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Chemical Cluster Performance in Shanghai-Ningbo Port Delta

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Abstract *–Seaport is a cluster of port-related economic activities. This paper focuses on the production activity of the chemical industry in a port cluster. SCIP and NPETD are two chemical clusters located in Shanghai and Ningbo port delta. The results suggest that SCIP and NPETD perform differently on cluster structure and cluster governance. SCIP performs greater than NPETD on the quality of labor pool, on the diversity of the cluster population, and on the quality of internationalization regime. On the other hand, NPETD only performs greater than SCIP on the diversity of patents. SCIP and NPETD both perform poorly on the presence of trust in the clusters. The performance on quality of innovation regime cannot be ranked. They both perform well on innovation regime. Cooperation between SCIP and NPETD is a good strategy to improve the performance of the cluster. The cooperation could create some synergies, such as a high-quality shared labor pool, higher diversity of cluster population, and information and knowledge resource, complemented innovation regimes, and greater international cluster environment. Nevertheless, it is essential for SCIP and NPETD to increase the level of trust in the deltar. Otherwise, it would be difficult to achieve such synergies.*

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1. Introduction

1.1 Background

Competition between seaports takes place at different geographical levels, including competition between port-rages, competition between ports in the same range and competition between operators in the same port (Goss, 1990A). Competition between port-ranges is relatively limited, whereas competition within the range or port appears usually. European ports compete for one economic hinterland, which is the European common market (Parker, 1999). The fierce competition between Hamburg - Le Havree port range is a good example given to illustrate the inter-port competition in European market. The competition between the neighboring container ports of Shanghai and Ningbo in China is also an example showing the port competition within the range, while they are serving the common Chinese mainland market. In order win in the competition, measuring port performance becomes an important approach to provide management information for port planning and control (UNCTAD, 1976). To collecting information to maintain port performance indicators can be used to improve port operations and provide an appropriate basis for planning future port development (United Nations Conference on Trade and Development). Therefore, measuring port performance is considered as an essential approach to help improve the competitiveness of ports.

Seaports are not just transport nodes, but can be seen as regional clusters of economic activities (De Langen, 2004[a]). Shortly, seaports are regarded as concentrations of economic activities, where cargo handling, logistics and port related manufacturing takes place (De Langen et al., 2007). De Langen et al. (2007) clarified the port performance indictors according to the three different port products, namely the cargo transfer product, the logistics product and the port manufacturing products. The geographical scope of competition differs between these three port products. The competition for cargo transfer exists between ports in the proximity, whereas the competition for logistics products exists between logistics zones either in port or in inland distribution centers; in addition, port manufacturing competes with other sites for manufacturing activities (De Langen et al., 2007).

Due to the continued economic development in the hinterland, the demand for port services in China is growing. Increasing number of China's ports become the most important ports in the world. There are 7 ports out of the 10 largest tonnage ports worldwide that are Chinese (AAPA World Port Ranking 2011). China's port system geographically is composed of three port ranges: the northern range of Bohai Rim, the central range centered on Yangtze River Delta, and the southern range with a cluster of ports in the Pearl River Delta (Figure 1).

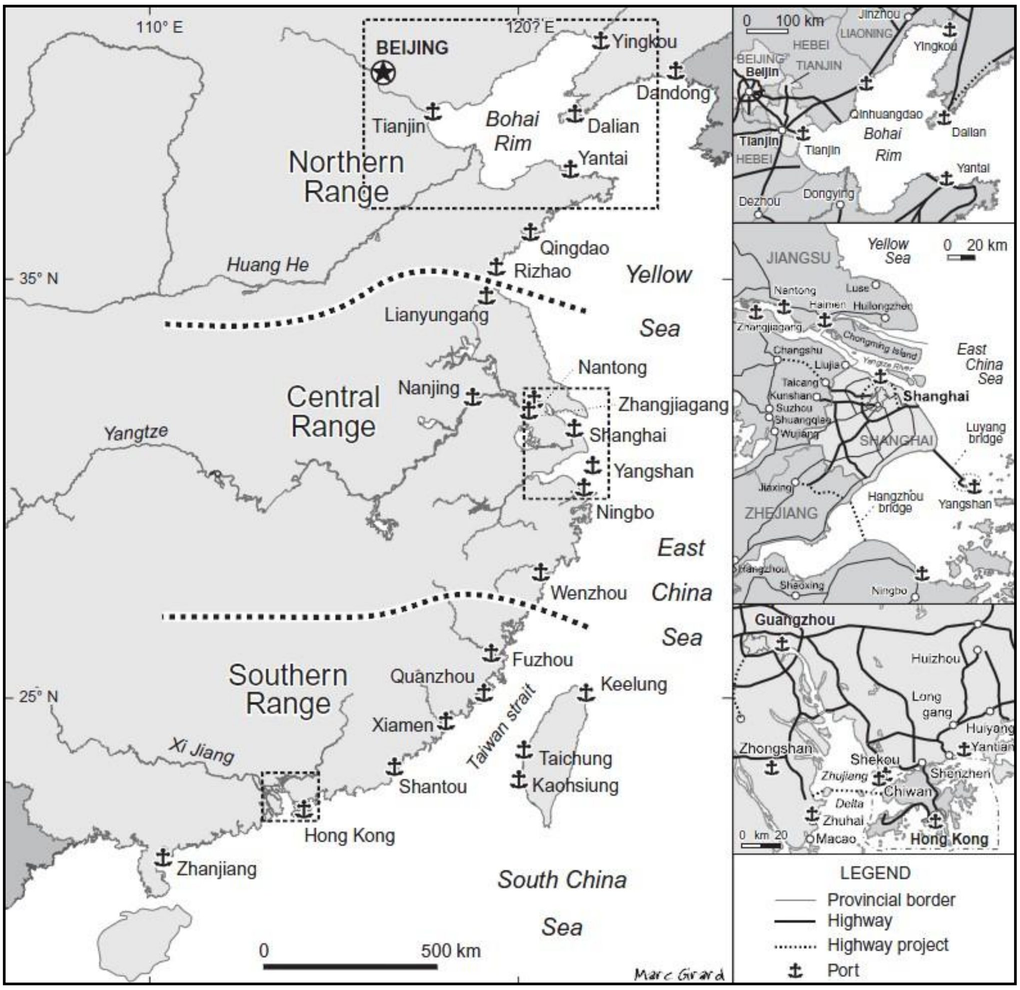


Figure 1: Three port ranges in China's port system. *Source: Comtois and Dong, 2007*

The Yangtze River flows along the municipalities of Shanghai and Chongqing and seven Chinese provinces; and the municipalities and provinces together produce about 40 per cent of total GDP of China (Notteboom, 2012). In Yangtze River Delta, there are mainly fiver ports, namely the port of Shanghai, Ningbo, Suzhou/Changzhou, Nanjing and Nantong (Figure 2). The port of Shanghai and Ningbo are the two largest in the delta. The other ports in the delta take the role of inland port. The port of Shanghai and Ningbo located in Yangtze River delta both offer the cargo transfer, logistics and port manufacturing products. The competition in attracting cargo between the port of Shanghai and Ningbo is fierce. Both of them play the role of global transit hub, which means that most of the containers from the inland port are consolidated at the port of Shanghai and Ningbo and then transported to the destinations. In addition, the hinterland of container distribution is overlapping (Comtois and Dong, 2007; Cullinane et al., 2005). In short, the port of Shanghai and Ningbo compete with each other in cargo transfer and logistics products.

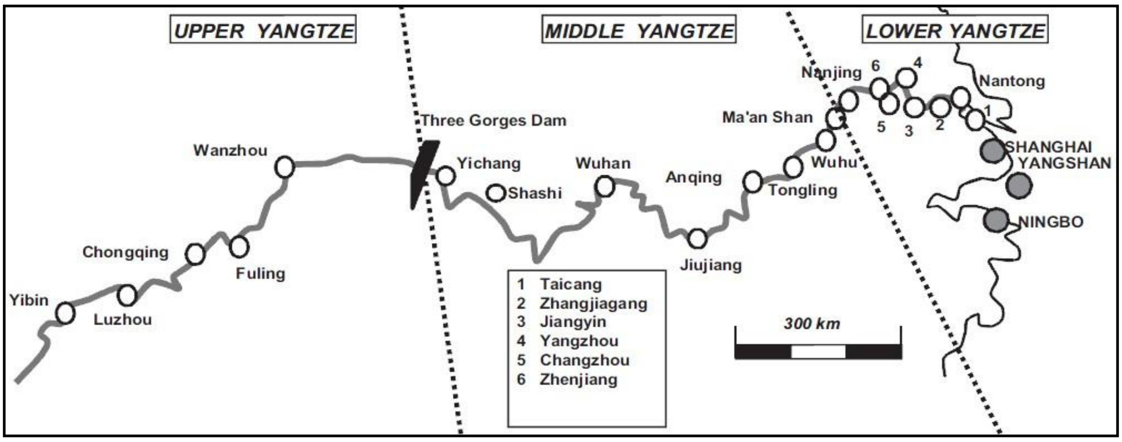


Figure 2: The main ports along the Yangtze River Delta. *Source: Notteboom 2012*

Also, the manufacturing activities, such as agro-food production, chemical industry, petrochemical industry, and so on, take place in the port of Shanghai and Ningbo. To certain extent, the competition exists between the different manufacturing sites (De Langen et al., 2007). However, the chemical industry in Shanghai and Ningbo are highly different. The differences lie in the business model, industry structure and focuses on products of the port manufacturing (Zeng and Bathelt, 2011). Shanghai chemical industry is foreign investment oriented; mainly joint venture firms and wholly foreign owned enterprises locate in this area; the products focus on petrochemicals, organic chemicals and downstream processing. Differently, the chemical industry in Ningbo is market- and cost-efficient oriented; mostly local private enterprises lead the development of the chemical industry; the product focus relies on mixture of specialty chemicals and organic chemicals. In order to meet the demand from the chemical industry, Shanghai port has built and is planning to build a batch of special purpose terminals for oil and chemicals (Pacific Ports Clean Air Collaborative). Additionally in Ningbo port, 8 dedicated chemical berths and 5 transshipment bases for oil and chemicals have been completed and will be completed and put into operation (Ningbo Port).

1.2 Problem statement

In general, the motivations of a cluster are low transport costs, a shared labor pool, a specialized set of supplies, and existence of demand and knowledge spillover (Porter, 1998; Porter, 2000; De Langen, 2004[b]). Therefore, an ideal location for concentration of related economic activities is necessary to fulfill these advantages. A port is a good location to provide these conditions. In addition, port is a popular place for chemical industry, since port can offer the specific cargo handling facilities and specific storage facilities. Therefore, Shanghai port and Ningbo port have the important competitive advantages for this delta to develop the chemical cluster in the region. Increased support and investment have been given for the development of new chemical cluster in the Yangtze River delta (Zeng and Bathelt, 2011). The formation of the chemical cluster brings out the interests on the performance of the cluster.

On the other hand, in order to foster the chemical industry development in other parts of China and reduce the financial incentives for foreign direct investment in the coastal areas, the central government reduced its financial support for further investment in chemical industry in the Yangtze River delta (Zeng and Bathelt, 2011). Thus, Shanghai-Ningbo port delta is faced up with challenges to further accelerate the chemical cluster development. Undoubtedly, port plays an important role for the delta development, since it provides advantages in lower transport costs, specific facilities and logistics services, pooled supplies and demand that other regions in China may not be able to provide.

There are already numerous research papers (Comtois and Dong; 2007, Cullinane et al., 2005; Feng et al., 2012) that only focus on the container competition between the port of Shanghai and Ningbo and the port performance indicator on container handling. However, additional research is needed to explore more precisely the performance of those two ports on the chemical industry. Currently, they strategically plan to form a chemical cluster to further stimulate the chemical industry development in Yangtze River Delta, while the central government reduced financial support. Hence, this research paper aims at concentrating on the chemical sector and addressing the following question:

What is the performance of the chemical cluster in Shanghai-Ningbo port delta?

1.3 Research aim and Sub-questions

The aim of this paper is to measure the performance of the chemical cluster in the Shanghai-Ningbo port delta. In order to address this question, 3 sub-questions are developed:

1. What are relevant Performance Indicators to measure the economic performance of chemical industry in a port cluster?

2. What is the relevant chemical cluster population in Shanghai-Ningbo port delta?

3. What is the chemical cluster performance of Shanghai-Ningbo port delta, according to the selected performance indicator?

1.4 Data and methodology

This paper is designed to evaluate the chemical cluster performance in the Shanghai-Ningbo port delta. In order to reach this objective, qualitative approaches and quantitative approaches are used and combined in this paper.

First, the output of qualitative approaches is used as input to quantitative approaches. Secondary research (desk research) is an important qualitative approach that is used in this paper. Secondary research is an efficient way of collecting relevant information from existing research. The synthesis of existing research can provide the framework to the empirical research. This paper is aimed at exploring relevant performance indicator for chemical clusters. The qualitative data, namely the output of secondary research, provide evidence to quantitative models by inclusion of performance indicators created from quantified experts judgments. We use such an approach for models providing support to decision-making on the selection of relevant performance indicators and discuss how those performance indicators affect the cluster performance. In short, qualitative approaches are mainly used for answering the first sub-question, in order to build the framework for the empirical research.

Second, quantitative approaches are mainly used for solving the second and the third sub-questions. Quantitative data is collected in numerical forms such as statistics and percentage in this paper. The main sources of quantitative data are from the website of relevant organization and the public database. The cluster population will be defined based on the statistics of cluster tenants. The official websites of the investigated clusters are important sources of quantitative data. Additionally, the public website, such as China Commodity Net, Shanghai Bureau of Statistics and Ningbo Bureau of Statistics, is widely used in this paper for data collection. Shanghai Statistical Yearbook, Ningbo Statistical Yearbook and Patent Search and Service System of SIPO are three public databases, which are used as well. The quantitative data provides us a powerful instrument to assess the performance indicators. In other words, the cluster performance will be measured by a series of quantitative data. Quantitative approaches offer strong empirical evidence that leads to the results.

