institute of this company established only for the R&D aim.

Facing competition in the land cables, NMEF7 is the first several companies in China to start the innovation of subsea cables and enjoys first-mover advantages. It has accumulated rich experiences and expertise and aims to continuously improve the innovation capabilities to satisfy the harsher environments (deeper sea and farther sea areas). Besides, it integrated the products and services and sought to offer integrated solutions to customers. It often participates in national S&T projects. The financial performance of NMEF7 has kept growing from about 2 billion yuan in 2017 to over 3.5 in 2019. The input into R&D was over 3%. From 2017 to 2019, 50 pieces of patents were applied by this company with 24 pieces of invention patents.

E.1. Selected sample firms by sub-sectors and sizes

Firm Case	SMEs	Large companies
Biotech	**5 firms** • *Qingdao*: QMBPF2, QMBPF3, QMBPF6 • *Ningbo*: NMBPF3, NMBPF6	**2 firms** • *Qingdao*: QMBPF1 • *Ningbo*: NMBPF5

Pharmaceutical	**2 firms** • *Qingdao*: QMBPF5, QMBPF8, • *Ningbo*: NMBPF2, NMBPF4	**1 firm** • *Qingdao*: QMBPF9
Chinese medicines	**3 firms** • *Qingdao*: QMBPF4, QMBPF7 • *Ningbo*: NMBPF1	**0 firm**
Machinery	**10 firms** • *Qingdao*: QMEF1, QMEF2, QMEF3, QMEF8, QMEF11 • *Ningbo*: NMEF1, NMEF2, NMEF3, NMEF4, NMEF6	**2 firms** • *Qingdao*: QMEF9, • *Ningbo*: NMEF7
Building of ships and floating structures	**4 firms** • *Qingdao*: QMEF6, QMEF7, QMEF10 • *Ningbo*: NMEF5	**2 firms** • *Qingdao*: QMEF4, QMEF5

Source: author.

E.2. Selected sample firms by ownerships and years of operation

	< 5 years	5-10 years	> 10 years
Private-owned	**3 firms** • **Qingdao**: QMEF8 • **Ningbo**: NMEF5, NMBPF3	**4 firms** • **Qingdao**: QMBPF2, QMEF6 • **Ningbo**: NMEF6, NMBPF6	**13 firms** • **Qingdao**: QMBPF6, QMBPF7 (P-SOEs), QMBPF9 (P-SOEs), QMEF1 (P-SOEs), QMEF2, QMEF9, QMEF10 • **Ningbo**: NMEF2, NMEF4, NMEF7, NMBPF2 (P-SOEs), NMBPF4, NMBPF5
State-owned	**2 firms** • **Qingdao**: QMBPF5, QMEF11	/	**5 firms** • **Qingdao**: QMBPF3, QMBPF4, QMEF4, QMEF5, QMEF7
Foreign owned	/	/	**2 firms** • **Qingdao**: QMBPF8 • **Ningbo**: NMBPF1
Sino-foreign joint venture	**1 firm** • **Qingdao**: QMEF3	/	**3 firms** • **Qingdao**: QMBPF1 (P-SOEs) • **Ningbo**: NMEF1 (P-SOEs), NMEF3

Source: author.

Appendix F. Interview Protocols and Key Questions

F.1. Semi-structured interview protocol - firm interviewees

Background	
History and status	When is the company established? Is there any innovation platform established on the corporate level?
Interviewee	What is your position in the company?
Ownership	What's the ownership structure of this firm
Human resources	How many employees in your company in the last three years respectively? How many employees in R&D in the last three years respectively?
Sales revenue	What is the sales revenue of your company over the last three years respectively? What percentage of revenue have your company spent on R&D during the last three years?
Finance	Where do the firm obtain external finance? How do you evaluate the regional access to finance? Have the company obtained government funds, grants or rewards for innovation in the past three years? - If yes, what is the amount of the government funding company over the last three years respectively? Which level of government are they from?
Products, technology and patents	What are the core products and technology of your company? How is the status and competitiveness of the core products and technology in your company compared with competitors? How many new products do your company introduce in the last three years? Do you have patents? How many patents do your company apply in the last three years? How many invention patents do your company apply in the last three years?
Sources of innovation ideas and technology	What the main sources of innovation ideas? What the main sources of new technology?
Industrial associations	Does your company join any industrial associations? Is it regional- or non-regional-based? What are the benefits for joining the industrial associations?
Perception about the region	
Regional	How do you evaluate the regional environments for innovation