In sum, qualitative method identifies the relevant performance indicators and provides additional evidence for the quantitative model. The qualitative method provide evidence for the research framework. The quantitative method is used to define the cluster population and measure cluster performance indicators according to the output of qualitative method. The results of quantitative research will lead to conclusions and feed into further research.

1.5 Outline

The paper will be structured on a logical way. Firstly, the first sub-question will be solved. Chapter 2 will review the relevant literatures and build a theoretical background for the relevant performance indicators. This chapter provides the framework for the next chapters. Secondly, the cluster population will be defined in Chapter 3. This will answer the second sub-question. The cluster population defined will establish the scope of the research. The empirical research will only be developed within the scope, namely the cluster population. Thirdly, Chapter 4 will describe the results of the cluster performance. This chapter will give the answer to the third sub-question. This chapter will evaluate the selected relevant cluster performance indicators. Finally, we will draw a conclusion on the results of the cluster performance in Chapter 5. Some suggestions and further research will be given in this chapter.

2. Literature Review

Literature study must be done to construct framework for the empirical research. In this chapter, three issues will be studied, namely port performance measurement, port cluster and port performance indicators of the chemical industrial cluster. First, the objective and method of port performance measurement are briefly discussed in section 2.1. Second, port as a cluster perspective is analyzed in section 2.2. Finally, section 2.3 describes the performance indicators from the perspectives of port cluster and chemical industry in more detail. As noted above, the first sub-question is addressed in this chapter. The relevant indicators are found to represent the performance of the chemical cluster of Shanghai-Ningbo port delta. This is the starting point for the analysis in Chapter 3 and 4.

2.1Port Performance Measurement

Port performance is seen as background initiatives or important information for port governance and management (UNCTAD, 1976; Brooks and Pallis, 2008).The traditional way to measure port performance is to compare actual throughput with optimum throughput. However, the port function is more than cargo handling and port products are various (De Langen et al., 2007). Measuring port performance only on cargo handling is a one-sided view. Port performance should be measured to a full extent (De Langen, 2004[a]).

2.1.1 Port Performance and Port Management

The major objective for measuring port performance is to provide management information for planning and control (UNCTAD, 1976). However, control of a process or an operation is only feasibly if there is feedback of performance. Research of UNCTAD (1976) determined two control systems: open loop control system (Figure 3) and closed loop control system (Figure 4). The first is without feedback, whereas the latter is with feedback loop. Different open loop control system, closed loop control system illustrates that management firstly identifies the part of the operation that is holding down productivity and then improves it. In the case of an open loop control system, feedback occurs only when actual productivity is poor (UNCTAD, 1976). As a result, plan and control becomes more difficult in open loop control system. Therefore, measuring port performance is a necessary process to realize the weakness of the port, address the problems and then improve the port performance in productivity and efficiency. It has been noted that an image of poor port performance affects both the port's market position and the port users who have to invest additional capital in their business to cope with such inefficiency (Marlow and Casaca, 2003).

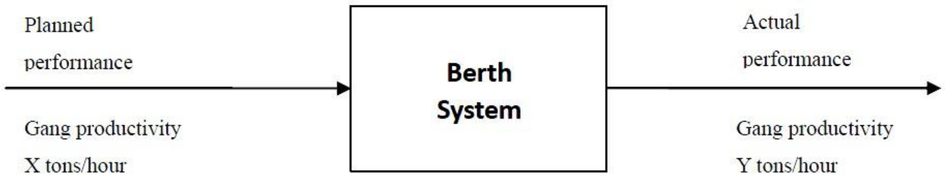


Figure 3: Open loop control system *Source: UNCTAD, 1976*

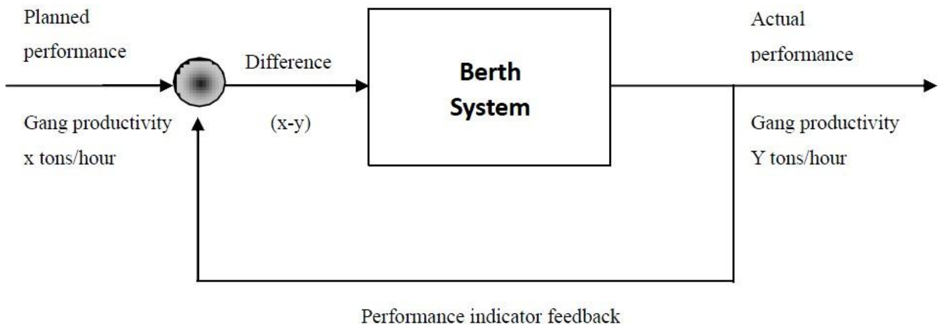


Figure 4: Closed loop control system *Source: UNCTAD, 1976*

A more extensive discussion of port performance and port management is available in Brooks and Pallis (2008). They have discussed the process of port governance in depth and the role of port performance in the process. The observed process is shown in Figure 5. Within the process, port performance is taking the role of providing background initiatives for governance decisions, such as port policy. After implementing the new port policy or strategy, the output reflects on port performance that will provide information for port reform again. Port performance has been seen as an indispensable practice in port management for planning and control (UNCTAD, 1976, Brooks and Pallis, 2008).

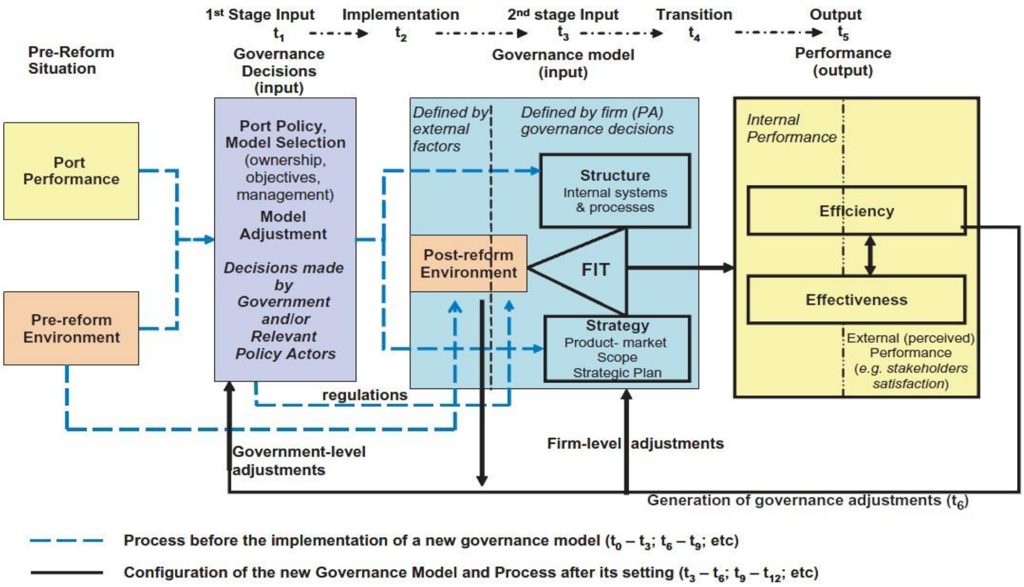


Figure 5: Linking governance and performance *source: Brooks and Pallis (2008)*

Brooks and Pallis (2008) define the port performance composed of efficiency and effectiveness. Efficiency performance measures relate to the physical quantities of items, level of effort expended, scale or scope of activities and the efficiency in converting resources into some kind of product or service (Brooks and Pallis, 2008). Effectiveness performance measurement is related to the quality of service provided to port users, where user satisfaction is one of the critical performance indicators (Brooks and Pallis, 2008). Also Marlow and Casaca (2003) state the importance of qualitative performance measures adding to quantitative measures. Efficiency may be absolute and then measurable, while effectiveness is measured relative to the objectives (Brooks and Pallis, 2008). However, many studies found the difficulties to fully examine effectiveness (Tongzon, 1995; Brooks and Pallis, 2008; Feng et al., 2012). The results of port efficiency and effectiveness, consequently, influence port governance decisions.

2.1.2 Port Performance Evaluation

Traditionally, the performance of ports has been evaluated by comparing actual throughput with its optimum throughput for a specific time period (Talley, 1994). Talley (2006) adds that port performance can be evaluated from the standpoint of technical efficiency, cost efficiency, and effectiveness by comparing the port's actual throughput with its economic technical efficient, cost efficient and effectiveness optimum throughput, respectively. Hereby, ports have generally taken the engineering optimum throughput, which means the maximum throughput that can be physically handled by the port under certain conditions (Talley, 1994). This approach is inconsistent with that of De Langen et al. (2007). De Langen et al. (2007) remark that throughput volume is just one of port performance indicators used in port industry. Throughput volume cannot reflect the economic impact of the port and the attractiveness of the port as a location for port-related industries. Moreover as De Langen et al. (2007) notes, 'ports have developed into clusters of economic activities, where cargo handling, logistics and port related manufacturing take place.' Throughput volume only indicates port performance on cargo handling product. The traditional method of port performance measurement does not show port performance to a full extent.

There is an alternative methodology that makes use of port performance indicators (Talley, 2006). Port performance indicators are choice variables whose values are under the control of port management and optimize the economic objective (UNCTAD, 1976; Talley, 2006). The methodology of performance indicators is implemented in many recent studies. In the research of Feng et al. (2012), the methodology of performance indicators are also used to measure the port performance of a western European port and a China's port. By comparison, they find each port has so bad or good performance in the different aspects that give implications to the port management and development. Monteiro (2010) adopted several port performance indicators to measure the efficiency of the major ports of India, by taking use of Data Envelopment Analysis. Furthermore, Brooks et al., (2011) defines several performance evaluation criteria (PPI) and measures the port effectiveness by the method of survey. Different port performance indicators are widely used by researchers to measure port performance; and it shows that the results of port performance have implications for port governance (Monteiro, 2010; Brooks et al., 2011; Feng et al., 2012).

2.2 Port as a cluster perspective

Cluster is a concept that often appears in spatial economics. Nowadays, it is also frequently used in the study of port industry. What is a cluster? What is a seaport cluster? Why measuring port performance from a cluster perspective? Those are the three questions that will be addressed in this section. Porter is one of the most important researchers who developed the cluster concept. And De Langen (2004[b]) is one of the first scholars that applied the cluster concept to seaports.

2.2.1 Review of Cluster Concept

Clusters have been widely studied and the literature offers different definitions of cluster performance. Porter (2000) defines that clusters are geographical concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions in a particular field that compete but also cooperate. Clusters attract many researchers' attention, because they are critical to competition (Porter, 1998). Clusters affect competition by increasing the productivity of companies based in the area, by increasing the capacity of cluster participants for innovation and productivity growth, and by stimulating the formation of new business, which expands and strengthens the cluster itself (Porter, 1998; Porter, 2000). Meanwhile, many scholars treat the concentration of firms in terms of agglomeration economics. Marshall (1920) highlights the three main agglomeration economies, namely as shared labor market, the presence of customers and suppliers within a cluster, and knowledge spillovers. The advantages of cluster do not only increase the competitiveness of the cluster itself, but also accelerate the regional economic development.

Widely viewed, regional economic growth is related with industry clusters in the region (Romanelli and Khessina, 2005; Balazs et al., 2010). Balazs et al. (2010) find the evidence from Hungarian firms that industrial concentration has a significant positive impact on production growth and it drives up the regional development.

Romanelli and Khessina (2005) agree with the positive influence of cluster on regional economic development. The development of cluster will accelerate the development of relevant clusters in the region. For example, Silicon Valley was the semiconductor cluster and over time became related to computer, biotechnology, bioinformatics and nanotechnology clusters.

2.2.2 Review of Seaport Clusters

As introduced, Seaports are not just transport nodes, but can be seen as regional clusters of economic activities (De Langen, 2004[a]).Mainly, cargo handling, logistics and port related manufacturing activities take place in the port area (De Langen et al., 2007). Relating to the theory of Romanelli and Khessina (2005), port can be seen as the region with a dominant cluster that is related to other clusters. Cargo handling cluster is the dominant cluster and logistics cluster and manufacturing cluster are the related clusters in the port area (De Langen, 2004[a]; De Langen, 2004[b]). Overall, seaports are regarded as concentrations of economic activity related to the arrival and services of ships and cargoes at ports (De Langen, 2004[b]). Moreover, the study of DeLangen (2004[b]) explicitly explains how to construct a port cluster.[1]

The economics activities in port clusters often involve cargo handling activities, transport activities, logistics activities, specific production activities and specific trade activities (De Langen, 2004[a]; De Langen, 2004[b]). Cargo handling is considered as a cluster core; and the other activities are strongly linked to cargo handling activities (De Langen, 2004[a]; De Langen, 2004[b]). Nevertheless, the cluster core in following research would be chemical industry, namely the production activities. The non-business organizations play important roles in port cluster as well. For instance, port authority takes the role of cluster manager, who is able to generate benefits for the whole cluster (Baccelli et al., 2008). De Langen (2004[b]) makes a list of all

1There are four steps to construct clusters (De Langen, 2004): 1)select an economic specialization and a roughly defined region for which the cluster analysis will be made; 2) identify economic activities and non-business organizations included in the cluster; 3) define the relevant region for the cluster; 4)identify the cluster population, consisting of business units, associations and public (-private) organizations that are both relatively strongly linked to the cluster core and located in the relevant cluster region.

activities in port clusters, as shown in Table 1. Any organization in those activities should be involved in a cluster population. Chapter 3 will define the port cluster population in chemical industry, located in Shanghai and Ningbo.

Table 1: port cluster activities	
Cargo handling activities	TOCs; specific stevedoring supplies; rail terminals; towage, pilotage and mooring; port engineering
Transport activities	Shipping companies; transport companies; ship agents; forwarding agents; maritime service provider; transport service providers; ship repair; ship finance and insurance companies
Logistics activities	Logistics service provider; warehouse operator; logistics consultants and ICT firms
Production activities	Production firms using commodities as resources; specialized suppliers of production activities
Trade activities	Commodity traders; port related trade agents; commodity auctions
Associations	Branch organizationfor firms in the port cluster; business associations for TOCS, survey companies, inland shipping companies, container repair companies, cargo agents and container shipping companies; marketing and acquisition body organizes joint promotion programs; export promotion association
Public-private organizations	Knowledge dissemination organization; organization encourage sustainable production and transport; labor pool
public organizations	Educational organizations; pilotage; landlord function; port management; traffic control; customs

Clusters generate a series of advantages for the participants within the cluster (Porter, 2000). The performance of the port can only be measured fully when taking the embeddedness of participants into account (De Langen, 2004[4]). Seaport performance is analyzed with a cluster perspective, which will also include and illustrate the force of agglomeration. The fact is that the economic activities concentrating in the port area obtains various benefits from the behavior of agglomeration. And some activities choose to locate in the port areas, partly because the numerous advantages of the location (Porter, 1998; Porter, 2000). The actors in a port cluster can benefit the low transport costs and a specialized set of supplies. To illustrate this point, three examples are given. Firstly, Grace Davison, a US petrochemical firm, can reduces its costs while simultaneously increasing quality, reducing lead-time, and reducing raw material inventory, if Grace Davison outsources two raw-material to a co-located firm (Patti, 2006). Secondly, Antwerp is the largest petrochemical commodities center of

Europe. The backbone of such an impressive petrochemical cluster is the port of Antwerp's 5 refineries and 4 steam crackers (Antwerp, 2003). Thirdly, Singapore is becoming the petrochemical hub of the Asia-Pacific. There are more than 70 chemicals companies locating in Jurong Island within Singapore. One of the advantages to locate in Singapore is the Banyan Logistics Park, which provides integrated chemical logistics support to the companies, making the island a one-stop solution for chemical companies (MPA Singapore). The three cases of port chemical industry illustrate that manufacturers are beneficial from various advantages created by port clusters. Hence, to measure port performance in terms of cluster will be a more appropriate concept, since the fact of interconnection and interdependency between actors within the port areas also influences the port performance.

2.3 Port performance indicators from the cluster perspective

In this section, we focus on determining the relevant indicators to measure port performance from the port cluster perspective and chemical industry. De Langen (2004[b]) has sought to analyze the port performance by measuring various performance indicators; and he illustrates that the variables can be classified as either structure variables or governance variables. De Langen (2004[b]) emphasizes that both structure and governance variables influence port performance and cluster and governance of a cluster are interdependent. Structure variables represent the structural characteristics that have influence on port performance. Governance variables represent the behavioral factors that have influence on port performance, where the central behavioral issue is the interactions of firms in the cluster, suggested by De Langen (2004[b]). In other words, structure variables reflect on structural characteristic indicators, while governance variables reflect on indicators that illustrating the interactions of firms in the cluster. Concluded by De Langen (2004[b]), there are four variables related to the cluster structure and four related to the cluster governance. Figure 6 displays the relevant variables as well as the relationships between cluster structure, governance and performance.

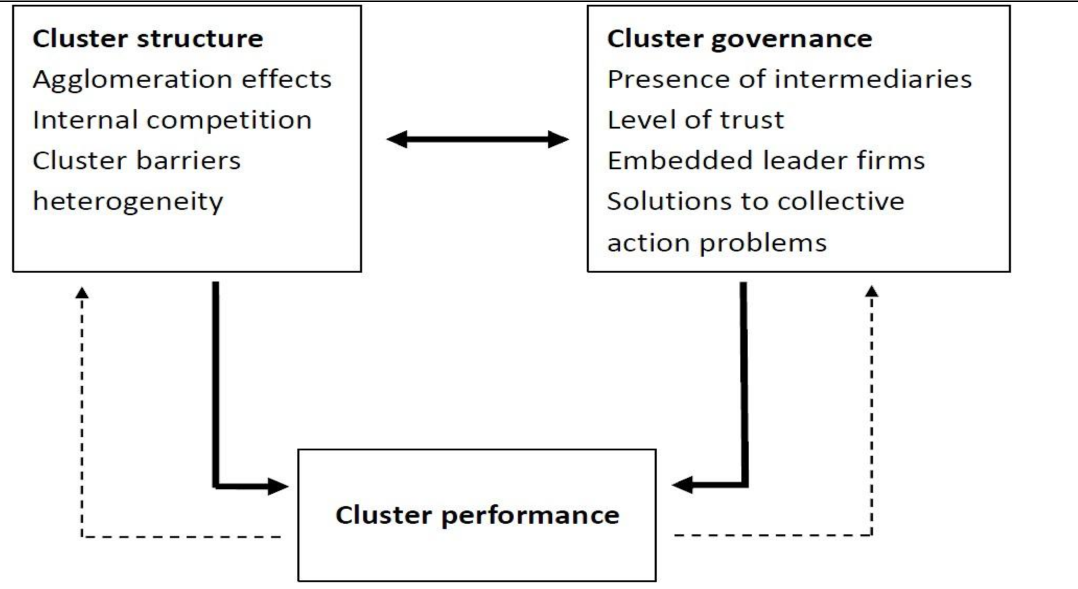


Figure 6: Variables, structure, governance and cluster performance

De Langen (2004[b]) assesses the importance of each variable for the quality of cluster structure and cluster governance. In his research, the importance of structure variable scores from 1 (most important) to 9 (lest important); the importance of governance variable scores from 1(most important) to 4 (lest important). In the following arguments, the variables are selected according to the average score of variables (score of structure variables should be less than 5.5; score of governance variables less than 2.5; see De Langen, 2004[b]).

2.3.1 Agglomeration effects

The first variable related to cluster structure is agglomeration effects. As already indicated, the three important agglomeration economies involve a shared labor market, the presence of customers and suppliers and knowledge spillover (Marshall, 1920; De Langen, 2004[b]). Apart from the three agglomeration economies, De Langen (2004[b]) outlines two agglomeration diseconomies: land scarcity and congestion. However, the research results of De Langen (2004[b]) show that the level of land scarcity and the presence of congestions are two performance indicators that are significantly less important than agglomeration economies indicators. Thus, the two variables of diseconomies are not discussed in this paper. This study focuses on the agglomeration economies.

A shared labor market

Labor is an indispensable input to the productive process of a cluster (Porter, 1990; Padmore and Gibson, 1998). Carpinetti et al. (2007) determine specialized labor force availability and employment opportunities as economic benefits of clusters. Often skilled workers are attracted by employment opportunities of clusters, and those workers already have specialized skills that are essential for the cluster. To give an example of this, Silicon Valley attracts numerous workers with specialized skills of engineering and computer science. As such, search costs to find qualified labor are relatively lower for the firms locating in clusters (De Langen, 2004[b]). Therefore, clusters with a shared labor pool are attractive for firms. The presence of a labor pool is regarded as the most important variable for performance of the cluster (De Langen, 2004[b]).

Great Akron is another example of industrial clusters and its cluster industries involve chemicals (Rebadow, 2006). Rebadow (2006) suggests that labor pool is an important benefit for companies within the Akron's clusters. Within a 50-mile radius of Akron, there are 32 colleges and universities, including four major universities. Thanks to its great amount of higher-educational institutions, the great labor pool in the field of chemical is formed and it is beneficial for chemical-industry clusters. Therefore,the quality of labor pool in chemical clusters of Shanghai-Ningbo port delta could influence the attractiveness and performance of the clusters.

Presence of customers and suppliers

The presence of customers and suppliers is attractive for firms, since 'trade costs' are higher for transactions with firms outside cluster (De Langen, 2004[b]). Porter's diamond model has been studied extensively over the last decades (Porter, 1990; Padmore and Gibson, 1998; De Langen, 2004[b]). The related and supporting industries and market conditions are two elements of cluster performance/competitiveness (Porter, 1990; Padmore and Gibson, 1998). The related and supporting industries deal with local suppliers, while market conditions deal with customers. The composition of the cluster is a key explanatory factor affecting a cluster's overall success (Haussler and Zademach, 2007). The presence of customers and suppliers is characteristic of the cluster composition, so it may have large influence on cluster performance. Besides, the local suppliers facilitate coordination and information exchanges (Porter, 1990). This is the additional benefits that the presence of suppliers creates. Also, the presence of customers and suppliers are regarded as one of the most important elements of cluster performance (De Langen, 2004[b]).

Even though Taiwan's petrochemical industry has not receive so much attention as its technology companies, the chemical industry actually is important and vibrant on the island. Before 1992 there was no basic petrochemical raw material available in Taiwan. The downstream and midstream businesses were reliant on imports (Asiamoney, p. 84). After the presence of Formosa Petrochemical – the only raw material supplier in Taiwan, the whole chemical cluster is bolstered (Asiamoney, p. 84). Its products are mainly transacted inside the chemical cluster in Taiwan. The domestic ethylene production can meet 90% of domestic demand, instead of only 38% before the presence. At downstream and midstream, there are 10 companies in total demanding raw material. Because the costs are lower for customers to purchase raw material directly from the island, the 10 downstream and midstream firms want to buy from Formosa Petrochemical. This guarantees the success and profitability of Formosa Petrochemical, and attracts the investors' interest on Taiwan's chemical industry. This example illustrates that the presence of suppliers and customers improve the industrial performance in the region and then attracts investors/firms to the region.

Knowledge spillover

Clusters create the social environment for knowledge spillover and then prompt innovation (Harrison, 2007). This statement has been supported in several existing research (Audretsch and Feldman, 1996; De Langen, 2004[b]; Carpinetti et al., 2007).

Industries where knowledge spillovers are more prevalent have a greater propensity for innovative activity to cluster (Audretsch and Feldman, 1996). Carpinetti et al. (2007) developed a model that considers four different perspectives of cluster performance and company's performance is one of the perspectives. Firm's innovation capability is one of the aspects of the firm's performance. Furthermore, Li (2000) finds the evidence that supports the positive influence of firm's innovation capability on the firm's overall performance. All in all, knowledge spillovers between firms in cluster prompt innovative activity and the innovative activity improve the cluster performance. Nevertheless, Nijdam (2009) points that chemical companies are poorly connected with other port related companies when it comes to knowledge spillover. Moreover, the overall importance of presence of knowledge scores 5.9 in the study of De Langen (2004[b]), which means this variable is relatively less important. Hence, the variable of presence of knowledge spillover is not selected for the empirical investigation.

2.3.2 *Internal competition*

The second variable related to cluster structure is internal competition. The importance of internal competition has long been recognized (Porter, 1990), because the internal competition in a cluster leads to competitive pressure and then stimulate dynamics and innovation. In the literature study of De Langen (2004[b]), he also recognizes three positive effects of internal competition. First, internal competition prevents monopoly pricing. Second, internal competition leads to specialization. Third, internal competition promotes innovation. De Langen (2004[b]) found evidence that the presence of internal competition contributes to the cluster performance. The importance of this variable has 5.0 scores (see De Langen, 2004[b]). It meets the required criteria, so the presence of internal competition is an important variable for port cluster performance.

Besides, market share could be the indicator to assess the presence of internal competition Market share can be considered as a competitive constraint from the existing competitors. Also, it indicates the dominant position in the relevant market. Under EU Case Law, if the market share is more than 50%, the firm can be presumed at a dominant position; but a firm is unlikely to be individually dominant, if the firm's market share is lower than 40% (*Abuse of dominant position: understanding competition law* 2004). If the firm has a dominant position, it might abuse of the dominant position by imposing unfair trading, prejudice of customers, etc. In other words, the relatively high market share implies the risk of abuse of a dominant position. Therefore, the relevant organization should intervene in the internal competition for preserving a good competition environment.

2.3.3 Cluster barriers

Three types of cluster barriers are determined by De Langen (2004[b]), namely entry barriers, start-up barriers and exit barriers. He makes a distinction between entry barriers and start up barriers. Entry barriers are barriers for firms outside a cluster that intend to establish activities in this cluster (De Langen, 2004[b]). Start-up barriers refer to administrative barriers and the availability of venture capital. De Langen (2004[b]) indicates that entry, start-up and exit barriers reduce cluster performance. However, compared to other structure variables, cluster barriers are relatively less important on cluster performance. Particularly, the level of exit barriers is the least important (See De Langen, 2004[b]). The cluster barriers are not discussed in detail in this study and they are not selected in the following empirical study.

2.3.4 Cluster heterogeneity

It was pointed out by Padmore and Gibson (1998) that the diversity of local suppliers is a performance indicator of cluster with respect of related and supporting industries in clusters. Padmore and Gibson (1998) suggest that the diversity of local suppliers contribute to cluster performance. This statement is approved in the research of seaport cluster performance (De Langen, 2004[b]). The study indicates that cluster heterogeneity has positive effects on cluster performance (De Langen, 2004[b]). Cluster heterogeneity can reinforce its compression from external shocks, and enhance opportunities for cooperation and innovation. Boston is a good example of cluster heterogeneity. Between 1663 and 2003, Boston experienced three times reinvention (Glaeser, 2005). It becomes a center of information economy, manufacturing and maritime industry. Glaeser (2005) suggests that Boston's success owes much to its diversity. Thanks to Boston's diversity, it has abilities to overcome external shocks, and to create the opportunities for cooperation and innovation (Glaeser, 2005).In short, cluster heterogeneity contributes to cluster performance.

Cluster heterogeneity does not only involve the diversity of cluster population, but also the diversity of cluster resources (De Langen, 2004[b]). The cluster population can be diverse in terms of economic activities, as well as size and products (Glaeser, 2005).Cluster resources can be knowledge, information, labor and raw material. The chemical industry is the one where process development could be kept most proprietary (Lieberman, 1989). It implies that knowledge and innovation also are very important resources in the chemical industry. Due to the development of bio-based chemical industry, the raw materials also become diverse. Diverse resources play important role in the chemical industry. Both of diversity of cluster population and cluster resources are testified as relatively important indicators of cluster performance (De Langen, 2004[b]). Those two variables both are selected in the empirical study of this paper.

2.3.5 <u>Trust</u>

As already indicated, the interactions between individuals within a cluster have influence on cluster performance. Yue (2011) suggests that the interactions are constrained by the level of trust. In clusters where the level of trust is high, there is a tendency among individuals within the cluster to interact and cooperate with each other. In addition, De Langen (2004[b]) suggests that in high trust clusters, transaction costs are relatively low and specific investments for partners are more likely to occur. Also, Liao (2010) finds evidence demonstrating that firms located within clusters with high level of trust can enjoy improved performance. Moreover, Simon and Troblova (2007) think trust is necessary for cluster functioning and development.