environments	(for example, the supporting infrastructure, and the atmosphere)? How is the regional marine industrial basis? How do you evaluate the region compared with other Chinese marine cities? How do you evaluate the regional industrial and S&T policies? Do you find the policies difficult to implement? How do you evaluate the local UPRIs?
Relational networks with external players	
With equipment (e) and core parts or materials (cp/m) suppliers	<u>Background</u>: What are the main e and cp/m used in your company? Where are the main suppliers of e and cp/m come from? Can you briefly describe them (e.g., the size, ownership, industrial position, etc.)? <u>Establishment of relationships</u>: How do you establish the relationships (direct/indirect channels) with your main suppliers? Is personal relationship critical? How do you make decision in choosing suppliers (e.g., the relative important of price, quality, relationships and experiences, etc.)? <u>Length</u>: How long have you established relationships with your main suppliers? <u>Communication and collaboration</u>: What is the frequency of your communication with your main suppliers? What do you communicate? What and how do you collaborate in the process of innovation or innovation related aspects? What is the intensity or degree of your collaboration in different aspects? - For example, in information exchange, improvement of the supplied products (outbound knowledge flow to suppliers), production, involvement in each other's innovation process, collaboration in new products/technologies, collaboration to improve existing products/technologies (the degree of the input and exchange of resources, e.g., merely information exchange or co-R&D), technology transfer/sharing agreement, and etc. - If you don't collaborate beyond trading (buying-selling, communicating about delivery time), what is the reason? <u>Trust</u>: To what degree do you believe that your main suppliers are trustworthy? To what degree do you believe that they will not harm your benefits in pursuit of their own profits? Do you change suppliers frequently? To what degree will you replace the existing main suppliers if you have access to products and services with higher quality and lower prices?
With customers	<u>Background</u>: Where are the main customers come from? Can you describe your them (e.g., the size, ownership, industrial position,

	etc.)? Establishment of relationships: How do you establish the relationships (direct/indirect channels) with your main customers? Is personal relationship critical? Length: How long have you established relationships with your main customers? Communication and collaboration: What is the frequency of your communication with your main customers? What do you communicate? What and how do you collaborate in the process of innovation or innovation related aspects? What is the intensity or degree of your collaboration in different aspects? - For example, in information exchange, improvement of the existing products (outbound knowledge flow to suppliers), production, involvement in each other's innovation process, collaboration in new products/technologies, collaboration to improve existing products/technologies (the degree of the input and exchange of resources, e.g., merely information exchange or co-R&D), technology transfer/sharing agreement, and etc. - If you don't collaborate beyond trading (buying-selling, communicating about delivery time), what is the reason? Trust: To what degree do you believe that your main customers are trustworthy? To what degree do you believe that your customers stick to their commitment and will not harm your benefits in pursuit of their own profits? To what degree will you be replaced by the existing main customers if they have access to products and services with higher quality and lower prices?
With UPRIs	Do you have collaboration with UPRIs (incl. their agencies)? - If yes Background: Where are the main collaborators come from? Can you briefly describe them (e.g., the agencies, the levels, etc.)? Establishment of relationships: How do you establish the relationships (direct/indirect channels) with your main collaborators? Is personal relationship critical? How do you make decision in choosing collaborators (e.g., the relative important of S&T capabilities, relationships and experiences, etc.)? Length: How long have you established relationships with your main collaborators? Communication and collaboration: What is the frequency of your communication with your main collaborators? What do you communicate? What and how do you collaborate in the process of innovation or innovation related aspects? What is the intensity

	or degree of your collaboration in different aspects? - For example, in information exchange, merely trading-based technical services/consultancy, production, collaboration in new products/technologies, collaboration to improve existing products/technologies (the degree of the input and exchange of resources, e.g., merely information exchange or co-R&D), technology transfer/sharing agreement, training and talent exchange (e.g., recruitment, industrial/research projects targeting undergraduates/postgraduates/post-docs/high-level professions such as academicians), and etc. - If you don't collaborate, what is the reason? <u>Trust</u>: To what degree do you believe that your main collaborators are trustworthy? To what degree do you believe that your collaborators stick to their commitment and will not harm your benefits in pursuit of their own profits? To what degree will you replace the existing university collaborators if they have access to UPRIs in higher levels or stronger capabilities?
With government	<u>With local government:</u> <u>Background</u>: What are the main government agencies that you interact most regarding innovation? Can you briefly describe them (e.g., the departments, functions, etc.)? <u>Communication and collaboration</u>: How do you communicate with the local government agencies (direct/indirect channels)? To what extent, personal relationships with government officials are used? Is industrial association critical? How do you evaluate the efficiency of the communication channels? What is the frequency of your communication? What do you communicate? Will government participate in the corporate decision? What and how do you collaborate in innovation related aspects? What is the intensity or degree of your collaboration in different aspects? - For example, in information exchange, funding, governmental S&T projects, policy dissemination, formulation/implementation of regional policies (If yes, how do you participate? Do the policies reflect your opinions? Are the policies difficult to implement/realise? If no, why don't you participate?), building of industrial associations, production process (equipment, control of pollution, etc.), trading fairs/S&T events, approaching to suppliers/customers/UPRIs, etc. - If you don't collaborate, what is the reason? <u>With higher-level government:</u> Do you have any access (direct/indirect) to communicate higher-

	level government in innovation affairs (e.g., funding, policies, governmental S&T projects, etc.)? How do you react on the higher-level marine industrial and innovation policies?
Others	Do you have other important innovation collaborators? Please specify.

Source: author.

F.2. Semi-structured interview protocol with informants

Government officials

• How do you view and evaluate the regional marine innovation? What are the key competences? What are the shortcomings?
• How do the local government participate in regional marine innovation and industrial development?
• Have the local government provided any supports to local marine innovation, and particularly the firm innovation?
  - If yes, what kinds of support do you offer? How do you implement the support?
  - If no, can you explain the reason?
• How do the local government coordinate with firms in marine innovation and industrial development?
• How do the local government coordinate with relevant organisations in innovation and industrial development?
• How do the local government internally coordinate to influence marine innovation and industrial development?
• How do the local government interact with higher-level governments to influence marine innovation and industrial development?