De Langen (2004[b]) found that seaports are not high trust clusters, but trust is the most important variable for the quality of the governance of the cluster. Hence, the level of trust is taken as a important performance variable for the empirical research. Becchetti et al. (2013) find the positive effect of membership on trust development. The study suggests that membership induces higher level of trust and trustworthiness (Becchetti et al., 2013). In addition, affiliation-trustworthiness link works only among members, contrary to non-members' expectations. Therefore, membership of relevant associations reflects the presence of trust. The higher the membership rate, the higher the level of trust

2.3.6 *Presence of intermediaries*

The presence of intermediaries is considered to positively affect cluster governance and therefore cluster performance. De Langen (2004[b]) concludes three reasons contributing to the positive effect of intermediaries. First, intermediaries provide a bridge tie between individuals that are not connected partners. Second, intermediaries reduce coordination costs because they 'connect cognitions'. Third, intermediaries can reduce cooperation costs by managing cooperative projects. However, the results of his research show that a relatively large part of respondents do not agree with the positive effect of intermediaries (De Langen, 2004). However, it is recognized that the presence of intermediaries is the least important variable for the quality of cluster governance. The variable of presence of intermediaries is not involved in the empirical part.

2.3.7 *Leader firms*

De Langen (2004[b]) finds that leader firms generate positive external effects for clusters by encouraging innovation, promoting internationalization, and organizing investment in the training and education infrastructure, the innovation infrastructure and the infrastructure for collective action. Furthermore, the presence of leader firms is a relatively important variable for the quality of cluster governance (De Langen, 2004[b]). However, the leader firm impact on the port is not expected in the port chemical industry (Nijdam, 2009). Nijdam (2009) discussed that the main characteristic of leader firms is the creation of external effects by knowledge spillover. As has already been mentioned, chemical companies perform poorly on sharing knowledge with the other port related companies. Therefore, the leading chemical companies are expected to have no leader firm impact on port cluster. For this reason, the presence of leader firm is not investigated in the empirical part.

2.3.8 Collective action regimes

In the research of De Langen (2004[b]), the importance of quality of collective action regimes scores 2.5, which implies this variable is also relatively important for the quality of cluster governance. A collective action problem arises when members are free to choose whether to contribute or not to the provision of the collective benefit. In clusters, a number of collective action problems (CPA's) is present (De Langen, 2004[b]). Some individual firms can be free rider in clusters, who just take advantage of the cooperative efforts of other firms. For this reason, collective action does not develop spontaneously. Besides, collective action problems may be caused by conflicts between individual firms' interest. Within the chemical industry the divergence of interest gives rise to serious collective action problems (Neil, 1995). De Langen (2004[b]) discusses that the performance of cluster where collective action problems are solved is better. Therefore, the collective action regime to solve a specific CAP should be analyzed.

De Langen (2004[b]) developed five potential collective action regimes: hinterland access, training and education, marketing and promotion, internationalization, and innovation. His research results indicate that the five potential collective action regimes are relevant and important in port clusters. Moreover, there is evidence that quality of five collective action regimes have positive effect on cluster performance.

Carpinetti et al. (2007) agree with that the collective actions of companies within clusters can produce external economies and collective efficiency. To develop collective actions will enhance cluster performance. De Langen (2004[b]) suggests the higher the quality of collective action regimes, the better the performance of a cluster.

Quality of innovation regime

First, innovative products may be featured in terms of non-excludable or non-rival (Thomas, 2001). Others may imitate its innovation by learning or information exchange in the cluster. Consequently, the companies within clusters have less incentive to innovate. To create a great innovative environment and to encourage innovation are important for the cluster governance. For instance, the government law for patent protection and financial support for innovation increase the incentives to innovate. All of those effects collectively contribute to the result of innovation. Innovation is widely measured by number of patent. Number of patent is the indicator that could be used to evaluate innovation and then reflects the quality of innovation regime.

Quality of hinterland access regime

Second, improving hinterland access needs collective investment, rather individual benefits, therefore collective action is especially relevant for seaport community (Van der Horst and De Langen, 2008). However, this paper focuses on analyzing the chemical cluster in seaport. For the chemical cluster, hinterland access seems less important. Hence, this variable is not selected for the empirical research.

Quality of internationalization regime

Third, local embeddedness of firms in a cluster may create barriers to internationalization. De Langen (2004[b]) outlines that external networks guarantee that a cluster remains open for new developments. To some extent, the quality of internationalization regime shows the prosperity of new development. If the cluster governance can effective encourage internationalization, the accessibility to external market will be reinforced. In other words, the quality of internationalization regime is higher. The quality of internalization regime could reflect on the internationalization of companies within the cluster. Nijdam (2009) uses the origin of shareholders of companies in the port of Rotterdam to measure the internationalization of the port of Rotterdam. The result shows that the port of Rotterdam is a good example of internationalizing port business. Hereby, the origin of shareholders of companies in the cluster could be used as the performance indicator to examine the internationalization of the cluster.

Quality of marketing and promotion regime

Investing in marketing and promotion of a cluster is also beneficial for all firms within the cluster, but it does not mean their return is directly proportional to their contribution. Therefore, it is important to solve this collective action problem by modifying individual incentives to engage in desirable behavior (Thomas, 2011). The quality of marketing and promotion regime reflects on the marketing and promotion performance. Gronholdt and Martensen (2006) suggest that the performance indicators can be categorized into mental consumer results, markets results, behavioral customer results and financial results. Furthermore, they have noted the most common used indicators, which respectively are customer loyalty, market share, and market trend. Those three performance indicators all could be used for measuring market and promotion performance.

Quality of training and education regime

Fourth, investment in training and education increases the availability of skilled labor and then cluster performance. However, the benefits of such investment spread to all firms in the cluster, regardless of their contribution to the investment (De Langen, 2008). Therefore, it is necessary for the cluster to convince and encourage the companies to collectively invest in training and education. This will lead to the higher quality of labor pool. In the end, all companies in the cluster can benefit from the qualified labor pool. Cluster generally collaborates with education institution or relevant association to provide training and education to the employees within the cluster. Therefore, the number of collaborated education institutions could be the performance indicator of quality of training and education regime.

2.4 Conclusion

In sum, port performance measurement is critical for the port management, since it provides information for the management. Currently port is widely regarded as a cluster with cargo handling, logistics and manufacturing activities. To define a port cluster, it is necessary to involve all of the related activities happening in the port. Furthermore, De Langen (2004[b]) reviewed relevant literature and conclude four steps to define a port cluster. At the meanwhile, he illustrates that to measure port performance from a cluster perspective is a more appropriate way, since the cluster generates influence on the overall port performance as well. Hence, to measure the port performance from the cluster perspective will fulfill the integrity and accuracy to a larger extent.

In different paper, different performance indicators are used. This is because of that performance components are different between different port products, the interest group for research are different, port environment varies between ports (Brooks and Pallis, 2008; De Langen et al, 2007; Feng et al, 2012). In the study of the performance of seaport clusters, De Langen (2004[b]) agrees the use of a number of possible indicator, but he emphasizes that the valued added generated in the cluster is the most appropriate indicator. The complexity of port leads to the different choices for performance variables in research (De Langen, 2004[b]; De Langen et al., 2007).

In this paper, the chemical manufacturing activity is defined as the economic specification. Therefore, all relevant performance indicator should be related to the chemical industry in the port. Above, we discussed all of the relevant performance variable for the performance of clusters. However, not all of the variables are used in this research, either because of the chemical industrial characteristics or the variable importance analyzed by De Langen (2004[b]). The relevant performance variable and the relative performance indicator are summarized in Table 2.

Table 2: The relevant performance indicators for cluster performance

	Performance variable	**Performance indicator**	**References**
Cluster structure	Quality of labor pool	The percentage of higher educated employees	Carpinetti et al. (2007), De Langen (2004[b]), Rebadow (2006)
	Presence of customers and suppliers	The output transacted inside the cluster	Padmore and Gibson (1998), De Langen (2004[b]), Haussler and Zademach (2007), Asiamoney, p. 84
	Presence of internal competition	Market share of manufacturers	Porter (1990), De Langen (2004[b])
	Diversity of the cluster population	The diversity of cluster population in size	Padmoreand Gibson (1998), De Langen (2004[b]), Glaeser (2005)
		The diversity of cluster population in product	
	Diversity of cluster resources	The diversity of raw material	De Langen (2004[b])
		The diversity of labor	
		The diversity of patents	
Cluster governance	Presence of trust	The membership of sector association	Yue (2011), Simon and Troblova (2007), De Langen (2004[b]), Liao (2010), Becchetti et al. (2013)
	Quality of innovation regime	The number of patents	De Langen (2004[b]), Thomas (2001)
	Quality of internationalization regime	The number of international firms	De Langen (2004[b]), Nijdam (2009)
	Quality of marketing and promotion regime	Customer loyalty	De Langen (2004[b]), Thomas (2001), Gronholdt and Martensen (2006)
		Market share	
		Market trend	
	Quality of training and education regime	Number of collaborated education institutions	De Langen (2004[b]), De Langen (2008)

Overall, this section provides the theoretical basis for the empirical analysis in the next chapter. In other words, it completes the relevant performance variables and performance indicators for the analysis of cluster performance.

3 The chemical cluster in Ningbo and Shanghai defined

This chapter constructs the chemical cluster population of Shanghai and Ningbo port. According to De Langen (2004[b]), four steps should be developed to define the cluster population. First, the economic specification is chemical manufacturing activities and the roughly defined region is Ningbo and Shanghai. Second, the relevant economic activities have already been noted in Section 2.2.2. Nevertheless, the third step of defining the relevant region for the cluster is discussed in Section 3.1 of this chapter. Furthermore, the fourth step of the cluster population is identified in Section 3.2.

3.1 The relevant region for the cluster

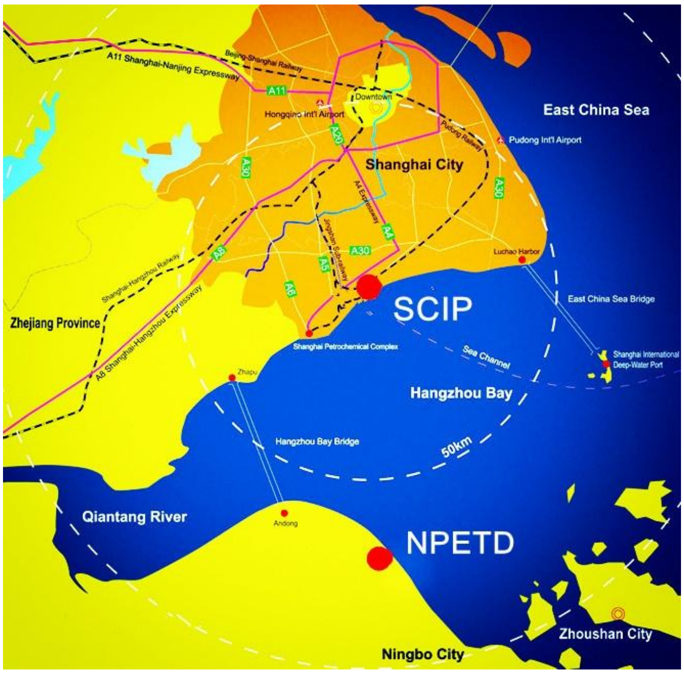


Figure 7: The geographical location of SCIP and NPETD

Petrochemical and fine chemical industry is one of the four industrial production bases in Shanghai. The other three industrial production bases include the microelectronics industry base, Shanghai International Automobile City, and fine steel manufacturing base. In 2012, the sector of petrochemical and fine chemical generates over 4000 billion RMB operating revenue and contributes about 24.7 billion tax and duties to the municipality government. Undeniably, the chemical industry plays a key role in Shanghai's economic system. Thousands of chemical firms have been located in Shanghai. In the south of Shanghai there was a Greenfield development of 29.4 km^2, where a large amount of chemical firms have agglomerated together. This is Shanghai Chemical Industry Park (SCIP). Since 2004, SCIP is developed into a world-scale industry site for chemical production. SCIP is located in the south-western area of Shanghai port and at the northern coast of Hangzhou Bay (Figure 7).

At the southern coast of Hangzhou Bay, there is another chemical industry park located in Ningbo port (Figure 7). Also, the chemical industry is relatively important in Ningbo's economic system. Ningbo Municipal Statistics Bureau published that 7 out of top 20 enterprises on annual revenue are chemical firms, such as Sinopec Zhenhai Refining & Chemical Co., Ltd. (Top 1) and Ningbo LG Yongxing Chemical Industry Co., Ltd. (Top 9). Moreover, the listed two enterprises are located in Ningbo Petrochemical Economic & Technological Development Zone (NPETD). Similar to SCIP, NPETD is a government-support chemical cluster in Ningbo port. The planned area of NPETD is 56.22 km^2. Hundreds of firms have already been located in NPETD since the establishment in 2003.

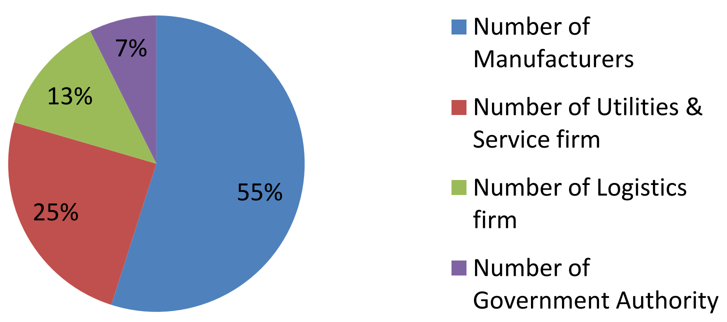
The location of SCIP and NPETD both has convenient water and land transportation extending in all directions. They are not far away from the deep water ports. Particularly SCIP has jetty inside the industrial park. In short, SCIP and NPETD are two industrial parks with geographical location advantages. In this paper, they are identified as the two relevant regions, since the chemical industrial parks are supposed to form a chemical cluster (Zeng and Bathelt, 2011). Therefore, the cluster population is defined according to the chemical products manufacturers and relevant organizations in SCIP and NPETD.

3.2 The cluster population

The chemical population of SCIP and NPETD includes the chemical manufacturers, firms/associations that provide utilities or relevant services to the manufacturers, the logistics firms that are specialized in chemical products storage and transport and government authorities that provide services to the cluster tenants. There are 122 firms/organizations in total in SCIP, whereas 101 in NPETD. The cluster structure is present in Figure 8 and Figure 9. In SCIP, there are 55% companies are chemical manufacturers. The Utilities & Service firms and logistics also account for 25% and

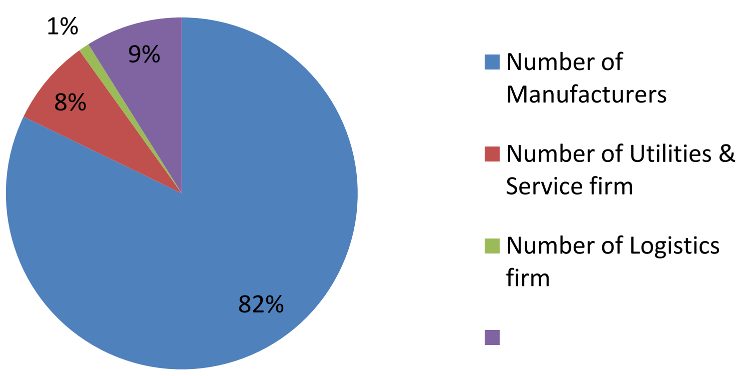
13% respectively. On the other hand in NPETD, manufacturers account for 82%, whereas other types of companies only occupy relatively a small part. The differences of cluster structure between SCIP and NPETD are quite significant, especially the Utilities & Service firms and Logistics firms. Amongst, the similar government authorities play a part in the two chemical industrial parks, such as the industrial park management associations, supervision bureau of safety production, etc. Therefore in the next sections, the focus lies in analyzing the cluster structure differences in utilities and service firms and logistics firms. The differences in manufacturers will be mainly discussed in depth in Chapter 4.

Figure 8: The cluster structure of SCIP in terms of economic activities



Source: website of SCIP

Figure 9: The cluster structure of NPETD in terms of economic activities



Source: website of NPETD

3.2.1 *Utilities & Service firms*

In terms of quantity, SCIP has much more firms specialized in utilities and service. There are 30 utilities & service firms in SCIP, but only 8 firms in NPETD. In this case, SCIP probably perform better than NPETD, because SCIP is more able to provide various services to the manufacturers within the cluster. In other word, the cluster population of SCIP is more diverse than NPETD. This section will take attention on the specific services that those utilities & service firms provide to the cluster.

Table 3: The composition of utilities and service firms

Utilities & Service	SCIP	NPETD
Power and heat supply	1	3
Water supply and sewage treatment	1	2
Waste service	1	1
Industrial gases	2	0
R&D/Technology service	3	1
Infrastructure construction and maintenance	9	1
Chemical container and packing	3	0
Trading	4	0
Other services	6	0
Total number of utilities and service firms	**30**	**8**

Source: official website of SCIP and NPETD, combined by the author

The composition of utilities & services firms within SCIP and NPETD are summarized in Table 3. As was said earlier, there are much more firms in SCIP than NPETD that provide utilities or matching services to the chemical manufacturers. Water, power, heat and industrial gas supply is the matching infrastructure that SCIP and NPETD both can provide to the cluster. Although Table 3 indicates there is no firm that provides industrial gas locating in NPETD, the industrial gas supplier is located outside of NPETD. In short, it implies that both SCIP and NPETD have ability to supply the basic utilities and treat the environmental problems. However, they perform obviously differently on other services.

First, NPETD has one firm specialized in infrastructure construction and maintenance, while SCIP has 9. A large quantity of construction and engineering firms within SCIP ensures the infrastructure to be advanced, developed and maintained. This is an important guarantee for plant productivity. Thus, SCIP probably perform better than NPETD on productivity, due to the advanced infrastructure. The additional services that SCIP provide, but not NPETD, are chemical container and packing, trading, industrial gas, declaration and inspection, and some other services.

Second, the existence of chemical container and packing firms in SCIP, to some extent, makes the storage and transport more convenient. Meanwhile, the existence of specialized container and packing firms could be caused by the clustered logistics firms within SCIP. SCIP plans to satisfy the entire industry chain. This issue is pursued below.

Third, trading company also play an important role within a industrial cluster. In general, they import the raw material ‘for’ manufacturers or help manufacturers sell their products. From this perspective, manufacturers in SCIP may have more ways to buy raw materials and sell their products not only domestically but also externally.

Lastly, SCIP also has two declaration and inspection service firms. This to some extent guarantees the quality of the chemical products in SCIP. This service increases the reliability of the products and makes the products trust worthier. Plus, SCIP has an association that organizes and gives training for the employees within the cluster. This improves the quality of pooled labor. Because SCIP has jetty within the cluster, there is Vopak (Shanghai) Port Limited who stores and handles liquid cargoes for the manufacturers within the park. This reduces the transport costs of the supply chain to large extent. Nevertheless, even though NPETD does not have liquid chemical jetty within the park, there are dedicated liquid chemical jetty and tank farm nearby and the transmission pipelines of the jetty are extending to the entire park directly.

Overall, while looking up the structure of utilities and service firms, it seems SCIP does not only provide more services, but also value-added services to the cluster. Also, NPETD is capable of providing the basic infrastructure, although not all of those firms located within the park. However, if NPETD can cooperate with SCIP and they are formed as one cluster, they can share the information and resources on trading, infrastructure management, employee training, chemistry packing and yet more. For SCIP and NPETD, cooperation could be a good way to improve the shortages in NPETD. In the next section, we turn to explore the logistics firms in the cluster.

3.2.2 Logistics Firms

Surprisingly, we can say that there is a small cluster of logistics firms specialized in chemical products within SCIP. This is an extra service that SCIP has planned and developed for the manufacturers. We found 16 logistics firms locating within SCIP, whereas only 1 within NPETD. This is a big difference.

The important force behind the form of agglomerated logistics firms is the management and plan of SCIP Commission. SCIP has developed the north-west area of SCIP to be SCIP Logistics Industry Zone. The strategy of this is to combine manufacturing industry with logistics industry and satisfy the logistics needs from SCIP. The logistics zone is positioned as chemical manufacturing service sector aggregation. In the industry chain, some basic chemicals or petroleum can be imported via the dedicated jetty within SCIP. Then the manufacturers can produce a variety of petrochemicals, fine chemicals and specialty chemicals through industry processing. Moreover, those products can be stored or packed and then transported to the consignee by the chemical-professional logistics firms. The SCIP can complete the full supply chain. It is highly likely to increase the efficiency and reduce the costs of the chain.

In sum, SCIP develops one step further than NPETD. The whole supply chain can be completed within SCIP, but not within NPETD. Since there is Greenfield available in NPETD, to plan an area for logistics will be great for the transport efficiency. To cooperate with SCIP is important for NPETD to learn experience on logistics area planning and management from SCIP. Furthermore, some logistics firms in SCIP will also be interested in starting business in SCIP. By cooperation, NPETD may directly attract those interested players, since the entry barrier is reduced.

3.3 Conclusion

SCIP and NPETD are two chemical industrial parks located at the coast of Hangzhou Bay. The 122 and 101 organizations respectively in SCIP and NPETD are all determined as the cluster population. Chemical manufacturers account for the majority in both clusters. The structure and governance of manufacturers will be explored in Chapter 4. This chapter explicitly investigates the utilities & service firms and logistics firms. We have already reached some achievements.

First, SCIP and NPETD are both able to provide basic infrastructure service for the manufacturers, such as water, electricity, industrial gas, tank farm and pipeline. However, SCIP also provide extra services for the manufacturers, including employee training, chemical container and packing, and trading. Second, a logistics zone is developed within SCIP, as an aggregated logistics service sector for the chemical industry chain. On the contrary, NPETD has not focused on developing this service sector yet. Because the completion of the industry chain within SCIP, the cost is likely to be reduced. Third, the SCIP chemical industry combined services are more various. And those services are also vital for the chemical industry. In sum, compared to SCIP within the same port delta NPETD is lagging behind in matching service sector.

NPETD should cooperate with SCIP on developing its service sector. SCIP has the experience on developing and managing the matching services, for instance the SCIP logistics zone. SCIP can share its experiences with NPETD. Moreover, SCIP already have some players in chemistry packing, trading, etc. Those players can also serve the manufacturers in NPETD and they can be the potential entrants for NPETD, if NPETD cooperate with SCIP to form as one cluster. In the next chapter, the results will illustrate whether SCIP and NPETD should cooperate and how they should cooperate in depth.

4 Results of cluster performance on structure and governance

This chapter describes the results of cluster structure and cluster governance performance respectively. The aim of this chapter is to compare the relevant cluster performance indicators between SCIP and NPETD. SCIP and NPETD are two chemical parks located within Shanghai-Ningbo port delta. The two parks are planned to cooperate and form as a cluster. The comparison of SCIP and NPETD will lead to differences between them, namely weaknesses and strengths. The results will provide evidence and support for governance suggestions to the cluster.

Section 2.3.9 summarized 10 relevant and important cluster performance variables and 15 performance indicators for the empirical analysis. However, there are 6 cluster performance variables and 7 cluster performance indicators selected in the end. The selected cluster performance indicators are present in Table 4. As shown, 3 performance variables of cluster structure and 3 performance variables of cluster governance will be analyzed. Four variables are excluded from the empirical research in this paper.

Table 4: Selected cluster performance indicators for measurement

	Performance variable	**Performance indicator**	**Data resource**
Cluster structure	Quality of labor pool	The percentage of higher educated employees	*Shanghai Statistical Yearbook, Ningbo Statistical Yearbook, ShangPharma Corp, Ningbo Liwah Pharmaceutical Co., Ltd.*
	Diversity of the cluster population	The diversity of cluster population in size	*Company websites, China Commodity Net*
		The diversity of cluster population in product	*Company websites*
	Diversity of cluster resources	The diversity of patents	*State Intellectual Property of Office of P.R.C*
Cluster governance	Presence of trust	The membership of sector association	*Websites of SCIP and NPETD, websites of SCIA and NPCA*
	Quality of innovation regime	The number of patents	*State Intellectual Property of Office of P.R.C*
	Quality of internationalization regime	The number of international firms	*Company websites, Investment Shanghai*

Presence of customers and suppliers is the first variable that is excluded, because there is no sufficient information available about how much products are transacted inside the cluster. Partly manufacturers in the cluster export their products; some transact products with players within the cluster; some trade outside cluster but domestically. It is difficult to confirm who only deal with the players inside the cluster or how much they transact inside the cluster. Therefore it is uncertain about the output transacted inside the cluster.

Second, presence of internal competition is also removed from the empirical research. There is limited data about the market share of manufacturers in the cluster. We find that the manufacturers within SCIP and NPETD almost all produce various chemistries. Hence, they even cannot be determined as competitors to some extent. It is relatively tough to measure their market share.

Quality of marketing and promotion regime is the third performance variable excluded. The information about the cluster governance on marketing and promotion is very limited. We are uncertain about all of the strategies or policies that the cluster has taken for marketing and promotion. Furthermore, products of the cluster are exported, traded domestically or transacted inside the cluster. All the transactions are unknown. It is difficult to determine the market share, market trend and customer loyalty.

Lastly, variable of quality of training and education regime is excluded. There is insufficient data available about this variable. We find that partly companies in the cluster collaborate with the local education institution for training and education. However, this information is very limited. We cannot figure out all of the companies who has collaborated with education institutions.

The 6 performance variables will used to measure the performance of SCIP and NPETD. If they are formed as a cluster, the results of this paper will provide supports to which aspects they should cooperate to improve the cluster performance.

4.1 The performance of cluster structure

4.1.1 Quality of Labor Pool

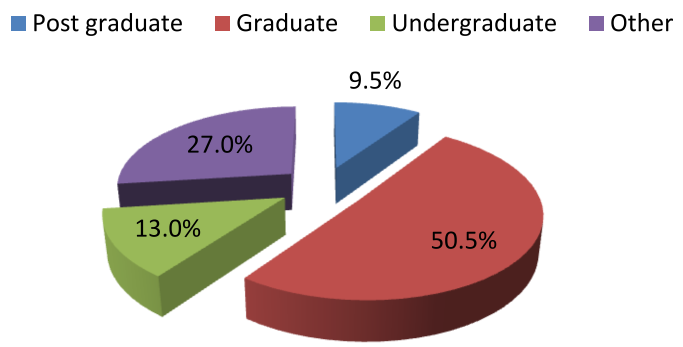
The formation of SCIP and NPETD creates thousands of jobs in the labor market. Therefore the chemical-specialized employees are pooled. The quality of labor pool affects the cluster productivity. The quality of labor pool is assessed by the education level of employees. Because there is limited information available, we cannot find the education level of the employees in all of the companies. Nevertheless, we select two examples to illustrate the cluster performance on quality of labor pool.

First, we briefly explored the education level of Shanghai and Ningbo. The higher educated labor is normally considered as skilled labor. Compared to Ningbo, Shanghai has much more educational institutions. Shanghai has 66 institutions of higher education, including 3 comprehensive universities and 25 science and engineering universities. All of the 28 universities provide chemical-related programs. On the other hand, Ningbo has 14 institutions of higher education, but only 7 institutions have chemical-related programs. We can see a big difference between Ningbo and Shanghai. In addition, Shanghai has 139000 graduates from institutions of higher education, whereas Ningbo has 37227 graduates from institutions of higher education. Although there is no explicitly data available about graduates from chemical programs, it can be recognized that in general Shanghai has a greater environment with skilled labor pool than Ningbo for the chemical industry. The manufacturers in SCIP can benefit from the rich human resource of Shanghai to a larger extent. Labor resource is just an aspect to foresee the quality of labor pool. We can imagine that SCIP is highly likely to have larger percentage of higher educated employees than NPETD. In order to investigate the labor quality within SCIP and NPETD, two examples are used to illustrate the quality of labor pool in SCIP and NPETD.