Financiers

• How do you view and evaluate the regional marine industry?
• How do you evaluate the regional financial environments? How about other financial organisations in the same region and in other Chinese marine cities?
• How do the local financial organisations participate in regional marine innovation and industrial development?
• Have the local financial provided any supports to the innovation of local marine firms?
  - If yes, what kinds of support do you offer? How do you implement the support? Why do you support?
  - If no, can you explain the reason?

Researchers
• How do you view and evaluate the regional marine innovation? • How do you evaluate the regional research environments? How do you compare

your organisation with other research organisations in the same region and in other Chinese marine cities? • How do the local UPRIs participate in regional marine innovation? • Have the local financial provided any supports to the innovation of local marine firms? - If yes, what kinds of support do you offer? How do you implement the support? Why do you support? Can you describe the innovation relationships with the local marine firms? - If no, can you explain the reason?
Business associations
• Are your government affiliated? Do you think business associations represent the government? • What are the functions of the business associations? How do the business associations reflect the corporate interests? How do the business associations participate in regional marine innovation and industrial development? • How do you view and evaluate the regional marine industrial development? What are the key competences? What are the shortcomings? • Have the business associations provided any supports to the innovation of the local marine firms? - If yes, what kinds of support do you offer? How do you implement the support? - If no, can you explain the reason? • How do the business associations coordinate firms in the region? • How do the business associations coordinate with relevant organisations in innovation and industrial development?

Source: author.

MANCHESTER 1824
The University of Manchester

Appendix G. Participant Information Sheet

Participant Information Sheet (PIS)

You are being invited to take part in a research study to understand the regional innovation patterns of marine technology development. Before you decide whether to take part, it is important for you to understand why the research is being conducted and what it will involve. Please take time to read the following information carefully before deciding whether to take part and discuss it with others if you wish. Please ask if there is anything that is not clear or if you would like more information. Thank you for taking the time to read this.

About the research

- **Who will conduct the research?**

Miss Xiaoyu Zhang, Alliance Manchester Business School, The University of Manchester.

This is a joint project funded by the Chinese Scholarship Council and the University of Manchester

- **What is the purpose of the research?**

This research is to explore the views and perspectives of key actors on the development of regional marine innovation and institutions. Actors include, among others, senior corporate executives, business leaders, financiers, government officials and academics. It aims to make explanations for the regional differences in the maritime technology development from the institutional perspectives, which will contribute to the understanding of the innovation in China, and more generally in developing countries. Empirically, it will make up for blanks of innovation literature in the ocean industry in China, which may generate new insights on innovation distinct from those concluded from the empirical evidence of sectors based on land area. It will shed light on the institutional construction in developing countries to support the innovative process and generate implications for policymakers.

- **Will the outcomes of the research be published?**

A doctoral dissertation and journal articles.

Participants will be informed of the findings and the publications.

- **Who has reviewed the research project?**

The project has been reviewed by the Alliance Manchester Business School Ethics Committee.

What would my involvement be?

- **What would I be asked to do if I took part?**

This research is a part of the researcher's PhD project, which aims to understand the technology innovation in marine industry in China, especially the regional differences in the maritime technology development explained from the institutional perspectives.

You will be asked to take part in an interview, which will take place in your working site. You will not be required to take a distant journey which will be safe for you. The duration of the research will usually take place 1 ½ hours to 2 hours interviews from consent to final visit. You will not be required any form of support during the course of their involvement.

- For participants from marine firms,

you will be asked questions about the firm's technological innovation and collaboration with different stakeholders, which is mainly about the extent of these collaborations in the research, development and commercialisation of new technologies and products. Confidential data such as the products and technologies details, financial or business contracts and other secret information will not be collected. No further actions are required after this interview.

- **Will I be compensated for taking part?**

No.

- **What happens if I do not want to take part or if I change my mind?**

It is up to you to decide whether or not to take part.

If you do decide to take part, you will be given this information sheet to keep and will be asked to sign a consent form. If you decide to take part, you are still free to withdraw at any time without giving a reason and without detriment to yourself. However, it will not be possible to remove your data from the project once it has been pseudonymised as we will not be able to identify your specific data. This does not affect your data protection rights.

If you decide not to take part, you do not need to do anything further.

Data Protection and Confidentiality

- **What information will you collect about me?**

In order to participate in this research project, we will need to collect information that could identify you, called "personal identifiable information". Specifically, we will need to collect:

- *Your name and your position in the organisation. Your information will be pseudonymised.*

- **Under what legal basis are you collecting this information?**

We are collecting and storing this personal identifiable information in accordance with data protection law which protect your rights. For this study, the specific reason is that it is "a process necessary for research purposes".

- **What are my rights in relation to the information you will collect about me?**

You have a number of rights under data protection law regarding your personal information. You can request a copy of the information we hold about you.
If you would like to know more about your different rights or the way we use your personal information to ensure we follow the law, please consult our Privacy Notice for Research.

- **Will my participation in the study be confidential and my personal identifiable information be protected?**

    - *Participants will be assigned with specific ID numbers only known to the research team (known as pseudonymised).*
    - *After the fieldwork, your data will be kept fully pseudonymised.*
    - *Data will be collected outside the EU (China) and be held and transferred between China and the UoM during and after the fieldwork through the UoM Research Data Storage Service.*
    - *Data will be stored until the end of this PhD project (for less than 5 years).*
    - *The data will not be shared with any other organisation*

Only the study team at The University of Manchester will have access to your personal information, but they will pseudonymise it as soon as possible. Your name and any other identifying information will be removed and replaced with a random ID number. Only the research team will have access to the key that links this ID number to your personal information. Your consent form and contact details will be retained at UoM Research Data Storage until the end of this PhD project (for less than 5 years) and will not be shared with others.

If sharing data:

When you agree to take part in a research study, the information about you will only be available to the research and the supervisory team. Your information will only be used by the researcher for her PhD project in accordance with The University of Manchester's Research Privacy Notice. It will not be shared with other researchers or organisations.

Your information will be pseudonymised. This information will not identify you and will not be combined with other information in a way that could identify you. The information will only be used for the purpose of research and cannot be used to contact you regarding any other matter.

Potential disclosures:

- If, during the study, we have concerns about your safety or the safety of others, we will inform your family member.
- If, during the study, you disclose information about misconduct/poor practice, we have a professional obligation to report this and will therefore need to inform your employer/professional body.
- If, during the study, you disclose information about any current or future illegal activities, we have a legal obligation to report this and will therefore need to inform the relevant authorities.
- Individuals from the University, the site where the research is taking place and regulatory authorities may need to review the study information for auditing and monitoring purposes or in the event of an incident.

Please also note that individuals from The University of Manchester or regulatory authorities may need to look at the data collected for this study to make sure the project is being carried out as planned. This may involve looking at identifiable data. All individuals involved in auditing and monitoring the study will have a strict duty of confidentiality to you as a research participant.

What if I have a complaint?

- ***Contact details for complaints***

If you have a complaint that you wish to direct to members of the research team, please contact:

Miss Xiaoyu Zhang,

xiaoyu.zhang-8@postgrad.manchester.ac.uk +44 (0) 742 293 7251

If you wish to make a formal complaint to someone independent of the research team or if you are not satisfied with the response you have gained from the researchers in the first instance, then please contact:

The Research Governance and Integrity Officer, Research Office, Christie Building, The University of Manchester, Oxford Road, Manchester, M13 9PL, by emailing: research.complaints@manchester.ac.uk or by telephoning.

If you wish to contact us about your data protection rights, please email dataprotection@manchester.ac.uk or write to The Information Governance Office, Christie Building, The University of Manchester, Oxford Road, M13 9PL at the University and we will guide you through the process of exercising your rights.

You also have a right to complain to the Information Commissioner's Office about complaints relating to your personal identifiable information Tel 0303 123 1113

Contact Details

If you have any queries about the study or if you are interested in taking part, then please contact the researcher(s):

Xiaoyu Zhang, 6.045 Alliance Manchester Business School, Booth Street West, M15 6PB, Manchester, United Kingdom

By email: xiaoyu.zhang-8@postgrad.manchester.ac.uk

By Tel: +44 (0) 7422937251 or +86 15098850718

Appendix H. Interviews with firms and informants

H.1. Distribution of firm interviews

Interview Code	Job Role	Date of Interview	Length of Interview	Firm Case
1st Stage of Interviews	November to December 2019			
I_QMBPF1	Vice President	20/11/2019	2 hours	QMBPF1
I_QMEF1	General Manager	21/11/2019	1 hour	QMEF1
I_QMEF2	Technical Manager	26/11/2019	1 hour	QMEF2
I_QMBPF2	CEO	28/11/2019	2 hours	QMBPF2
I_QMEF3	CEO	02/12/2019	1.5 hours	QMEF3
I_QMEF4	R&D Manager, Accounting Manager	02/12/2019	1 hour	QMEF4
I_QMEF5	Technical Director	02/12/2019	1 hour	QMEF5
I_QMBPF3	Technical Manager	03/12/2019	1.5 hours	QMBPF3
I_QMEF6	Technical Manager	03/12/2019	1 hour	QMEF6
I_QMEF7	General Manager	05/12/2019	1 hour	QMEF7
I_QMBPF4	R&D Director	05/12/2019	1.5 hours	QMBPF4
I_QMEF8	Research Outreach	06/12/2019	1 hour	QMEF8
I_QMEF9	Technical Manager	17/12/2019	1.5 hours	QMEF9
I_QMBPF5	President Assistant, R&D Scientist	17/12/2019	1 hour	QMBPF5
I_QMBPF6	R&D Director	18/12/2019	1 hour	QMBPF6
I_QMBPF7	General Manager	18/12/2019	1 hour	QMBPF7
I_QMBPF8	Vice President	18/12/2019	1 hour	QMBPF8
I_QMBPF9	R&D Manager	23/12/2019	1 hour	QMBPF9
I_QMEF10	Technical Manager	25/12/2019	1.5 hours	QMEF10
I_QMEF11	Technical Manager	26/12/2019	1 hour	QMEF11
2nd Stage of Interviews	July to December 2020			
I_NMEF1	Head of R&D Centre	26/07/2020	1 hour (Telephone)	NMEF1
I_NMEF2	General Manager	27/07/2020	1 hour (Telephone)	NMEF2
I_NMEF3	General Manager	29/11/2020	1 hour	NMEF3
I_NMEF4	Vice President	01/12/2020	1 hour	NMEF4
I_NMEF5	CEO	02/12/2020	1 hour	NMEF5
I_NMEF6	Technical Manager	03/12/2020	1.5 hours	NMEF6
I_NMEF7	Technical Director	04/12/2020	1.5 hours	NMEF7
I_NMBPF1	General Manager	07/12/2020	1 hour	NMBPF1