Two examples are selected. They are China Gateway Pharmaceutical Development

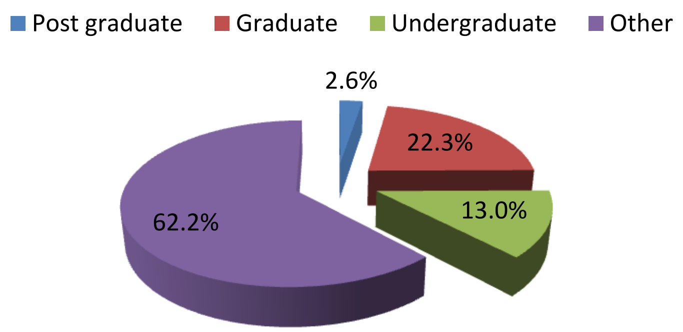
Limited in SCIP and Ningbo Liwah Plant Extraction Technology Limited in NPETD. They are representative and comparable because of three reasons. First, they all are organic chemistry producers, which accounts for a great part of the cluster distribution. Gateway and Liwah both are specialized in pharmaceutical intermediates and chemical raw medicine production. Second, they are small-sized manufacturers. Third, Gateway and Liwah both are domestic invested manufacturers. Due to the three commonalities, plus the availability of data, those two manufacturers are selected to compare the labor quality in terms of education level.

Figure 10: The education level of employees in Gateway



Resource: ShangPharma Corp

Figure 11: The education level of employees in Liwah



Resource: Ningbo Liwah Pharmaceutical Co., Ltd.

Figure 10 shows the education level of employees in Gateway. 73% of the employees in Gateway are higher educated. In other words, 73% of the employees are high skilled staff. Figure 11 describes the education level of employees in Liwah. It shows 38% of employees in Liwah are higher educated. Gateway and Liwah have the same size, over 200 employees. However, Figure 10 and Figure 11 illustrate that Gateway has almost two times more higher educated employees than Liwah.

In Gateway the post graduate, graduate and undergraduate respectively account for 9.5%, 50.5% and 13%, whereas in Liwah they respectively account for 2.6%, 22.3% and 13%. The main difference of labor quality between Gateway and Liwah is the number of graduates and post graduates. We found that there are 25568 graduates and 4610 graduates in Shanghai in 2011, which is almost the total number of graduates of higher education in Ningbo. Therefore, it is unsurprising that Gateway has much more employees who have master or post master education experience. In short, the difference of labor quality between SCIP and NPETD could be resulted from the gap between education industry developments in the cities. Gateway and Liwah have the same percentage of undergraduate employees in the companies. Even if Ningbo cannot provide high-skilled workers who have master or post master degree as many as Shanghai, there is likelihood for Liwah to hire more graduates.

As a result, the labor pool of SCIP shows higher education level than that of NPETD. In other words, the two examples illustrate that the quality of labor pool in SCIP is higher than that in NPETD. Actually, the idea to form SCIIP and NPETD as one cluster will improve the shared labor pool. Because the labor pool is shared in the cluster, the accessibility to high skilled labor pool is upgraded for NPETD. NPETD can benefit from the rich human resource from SCIP. Cooperation will lead to a higher quality of labor pool especially for NPETD.

4.1.2 Diversity of the cluster population

In Chapter 3, we have already explained the diversity of the cluster population in terms of economic activity. In general, SCIP shows higher diversity of the cluster population. Compared to NPETD, SCIP provides more diverse and specialized services, such as trading and logistics. The industry chain within SCIP is more complete than NPETD. Differently, this section is aimed at analyzing the diversity of manufacturers in the clusters. The analysis focuses on manufacturer diversity in terms of 'size' and 'product type'. The diversity of Utilities & Service firms and logistics firms are not investigated, because they almost all are specialized in different sectors. There is no unity of enterprise size or product type, since they provide different services and the provisions to enterprise size are various in different sectors.

<u>Diversity of manufacturer size</u>

There are 67 chemical manufacturers in SCIP, whereas 83 manufacturers in NPETD. It seems that NPETD is larger than SCIP. The manufacturer size is presented in Table 5, according to China's provisions. In 2011 June, the China's government made the "Small and Medium-Sized Enterprise Standard Provisions". The provisions indicate the rules for industrial enterprises: large-sized (number of employee >1000), medium-sized (300< number of employee < 1000), small-sized (20 < number of employee < 300), micro-sized (number of employee <20).

Table 5: The composition of different sized manufacturers

Size of manufacturers	SCIP	NPETD
Micro	3(4.5%)	5(6.0%)
Small	50(74.6%)	64(77.1%)
Medium	6(9.0%)	13(15.7%)
Large	8(11.9%)	1(1.2%)

Resource: company websites and China Commodity Net

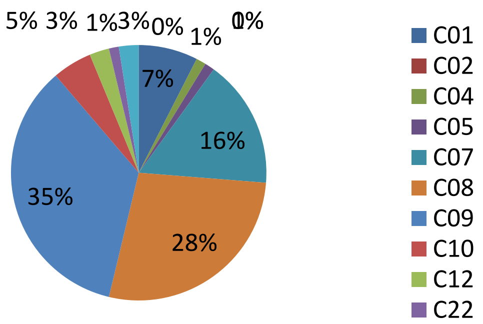
What is striking in Table 5 is that over 70% of manufacturers in NPETD and SCIP are small-sized enterprises. Particularly, there are even more small- and medium-sized firms agglomerated in NPETD. Nevertheless, only one large-sized manufacturer locates in the NPETD cluster, but 8 large-sized manufacturers in SCIP. This difference between SCIP and NPETD is quite obvious. This only large-sized manufacturer in NPETD is Sinopec Zhenhai Refining & Chemical Company (ZRCC), which focus on petroleum refinery. Also, Sinopec Shanghai Gao-Qiao Company in SCIPwho has more than 5000 employees produces the refinery products. In this case, both clusters have a large refinery firm that produce refining products. In addition, the other large-sized enterprises in SCIP includes 2 local-based firms, 1 joint venture of BP

Group, as well as 4 foreign-invested chemical manufacturers, such as Evonik Degussa, Bayer and Air Products. Compared to NPETD, it seems that SCIP is more internationalized. The internationalization of clusters will be discussed in greater detailed later. Besides, the existence of large chemical manufacturers in SCIP can create reputation and improve accessibility to the external markets for the cluster. Those large manufacturers in SCIP may play a role in leader firms that collaborates small and medium sized manufacturers and create collective benefits. Due to the existence of some large world players in the chemical industry, the performance of SCIP on the diversity seems greater than NPETD.

Diversity of manufacturer in products

The second dimension of manufacturer variety is ‘product type’. We investigate the chemical products that are produced by each manufacturer in the clusters. According to IPC, we make a classification of those chemical products. IPC is International Patent Classification. Chemistry and Metallurgy are classified as ‘main group C. The result of the distribution of manufacturers in terms of IPC is shown in Figure 12 and Figure 13.[2]

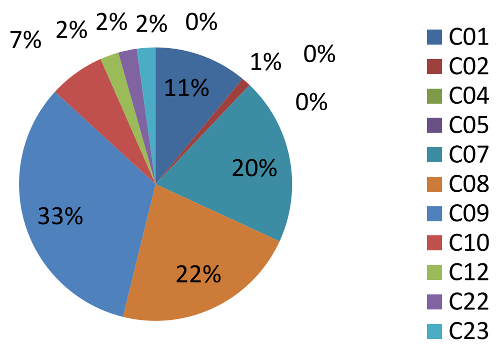
Figure 12: The distribution of manufacturers in SCIP in terms of IPC



Resource: company websites

[2] Figure 14 summarizes the distribution of manufacturers in different subgroups of main group C. C01: Inorganic Chemistry; C02: treatment of water, waste water, sewage, or sludge; C04:cements, concrete, artificial stone, ceramics, refractories; C05: fertilisers, manufacturer thereof; C07:organic chemistry; C08: organic macromolecular compounds, their preparation or chemical working-up, compositions based thereof; C09: dyes, paints, polishes, natural resins, adhesives, miscellaneous compositions, miscellaneous applications of materials; C10: petroleum, gas or coke industries, technical gases containing carbon monoxide, fuels, lubricants, peat; C12: biochemistry, bear, spirits, wine, vinegar, microbiology, enzymology, mutation or genetic engineering; C22:metallurgy; C23: coating metallic material, coating material with metallic material; C25:electrolytic or electrophoretic process.

Figure 13: The distribution of manufacturers in NPETD in terms of IPC



Resource: company websites

The manufacturers in SCIP and NPETD both are involved in 10 chemical classifications. However, Figure 12 and 13 displays that the majority of manufacturers in SCIP and NPETD concentrates on producing chemistry in subgroups of C07, C08 and C09. The subgroups of C07 and C08 respectively are organic chemistry and organic macromolecular compounds, which mostly are important resources for other chemical process to produce other types of chemistry, such as the subgroup of C09. It can be recognized that the diversity of manufacturers in the clusters also influences the diversity of cluster resources and the presence of customers and suppliers. It is not clear in Figure 12 and Figure 13 which cluster is more diverse in terms of product types according to IPC. In order to explore the differences between SCIP and NPETD in the diversity of cluster manufacturers, we reclassify the cluster population in terms of product type.

The manufacturers' products can be divided into three types of chemical products: commodities, fine chemicals and specialty chemicals. Pollak (2007) defines "fine chemicals" is a three-tier segmentation of the universe of chemicals into commodities, fine chemicals, and specialty chemicals. Commodities are large-volume, low-price, homogeneous, and the standardized chemicals produced in dedicated plants and used for a large variety of applications. Fine chemical are complex, single, pure chemical substances produced in limited quantities in multipurpose plants by multiple batch chemical or biotechnological processes. Specialty chemical are formulations of chemicals containing one or more fine chemicals as active ingredients, traded outside the chemical industry. The specific products that each manufacturer produces have been investigated, and they are classified into those three types. Table 6 illustrates the manufacturer composition in terms of chemical product type.

Table 6: The composition of manufacturers in terms of chemical product type

Type of chemical products	SCIP	NPETD
Commodities	20(29.9%)	30(36.1%)
Fine chemicals	28(41.8%)	39(47%)
Specialty chemicals	19(28.3%)	14(16.9%)

Resource: company websites, combined and classified by author

Commodities, fine chemical and specialty chemical manufacturers in SCIP are nearly even distributed, since they respectively account for 29.9%, 41.8% and 28.3%. However, the specialty chemical manufacturers in NPETD seems much less than other two type chemical manufacturers, where manufacturers that produce specialty chemistry only occupy 16.9%. In the case, the cluster of manufacturers in SCIP is more various than NPETD. This could be caused by the difference between Shanghai and Ningbo city’s economic structure. Specialty chemical are traded outside the chemical industry and normally sold under brand. Hence, the prosperity of other industries, such as the construction industry, in the region may influence the development of clustered specialty chemical manufacturers. For instance, nearly half of specialty chemical manufacturers are paint producers, since auto making industry is another major industry in Shanghai. This is related to the existence of customers in the region.

In a value-added chain extending from commodities through fine chemicals to specialty chemicals, typical commodities, namely, low-price and multi-usage products provides necessary resources for fine chemical and specialty chemical manufacturers (Pollak, 2007). It means that if the cluster is more diverse, it will enhance the opportunities for cooperation in the cluster. The commodities, fine chemical and specialty chemical manufacturers can cooperate in the cluster and improve the value chain, which is beneficial for all of them. From this perspective, NPETD should consider to attract more manufacturers that produce specialty chemistry. Therefore, more commodities and fine chemical manufacturers in NPETD can take part of the value chain in the cluster.

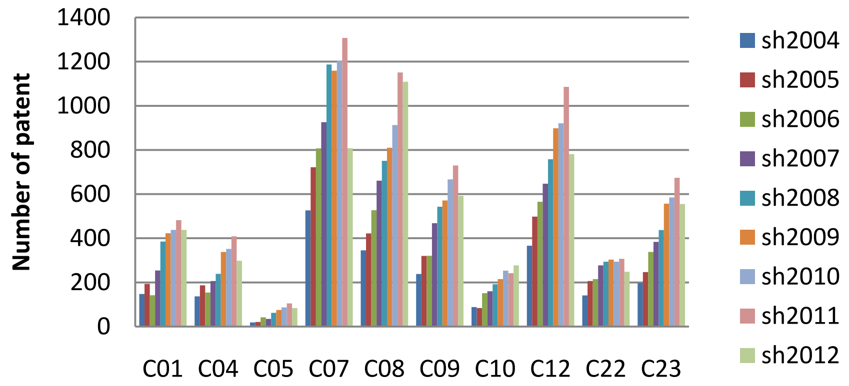
The diversity of SCIP in terms of manufacturer size and chemical product type both are greater than the diversity of NPETD. The cooperation between SCIP and NPETD will make the cluster population more diverse. There will be more diverse chemistries produced in the cluster, which means that the value-added chain will be more complete. The cluster can reduce the vulnerability to external shocks. More transactions can be done inside the cluster. Besides, NPETD can benefit from the reputation of SCIP, if they form as a cluster. SCIP has more large-sized world players, which makes the industrial park have a good reputation. NPETD can take advantage of it to develop the Greenfield and attract some large manufacturers.

4.1.3 Diversity of cluster resource

Diversity of resources improves cluster performance, because the cluster is not only dependent on one resource. Hence, a cluster is more capable of responding to external shocks. Availability of resources can differ between clusters. Resources does not only mean raw material, but also include knowledge and information, and labor. Because the manufacturers in SCIP and NPETD produce various chemistries, they use various raw materials. There is limited information available about the raw material available. Also, there is limited data about the labor in SCIP and NPETD. Therefore, the diversity of raw material resource and labor resource is not discussed. In this section, the focus lies in the availability of diverse knowledge and information sources.

Knowledge and information also is an important resource to reduce vulnerability to external shocks. Patent is an essential indicator that reflects the knowledge and information. In order to evaluate the diversity of knowledge and information, the number of patents in different classifications (in terms of IPC) is adopted. We have investigated the number of patents (including invention and practical patents) in different IPC groups over 2004 and 2012. Only the groups that are involved in SCIP or NPTED are selected. The results are present in Figure 14 and Figure 15, respectively for Shanghai and Ningbo.