I_NMBPF2	General Manager	08/12/2020	1.5 hours	NMBPF2
I_NMBPF3	R&D Scientist	08/12/2020	1 hour	NMBPF3
I_NMBPF4	Marketing Manager	10/12/2020	1 hour	NMBPF4
I_NMBPF5	R&D Manager	12/12/2020	1 hour	NMBPF5
I_NMBPF6	General Manager	15/12/2020	1 hour (Telephone)	NMBPF6

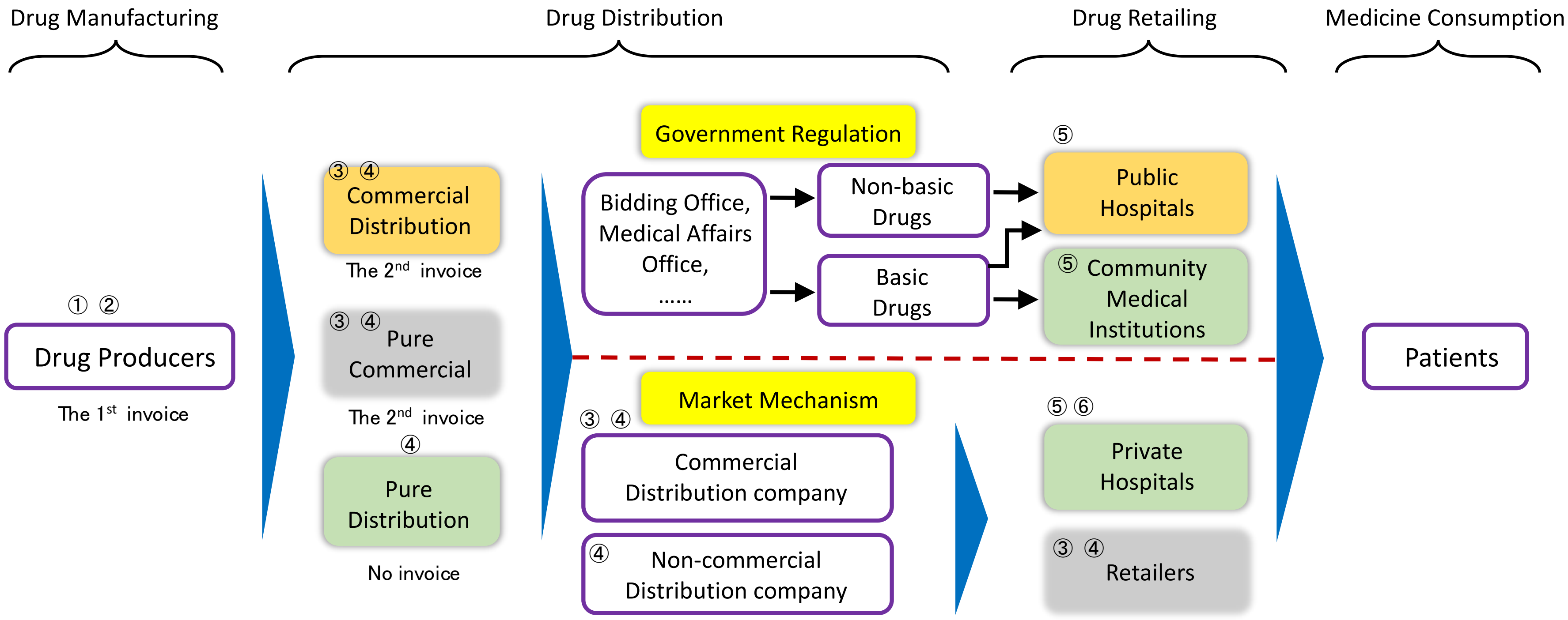
Source: author.

H.2. Distribution of interviews with informants

Interview Code	Identity	Date of Interview	Length of Interview	Organisation
1st Stage of Interviews	November to December 2019			
I_QG1	Government	01/12/2019	1 hour	Qingdao Municipal Bureau of Private Economic Development
I_QA1	Industrial association	06/12/2019	1 hour	Shandong Marine Industrial Association
I_QU1	University	17/12/2019	1.5 hours	Ocean University of China
I_QF1	Financier	17/12/2019	1 hour	Industrial and Commercial Bank of Chain, Qingdao branch
I_QG2	Government	18/12/2019	1 hour	Qingdao Municipal Bureau of Tax
I_QU2	University	25/12/2019	1.5 hours	Qingdao University of Science and Technology
2nd Stage of Interviews	July to December 2020			
I_NU1	University	16/07/2020	1.5 hours (Telephone)	Second Institute of Oceanography, Minister of Natural Resources
I_NF1	Financier	03/12/2020	1 hour	Huarong Securities, Ningbo Branch, Sales Department
I_NF2	Financier	04/12/2020	1 hour (Telephone)	China *Zheshang* (Zhejiang Commercial) Bank, Headquarters
I_NU2	University	08/12/2020	2 hours	Ningbo University

Source: author.

Appendix I. Drug Circulation Process in China



① Permit for Pharmaceutical Manufacturing

② Good Manufacture Practice of Medical Products (GMP)

③ Permit for Pharmaceutical Business Operation

④ Good Supply Practice of Medical Products (GSP)

⑤ Practicing License for a Medical Institution

⑥ Duplicates Business License (For-profit Medical Institutions)

Source: author summarised

Appendix J. Collaborative relationships of individual marine firms in Qingdao and Ningbo

J.1. Interaction between MBPFs in Qingdao and customers

Sample firms	Interaction with customers	
	Relational type	**Contents of their interaction**
QMBPF2 QMBPF3 QMBPF4 QMBPF6 QMBPF7 QMBPF8 QMBPF9	Obligational	Long-term interactive relationships, customer demand reflected by the diseases generates important insights to innovation, feedbacks from customers are essential to the further refinements of the existing products, the interaction is not geographically restricted to Qingdao, but the bridging roles of local UPRIs and the situated Shandong provinces as important customer bases are important.
QMBPF1 QMBPF5	Obligational	Besides the interaction above, they have also built collaboration with customers in joint R&D of new products.

J.2. Interaction between MEFs in Qingdao and customers

Sample firms	Interaction with customers	
	Relational type	**Contents of their interaction**
QMEF2 QMEF3 QMEF4 QMEF6 QMEF7 QMEF8 QMEF10	Obligational	Long-term relationships, interactions in innovation are mainly built upon the existing trading relationships, customer demand on the products is essential to the product design and engineering, frequent commutation with customers to obtain feedback and comments on products in the innovation process, product-related services have been more important, accumulated high-level mutual trust, the interaction is not geographically restricted to Qingdao but depends on the locational advantages provided by Qingdao.
QMEF1 QMEF5 QMEF9 QMEF11	Obligational	Besides the interaction above, they have also built joint R&D collaboration with customers often as a part of the government-funded R&D or S&T projects.

J.3. Interaction between MBPFs in Qingdao and suppliers

Sample firms	Interaction with suppliers	
	Relational type	**Contents of their interaction**
QMBPF4 QMBPF6 QMBPF7 QMBPF8 QMBPF9	Arm's-length	Most marine materials can be satisfied by the local or nearby coastal regions, interaction with most suppliers is not regionally constrained, standardised materials with little room to modify, equipment involves customisation but within the knowledge boundary of the focal firms, long-term trading experiences but contract-based, will not easily change suppliers due to the strict requirements on product revision.
QMBPF1 QMBPF3	Arm's-length (and integrate)	Similar to the above but integrate the supply of key materials - which constitutes their important technological capabilities.
QMBPF2	Obligational	Close interaction with material suppliers which facilitates the suppliers' innovation.
QMBPF5	Obligational	Collaboration in co-R&D, share the risks, benefits and expertise, transcends the simple "customer-supplier" relationships into collaborating alliance.

J.4. Interaction between MEFs in Qingdao and suppliers

Sample firms	Interaction with suppliers	
	Relational type	**Contents of their interaction**
QMEF1 QMEF3 QMEF6 QMEF7 QMEF10	Arm's-length	Contract-based relationships with domestic suppliers, usually stand at weaker positions in trading with large suppliers, trust in competence and contract, choose suppliers according to experiences but will consider replacing suppliers with other cost-effective choices, the relationship is not regionally constrained.
QMEF8	Arm's-length	Similar to the above but integrate the supply of key components.
QMEF4 QMEF5 QMEF11	Arm's-length	Similar to the above but stand at dominant positions as reputational subsidiary companies of the central SOE, use public tendering to approach new suppliers, prefer

		to choose the local supply for some components (have a group of local suppliers live relying on them).
QMEF2	Obligational	Strategic relationships with the core supplier (component), product design relies heavily on the performance of the supplying components, the relationship is not regionally constrained.
QMEF9	Obligational	Close interaction with material suppliers, long-term-oriented collaboration with the assumption that the innovation in the related industry affects its own innovation, the interaction is not geographically restricted to Qingdao.

J.5. Interaction between MBPFs in Qingdao and competitors

Sample firms	Interaction with competitors	
	Relational type	**Contents of their interaction**
QMBPF2 QMBPF3 QMBPF4 QMBPF6 QMBPF7	No collaboration	/
QMBPF1	Obligational	Strategic collaboration with foreign competitors by setting up the joint venture, share intellectual property (IP) and core technologies, involve the long-term and high-level mutual trusts, the interaction is not geographically restricted to Qingdao.
QMBPF5 QMBPF8	Obligational with "so-called" competitors	Close cooperation inherited from the university-firm relationship to develop core technologies and marine medicines, benefit each other's innovation by combining respective advantages, the collaboration is largely regional situated.
QMBPF9	Arm's-length	Short-term, and contractual- and project-based interaction, have collaborative experiences but the interaction is discontinuous, the collaborating partners are from other domestic regions, the interaction is not geographically restricted to Qingdao.

J.6. Interaction between MEFs in Qingdao and competitors

Sample firms	Interaction with competitors	
	Relational type	**Contents of their interaction**
QMEF1 QMEF2 QMEF3 QMEF5 QMEF6 QMEF7 QMEF10 QMEF11	No collaboration	/
QMEF4 QMEF9	Arm's-length	Project-based interaction, usually driven by the customer need to co-develop a new product or project but undertake different tasks, some interaction in the management aspect, the interaction geographically takes place at Qingdao relying on the dock site of this firm.
QMEF8	Obligational	Close and long-term relationship with foreign competitors to develop new products and technologies, establish technology sharing agreement, intensive knowledge exchange about the products, the market, and the technology, the interaction is bridged by the local universities in Qingdao – the place specific benefits.