Figure 14: Number of patent in Shanghai



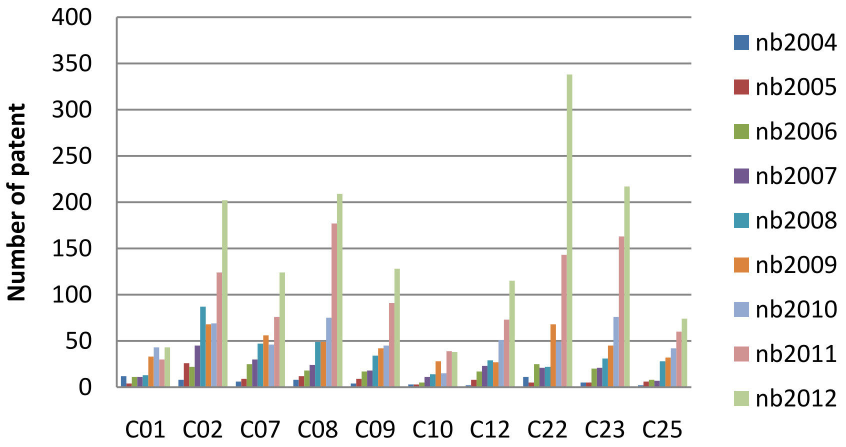
Resource: State Intellectual Property of Office of P.R.C

Figure 14 shows that all of the 10 groups of patents are available in Shanghai. It implies that the patents are diverse. Therefore, it reflects that the availability of knowledge and information is various in terms of IPC. In addition, we find that over 2004-2012, C07, C08, C09 and C12 are the largest groups with most patents. It means that there is large amount of knowledge and information regarding C07 (organic chemistry), C08 (organic macromolecular compounds), C09 (dyes, paints, etc.) and C12 (biochemistry) available in Shanghai. The possible reason is that the petrochemical chemical and fine chemical industry is one of the four industrial production bases and one of the six key development industries in Shanghai[3]. The chemistry grouped in C07, C08 and C09 normally is fine chemical. Therefore, the patents in those three groups are largely available and the relevant information and knowledge are well developed in Shanghai. The majority of manufactures in SCIP also are specialized in C07, C08 and C09. The large amount of information and knowledge developed in Shanghai provides great environment for the development of SCIP. Besides, the number of patents in group C12 is increasing dramatically over

[3] The sis key development industries in Shanghai include electronic information product manufacturing industry, automobile manufacturing industry, petrochemical and fine chemical manufacturing industry, fine steel manufacturing industry, equipment manufacturing industry and biological medicine industry.

2004 to 2012. It became the third largest in 2012. It tells that the knowledge and information of biochemistry is available developing fast in Shanghai, which is beneficial for SCIP to facilitate the development of bio-chemical industry.

Figure 15: Number of patent in Ningbo

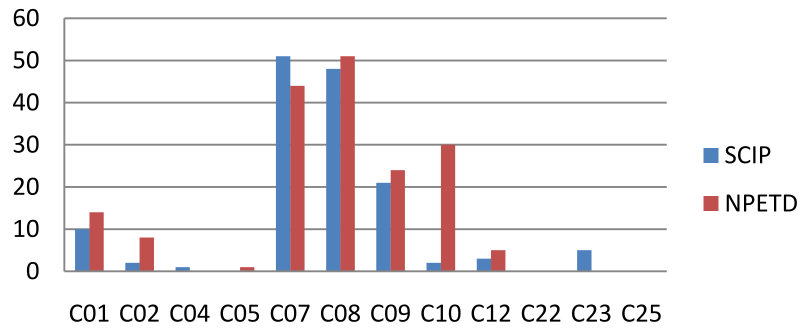


Resources: State Intellectual Property Office of P.R.C

Figure 15 also shows that there is diverse knowledge and information available in Ningbo. However, we cannot see significant trend over the last decade. Between 2004 and 2010, the number of patents is nearly evenly distributed in those different groups. It implies that during that period there is not any kind of knowledge and information that is outstandingly great. However, we have seen that the number of patents of group C02, C08 and C22 are increasing greatly in 2011 and 2012. It illustrates there is more knowledge and information regarding the chemistry in group C02, C08 and C22. The manufacturers in NPETD also concentrate on the production of chemistry of group C07, C08, and C09. The availability of information and knowledge regarding other types of chemistry is beneficial for NPETD to develop more manufacturers in other specifications. In short, it seems that diverse knowledge and information in terms of chemistry type is available in Ningbo.

To compare Shanghai and Ningbo, we found that Shanghai has much larger amount of patents than Ningbo. In other words, there is much more information and knowledge available in Shanghai. The difference of knowledge and information resource causes the larger amount of information and knowledge available in Shanghai. One phenomenon leads to the difference. A considerable amount of knowledge and information available in Shanghai is from abroad. What we have found is that a considerable part of patents of Shanghai are registered under foreigners or foreign organizations. On the other hand, the patents of Ningbo are registered under locals. Foreigners and foreign organizations are important resources that greatly contribute to availability of knowledge and information for Shanghai. In sum, the comparison between Shanghai and Ningbo shows that the availability of knowledge and information for Shanghai is more diverse than that for Ningbo. Shanghai provides the great knowledge and information environment for SCIP, but the question is how beneficial it is for SCIP.

Figure 16: Number of patent of SCIP and NPETD



Resources: State Intellectual Property Office of P.R.C

The number of patents of SCIP and NPETD are present in Figure 20. Even though Shanghai performs much better than Ningbo on the availability of information and knowledge, NPETD seems to perform better than SCIP on the diversity of information and knowledge. Figure 16 shows that the patents of SCIP concentrate on the group of C07, C08 and C09. It is logical showing that SCIP have more patents grouped in C07, C08 and C09. In this case, NPETD displays the similar trend. However, NPETD also shows the relatively more patents of C10 (petroleum, gas, fuels, lubricants and peat). This reflects that the information and knowledge development about C10 is processed greatly in NPETD. In addition, there are more patents of C01, C02 and C12 in NPETD, compared to SCIP. In short, the diversity of knowledge and information in NPETD is greater than SCIP. There is more potential for NPETD to develop more manufacturers that are specialized in other chemistry types.

Although Shanghai provides greatly amount of information and knowledge resource for SCIP, SCIP has not taken the advantage of it as much as possible. Conversely, Ningbo has relatively poorer information and knowledge resource, but NPETD even performance better than SCIP on the diversity of patents. The cooperation between SCIP and NPETD will lead to greater diversity of patents. Through cooperation, more diverse information and knowledge can be shared in the cluster and the lack of information and knowledge in any group can be complemented. SCIP and NPETD can benefit from a better environment with greater diversity of information and knowledge. Then the vulnerability to external shocks can be reduced to larger extent.

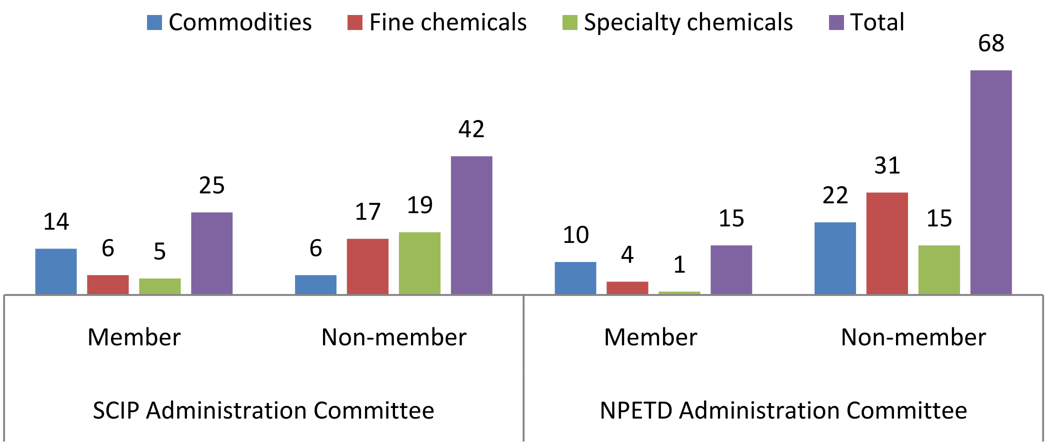
4.2 The performance of cluster governance

4.2.1 Presence of trust

The presence of trust could be measured by number of membership of the relevant association. In this section, we compare the membership of the relevant associations to illustrate the presence of trust. One public organization and one sector (public-private) association are selected for SCIP and NPETD. The assumption is that public organizations and sector associations contribute to solve collective action problems in the cluster. Interactions are constrained by the presence of trust. In cluster where the level of trust is higher, the cluster tenants are more likely to interact and cooperate. Therefore, it is more likely and easier to collect the tenants and solve problems together.

First, the number of membership of SCIP and NPETD Administration Committee are presented in Figure 21. The SCIP and NPETD Administration Committee both are appointed by Municipal People’s Government, who is responsible of drawing up and revising the development planning and industrial policies of SCIP and NPETD. SCIP and NPETD are entirely under the management of the two administration committee respectively. Furthermore, they play a role in coordinating the enterprises within the clusters and provide necessary guidance and services, such as investment guide and investment cooperation. If the result shows high membership rate of the two administration committees, it implies high level of trust to the administration committees. This is advantageous for the administration committees to coordinate the cluster tenants and implement new planning and policies.

Figure 17: The membership of SCIP and NPETD Administration Committee



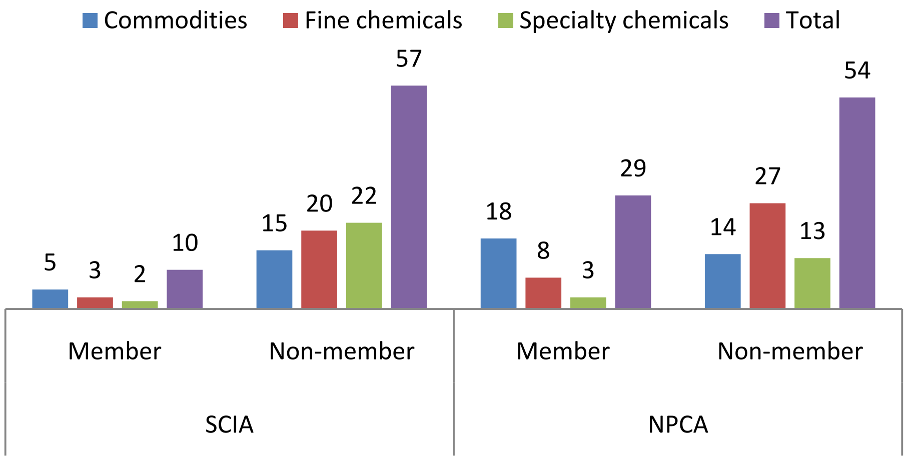
Resource: SCIP and NPETD

Three findings about the membership should be emphasized. First, SCIP and NPETD administration committees both perform poorly on the membership of the administration committees. This reflects the low presence of trust. 25 out of 67 (37.3%) are showed as member of SCIP Administration Committee, whereas only 15 out of 83 (18.1%) are members of NPETD Administration Committee. Neither have convinced the half enterprises within the clusters to become a member. This is not conducive to the coordination between enterprises and the implementation of revised policies. Overall they both should increase the membership of manufacturers and improve the trust of enterprises within the clusters. Second, the cluster of SCIP performs better than NPETD on the presence of trust. Figure 21indicates that more manufacturers in SCIP trust the administration Committee, although less manufacturers located within SCIP. Compared to SCIP, it is more urgent and necessary for NPTED to improve the manufacturer's trust. Third, what is striking in Figure 17 is that the manufacturers who produce commodities are seen to trust the administration committee more. The majority of members are commodities manufacturers – both of SCIP and NPETD. It implies that SCIP and NPETD both should take action in order to gain more trust from fine chemical and specialty chemical manufacturers.

Second, we selected Shanghai Chemical Industry Association (SCIA) and Ningbo Petrochemical and Chemical Association (NPCA) to measure the membership. The SCIA and NPCA are two public-private organizations in the sector. The important tasks of SCIA and NPCA are to coordinate members, organize events for marketing and sharing information, and help government organizations promote new innovations and manage safety and environment. In other words, SCIA and NPCA are bridges between government organizations and chemical manufacturers respectively in Shanghai and Ningbo. Even though they are organizations outside the clusters, the membership of manufacturers will be beneficial for sharing information and promoting the cooperation with government organization.

The membership of SCIA and NPCA are presented in Figure 18. Similar with situation of Figure 22, three results should be pointed out. First, the member rate of SCIA and NPCA both are relatively low for manufacturers within SCIP and NPETD. Respectively, 17% of SCIP manufacturer and 35% of NPETD manufacturers are members of SCIA and NPCA. Second, the cluster of NPETD performs better than SCIP on the presence of trust in this case. The overall member rate of NPCA is higher. Moreover, the member rates of NPCA in each product sector are also higher than SCIA. This illustrate that the more enterprises within NPETD show trust to NPCA. Third, the majority of members are manufacturers that are specialized in producing commodities. Again, this is the case both for SCIP and NPTED.

Figure 18: The membership of SCIA and NPCA



Resource: websites of SCIA and NPCA

Two cases jointly display that SCIP and NPETD both perform poorly on the presence of trust. It is crucial for both clusters to increase the presence of trust, especially the trust of fine chemical or specialty chemical manufacturers. This is because those two sectors always show the lowest member rates. Comparison of Figure 21 and Figure 22 demonstrates that in Ningbo, the membership of NPCA (29 members) is higher than that of the NPETD Administration committee (15), but in Shanghai it is converse. More than half members of the SCIP Administration Committee choose not to join SCIA. However, more manufacturers are more willing to join NPCA than the administration committee. The main difference between SCIA and NPCA is commercialization. NPCA is more commercial by helping sales of member’s products. In other words, NPCA is performing better on marketing and promotion. This result reflects that manufacturers tend to become member of the relevant association who adds value to marketing. As a result, to increase marketing and promotion is a way to increase the presence of trust.