J.7. Interaction between MBPFs in Qingdao and UPRIs

Sample firms	Interaction with UPRIs	
	Relational type	**Contents of their interaction**
QMBPF1 QMBPF3 QMBPF4 QMBPF5 QMBPF8 QMBPF9	Obligational (Local)	Diverse forms of collaboration ranging from technical services and consultancy to technology transfer and co-R&D, from innovation ideation to training, demonstrate a high-level of mutual trust built upon the long-term collaborative experiences, the interaction is localised bridged by the local government agencies and the personal relationships between the staff within a company and the UPRIs.
QMBPF7	Arm's-length (Local)	Project-based interaction centres on the short-term technical support, strong locally embedded

		feature.
QMBPF2 QMBPF6	Obligational (Non-local)	Similar to the above obligational kind, the choices of non-local collaborators are mainly due to the demand on a particular set of knowledge but the lack of such expertise in Qingdao.

J.8. Interaction between MEFs in Qingdao and UPRIs

Sample firms	Interaction with UPRIs	
	Relational type	**Contents of their interaction**
QMEF1 QMEF2 QMEF3 QMEF4 QMEF7 QMEF8 QMEF9 QMEF11	Obligational (Local)	Diverse form of collaboration ranging from technical services and consultancy to technology transfer and training, co-R&D is not common to all sample firms, the short-term and project-based interactions are embedded in the long-term relationships, demonstrate a high-level of mutual trust, the interaction is localised that are mainly bridged by the local government, the personal relationships, the parent company, and the industrial associations.
QMEF10	Arm's-length (Local)	Discontinuous technical support from the researchers of the local UPRIs.
QMEF5	Obligational (Non-local)	Similar to the obligational kind above, the choice of non-local collaborators is mainly due to the closeness with the brother companies (research institutes within the same group).
QMEF6	Obligational (Non-local)	Similar to the obligational kind above, the choice of non-local collaborators is influenced by the founder's preference.

J.9. Interaction between marine firms in Qingdao and the regional government

Sample firms	Interaction with regional government	
	Relational type	**Contents of their interaction**
QMBPF1 QMBPF3 QMBPF4 QMBPF5 QMBPF7 QMBPF8 QMBPF9	Obligational	Interact closely to obtain information about various kinds of financial schemes, rely on the formal sources to apply for government funds, regional protectionism happens in certain cases, participate in the formulation and implementation of regional policy, react upon the regional call to

		development marine economy and innovation, develop a common vision to build the regional marine cluster and rely on the regional government to forge the regional-based collaboration.
QMEF1 QMEF3 QMEF4 QMEF5 QMEF7 QMEF8 QMEF9 QMEF11	Obligational	Similar to the above, also interact in building the regional supplying base, constructing the industrial facilitates to retain talents.
QMBPF2 QMBPF6	Arm's-length	The innovation projects do not fit in their innovation directions, the available projects are in small amount, limited participation in the regional policies as small firms.
QMEF2 QMEF6 QMEF10	Arm's-length	Fail to meet the criteria of many financial support schemes, views of them as small private firms are not that cared or valued.

J.10. Interaction between MBPFs in Ningbo and customers

Sample firms	Interaction with customers	
	Relational type	**Contents of their interaction**
NMBPF1 NMBPF2 NMBPF3 NMBPF4 NMBPF5 NMBPF6	Obligational	Long-term interactive relationships, customer demand generates important insights to the product innovation, feedbacks from customers are essential to the refinements of the products, the interaction is not geographically restricted to Ningbo, but it is easier for firms to penetrate into the local market.

J.11. Interaction between MEFs in Ningbo and customers

Sample firms	Interaction with customers	
	Relational type	**Contents of their interaction**
NMEF1 NMEF3 NMEF5 NMEF6	Obligational	Long-term relationships and accumulated mutual trusts, interactions in innovation built upon trade, customer demand and feedbacks are essential to the product design and engineering of MEFs, frequent commutation with customers, the

		interaction seldom happens within the regional scope of Ningbo, but the location provides proximity to nearby customers and easier access to overseas ones.
NMEF2 NMEF4 NMEF7	Obligational	Besides the interaction above, they have also built collaboration with customers based upon the government-funded R&D projects.

J.12. Interaction between MBPFs in Ningbo and suppliers

Sample firms	Interaction with suppliers	
	Relational type	**Contents of their interaction**
NMBPF1 NMBPF2 NMBPF3 NMBPF4 NMBPF5	Arm's-length	Long-term trading experiences but contract-based, will not easily change material suppliers, limited interaction with suppliers in innovation-related aspects, limited reliance on the local supply of marine materials, the local supply of APIs and chemical ingredients has been important, core materials and equipment still rely on the import.
NMBPF6	Arm's-length (and integrate)	Similar to the above but integrate the supply of key materials - which constitutes their important technological capabilities.

J.13. Interaction between MEFs in Ningbo and suppliers

Sample firms	Interaction with suppliers	
	Relational type	**Contents of their interaction**
NMEF1 NMEF2 NMEF3 NMEF4 NMEF7	Arm's-length	Contract-based relationships with domestic suppliers, rely on the import of certain core materials and components, interact with suppliers mainly in the delivery time but also in some modifications of the components, some firms have built the supplying pool for the convenience of supplier selection, choose suppliers according to experiences but will consider replacing suppliers with better choices, the local or nearby areas within the same province can meet the basic demand of MEFs on the simple components.
NMEF5 NMEF6	Arm's-length	Similar to the above in most aspects, but usually stand at weaker positions in trading

		with large suppliers, maintain some flexible relationships with suppliers.

J.14. Interaction between MBPFs in Ningbo and competitors

Sample firms	Interaction with competitors	
	Relational type	**Contents of their interaction**
NMBPF1 NMBPF3 NMBPF5 NMBPF6	No collaboration	/
NMBPF4	Obligational	Collaboration based on family relationships with inter-personal trusts, complement each other in different aspects of innovation and production, the interaction is not geographically restricted to Ningbo but within Zhejiang.
NMBPF2	Arm's-length	Short-term, discontinuous, and contractual- and project-based interaction, the collaborating partners are from other domestic regions and the interaction is not geographically restricted to Ningbo.

J.15. Interaction between MEFs in Ningbo and competitors

Sample firms	Interaction with competitors	
	Relational type	**Contents of their interaction**
NMEF2 NMEF3 NMEF4 NMEF5 NMEF7	No collaboration	/
NMEF1 NMEF6	Obligational	Collaboration based on personal relationships with inter-personal trusts, introduce customers to each other (NMEF1) or collaborate to strive for new customers and co-conduct innovation or production (NMEF6), the interaction is geographically restricted to Ningbo.

J.16. Interaction between MBPFs in Ningbo and UPRIs

Sample firms	Interaction with UPRIs	
	Relational type	**Contents of their interaction**
NMBPF3	Obligational	Diverse form of collaboration but highlight

NMBPF5 NMBPF7	(Non-local)	the importance of co-R&D and postgraduate training, demonstrate a high-level of mutual trust built upon the long-term collaborative experiences, treat non-local UPRIs as better choices than the local ones, the interaction bridged by the personal relationships between the staff or the founder within a company and the UPRIs.
NMBPF1	Arm's-length (Non-local)	Project-based interaction with non-local UPRIs in the short-term technical services.
NMBPF2 NMBPF4	Arm's-length (Local)	Project-based and locally embedded interaction centres on the short-term technical services and consultancy.

J.17. Interaction between MEFs in Ningbo and UPRIs

Sample firms	Interaction with UPRIs	
	Relational type	**Contents of their interaction**
NMEF1 NMEF4 NMEF7	Mixed arm's-length and obligational (Non-local)	Distinguish different kinds of relationships with different organisations, proactive to maintain the co-R&D and high-end talent training collaboration with the high-level universities by which to build long-term networks and talent-based relationships, prefer the non-local UPRIs because of their higher R&D capabilities.
NMEF3	Arm's-length (Non-local)	Project-based interaction with non-local UPRIs on the short-term technical support.
NMEF2	Obligational (Local)	Close interaction with the local collaborators in technical supports and training, open to new opportunities and information exchange, prefer local collaborators because of the easier access and communication.
NMEF5 NMEF6	Arm's-length (Local, but technical schools)	Short-term and discontinuous interaction, centres on production and basic technical issues, the regional technical schools can well enough meet their requirements.

J.18. Interaction between marine firms in Ningbo and the regional government

Sample firms	Interaction with regional government	
	Relational type	**Contents of their interaction**
NMBPF1	Arm's-length	The interaction with the regional government

NMBPF2 NMBPF4 NMBPF5 NMBPF6		centres on specific issues, obtain marine-oriented financial support mainly from the high-level governments, seldom participate in the formulation of regional marine policies (limited in number) or coordinate in constructing the regional industrial atmosphere and the marine clusters.
NMEF1 NMEF2 NMEF3 NMEF4 NMEF5 NMEF6 NMEF7	Arm's-length	Similar to the above, p-SOEs or large firms have some participation in the regional policies that focus on the manufacturing or equipment industry in general will less marine orientation, certain firm mentions (NMEF3) the regional tax support associated to the construction of the Free Trade Zone.
NMBPF3	Obligational	Interact closely with the regional government, especially the district-level agencies, obtain tax benefits as a company brought in Ningbo - a kind of regional protectionism, communicate and interact in the regional marine policies.

Appendix K. Forms and contents of firm-UPRI collaboration in innovation

Forms of collaboration	Flow of knowledge or technology	Contents of collaboration	Collaborating agencies
Innovation ideation	Bidirectional	Unspecific and generalised	Research group, individual researcher
Technical services	From UPRIs to firms	Specific technical issues	Research group, individual researcher
Technical consultancy	From UPRIs to firms	Specific technical issues	Research group, individual researcher
Technology transfer	From UPRIs to firms	Specific, often involve the transfer of intellectual property	Research group, individual researcher, school or university may involve
Joint R&D	Bidirectional	Specific, but involves more sharing of resources and risk	University, school, research group
Talent training and cultivation	Bidirectional	Training-oriented, or R&D-oriented	UPRI, school, research group
Setting up companies or incubators	Bidirectional	Generalised, in-depth, and long-term oriented	UPRI, school

Source: author.