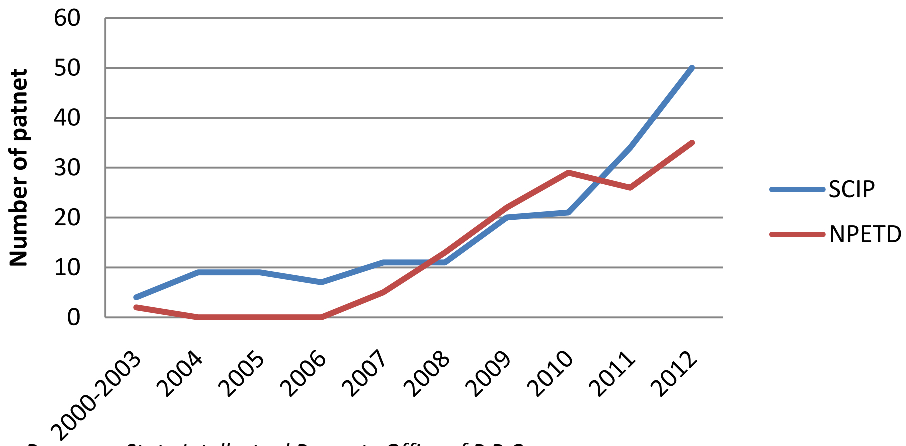
It is critical for SCIP and NPETD to increase the presence of trust. Especially when SCIP and NPETD cooperate for development, it will be important for them to increase the presence of trust and then reinforce the cooperation relationship. If the presence of trust is too low in the cluster of SCIP and NPETD, the tenants are less likely to interact. As a consequence, they cannot benefit from advantages of the clustering of SCIP and NPETD, such as presence of customers and suppliers, knowledge spillover and so on. The cooperation between SCIP and NPETD will make less sense.

4.2.2 Quality of innovation regime

The quality of innovation regime influences the cluster performance on innovation. Hereby, the quality of innovation regime is reflected on the number of patents. However, this is different from the analysis of the diversity of knowledge and information resource. In this section, the patents also are collected, when they are classified as “Group C” according to IPC. The difference is that the focus lies on investigating the changes of the number of patents over years in SCIP and NPETD instead of the types of patents, in order to analyze the relevant policies for innovation.

In order to compare the performance of clusters on innovation, we get insight into the patents registered from 2000 to 2012. This is displayed in Figure 19. According to Figure 19, it is tough to recognize who performs better on innovation. In general, SCIP and NPETD both show an increasing trend. SCIP is developed since 2004, and the territory was almost fully developed in 2006. NPETD was established in 2003, but its 60% territory was still unoccupied in 2006. We can see in Figure 19 that between 2000 and 2003 (before the development of SCIP and NPETD), there is a little patents registered. Those patents are registered under two government enterprises, namely Sinopec Shanghai Gao-Qiao Company and Sinopec Zhenhai Refining & Chemical Company. This implies there is lack of innovative activities. After the development of cluster, SCIP appears more patents, whereas NPETD still shows no patent. After 2006 when more enterprises enters the cluster, SCIP and NPETD both shows a steady increase in number of patents. That is to say, the development of cluster boosted the innovations. More and more patents are developed and researched, since the cluster has been developed in several years.

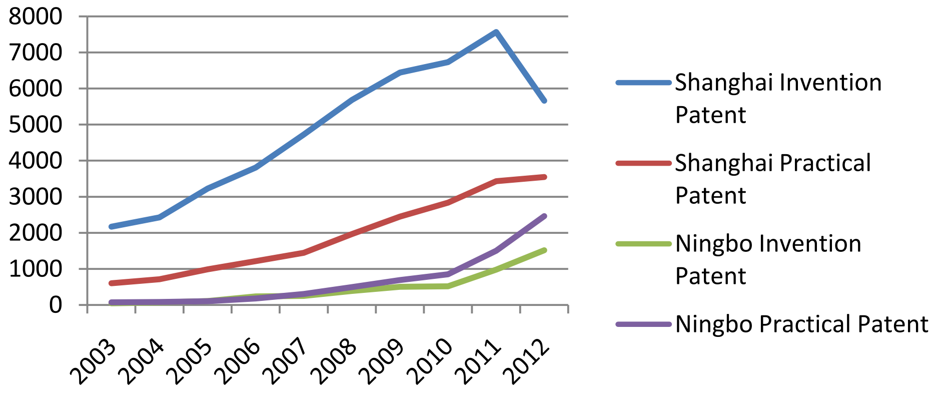
Figure 19: The number of patents of SCIP and NPETD over years



Resource: State Intellectual Property Office of P.R.C

The constant achievements on innovation in SCIP attribute to its strategy of production and research integration. Since the construction of SCIP in 2004, the administration committee already endeavors to attract R&D institution into the cluster by granting a special fund every year. There are three blocks within the cluster that are planned as R&D centers. First, SCIP has developed an integration of enterprises, universities and Research Institutes with East China University of Science and Technology (ECUST). It involves a R&D center and a production plant, namely Huachang Polymer Co., Ltd. of ECUST. This enterprise has contributed 38 patents to the cluster. Second, Sinopec Research Institution of Basic Organic Material Engineering Research Center is another important R&D center within the cluster. This institution is under Sinopec. And Sinopec in SCIP contributes 26 patents. Third, it is a waste water treatment R&D center, invested by Suez Group, ECUST and Tongji University. The construction of R&D centers plays an important role in innovation. On the other hand, NPETD has not planned any block within the cluster to be R&D center. Furthermore, NPETD has no special fund to encourage R&D within the cluster or to attract R&D institutions. Even though it is not clear that SCIP performs better than NPETD on innovation, the innovation in NPETD seems to be dependent on the manufacturers themselves. The administration committee of NPETD focuses on introduction of foreign talents, such as the technologies from Huntsman and Davy. In addition, NPETD spends financial fund on transactions in technology. NPETD takes different strategy from SCIP to solve the innovation problems.

Figure 20: The number of chemical patent of Shanghai and Ningbo over 2003 to 2012



Resource: State Intellectual Property Office of P.R.C

In order to investigate whether the cluster governance effectively facilitates innovation, we compare the patents of clusters with the city level. The number of patents in “Group C” of Shanghai and Ningbo city is shown in Figure 25. It shows that the number of patents of both cities is constantly increasing. This implies that the ability of innovation of Shanghai and Ningbo are progressing over years. However, comparisons of Figure 19 and Figure 20 show that the city level of innovation is greatly higher than the cluster level. On one hand, the number of patents of clusters only accounts for a extremely small part of the patents of city. On the other hand, the number of patents of city level is growing relatively faster than that of cluster level. It tells that the quality of innovation of the two clusters has not kept pace with the city level. SCIP and NPETD both should put more effort on facilitating innovation in the clusters. Particularly relative to the city level, SCIP seems to perform poorer than NPETD. It illustrates that it is insufficient to only encourage constructing R&D centers in the cluster. It is also important for SCIP to facilitate manufacturers themselves to invest in innovation.

SCIP is a good example that illustrates that the cooperation between cluster tenants accelerates innovation. But the innovation in NPETD depends on enterprises or associations outside the cluster. The cooperation between SCIP and NPETD will enhance the incentives for innovation. The funds in NPETED used to purchase technology or patent from outside can be used to encourage R&D within the cluster of SCIP and NPETD. They can share the results of R&D. Moreover, the tenants in NPETD can also cooperate with the R&D centers in SCIP to develop new projects for innovation. This is beneficial for NPETD to solve the problems of lack of innovative activities and beneficial for SCIP to collect more financial support for R&D.

4.2.3 Quality of internationalization regime

Internationalization is beneficial for port cluster. The benefit might come because of the international knowledge and accessibility to external market. Sometimes, the internationalization of a cluster can be affected by the cluster policies. In other words, appropriate policies or strategies will lead to the internationalization of port cluster. In this section, the internationalization of SCIP and NPETD are assessed by the origins of manufacturer's shareholders in the clusters. The two clusters will be compared. Also the reasons that lead to the difference will be analyzed.

Table 7: The category of manufacturers in terms of investment

The category of manufacturers	SCIP	NPETD
Domestic invested enterprise	35(52.2%)	70(84.4%)
Sino-foreign joint venture	6(9.0%)	6(7.2%)
Wholly foreign owned enterprise	26(38.8%)	7(8.4%)

Resource: company websites and Investment Shanghai, combined and classified by author

According to the composition of shareholders of those manufacturers within SCIP and NPTED, they are divided into three categories: wholly domestic invested enterprise, Sino-foreign joint venture, and wholly foreign owned enterprises. The result of SCIP and NPETD are present in Table 7. As we can see, only 15.6% of manufacturers (7.2% Sino-foreign joint venture plus 8.4% foreign owned enterprises) within NPETD are invested by foreign shareholders, whereas almost half manufacturers (9% Sino-foreign joint venture plus 38.8% foreign owned enterprises) within SCIP are invested by foreign shareholders. It should be recognized that SCIP is more international than NPTED. Furthermore, the enterprises in NPETD that provide utilities, logistics service and other services all are invested by domestic shareholders. On the other hand within SCIP, the enterprises that provide water, sewage treatment, industrial gas, cogeneration and tank farm all are foreign owned or Sino-foreign enterprises. Compared to NPETD, the cluster of SCIP is much more international. The question is raised how international the cluster of SCIP is.

The internationalization of SCIP is evaluated by investigating the origin of the shareholders. The result is summarized in Table 8[4].The origin of the foreign investors involve the USA, Germany, Hong Kong, Japan, the UK, France, Switzerland, Austria, Belgium, India, Italy and Taiwan[5]. The investors are all over the North America, Europe, and Asia. We cannot deny that those foreign investors bring international knowledge to the cluster and it may improve the productivity. Due to the unavailability of the enterprise's assets, it is unable to compare how much assets are controlled by different shareholders. However, we found that 5 out of 7 large-sized and 5 out of 7 medium-sized manufacturers are foreign invested, such as famous brands Lucite, Huntsman, Schaetti, Evonik Degussa and Bayer. Accordingly, a large part of assets in SCIP is controlled by the international firms. Besides, 23 out of 33 foreign owned enterprises or joint venture are specialized in producing fine or specialty chemicals. This also adds value to the cluster. All in all, SCIP is a typical case of internationalized cluster. Those international manufacturers do not only control a large part of the assets in SCIP, but also add value to the industrial chain of the cluster. This is greatly different from NPETD.

[4] When the manufacturer is foreign owned or sino-foreign joint venture, the origin of its shareholders all are counted in number of stakes.

[5] The investors from Hong Kong and Taiwan are also considered as foreign investors in Chinese research. For example in China Yearly Statistics Book, it shows that Taiwan and Hong Kong both are important foreign investors.

Table 8: Origin of shareholders in SCIP	
Country	Number of stakes
China	42
USA	12
Germany	6
Hong Kong	3
Japan	5
UK	2
France	1
Switzerland	1
Austria	1
Belgium	1
India	1
Italy	1
Taiwan	1
Resource: company websites, combined by author	

The difference is partly resulted from the cluster policies. SCIP and NPETD both provide the benefit of tax preference to attract the foreign investors. This is based on the China's central government policy. However, SCIP have taken two extra policies to attract foreign investors. First, SCIP grants the encouraged projects compensation awards. SCIP reserves a special fund. SCIP can use the fund to award committed projects in order to accelerate the construction of projects. SCIP has listed 25 encouraged foreign investment projects. Second, SCIP has a more simplified approval procedure than NPETD. In order to facilitate investment in SCIP, it has cancelled unnecessary items and procedures. In SCIP, foreign investors only need 15 workdays to establish an enterprise and only 8 workdays to add business projects. The time duration of administrative approval in SCIP is much less than in NPTED. All in all, SCIP has distinguished the preference policies for foreign investment, whereas the policies in NPETD are the same for domestic and foreign investment. This is an important reason that leads to the internationalization of SCIP.

Table 9: The contribution of foreign invested manufacturers to innovation		
	SCIP	NPETD
Wholly foreign owned	29	0
Sino-foreign	36	19
Resource: State Intellectual Property of Office of P.R.C and company websites, combined by author		

Furthermore, SCIP does not only perform well on attracting foreign investors, but also encouraging foreign enterprises to collaborate with domestic enterprises or research institution for R&D cooperation. As mentioned above, the waste water treatment R&D center is a good example. Table shows that the foreign invested manufacturers in SCIP contribute to R&D results. In addition, the Sino-foreign joint ventures have more patents than wholly foreign owned manufacturers in SCIP, although there are much more wholly foreign owned manufacturers (26) than Sino-foreign joint ventures (6). Plus, the wholly foreign owned manufactures in NPETD do not have any registered patent. However, we found those foreign owned manufacturers have many registered patents under their parent companies. It implies that the foreign owned manufacturers in cluster of SCIP and NPETD, especially NPETD, might do not cooperate with local research institutions or they only invest into manufacturing plants but not R&D activities. To encourage foreign enterprises to collaborate with local institution is also a good strategy to facilitate innovation activities in SCIP. All in all, SCIP does not only perform better on internationalization regime, but also on involving foreign investors into innovation activities.

To cooperate with SCIP, NPETD can take advantages of SCIP's international environment, such as international knowledge and external market accessibility, to develop its own international projects. Because of the internationalization of SCIP, it is more famous with its international reputation all over the world. The cooperation with SCIP will also increase the awareness and popularity of NPETD. It increases the opportunities for SCIP to attract international players to the cluster. Besides, the cooperation will make the cluster of SCIP and NPETD more powerful on negotiation. They can jointly negotiate with foreign investors who are interested investing the chemical industry in Shanghai and Ningbo, in order to let investors agree with innovation investment. Since the foreign investors seems more interested in investing production without R&D activities, it is critical for the cluster to deal with innovative activities that foreign investors will participate.

5 Conclusion

The paper aimed at measuring the chemical cluster performance in Shanghai-Ningbo port delta. The results of cluster performance could be used for cluster governance and management. In other words, we could be led to conclusions on the differences between SCIP and NPETD performance and the possible synergies. This is supposed to give implications on cluster development.

Three sub-questions were designed to achieve the objective. First, the relevant cluster performance indicators should be found, in order to examine the cluster performance from different aspects. Second, the cluster population should be defined, because it is the scope of our research. Third, the final cluster performance indicators should be selected. The performance of SCIP and NPETD should be measured according to the selected performance indicators.

10 performance variables and the relative 15 performance indicators were found. 5 performance variables and 8 performance indicators represent the cluster performance on cluster structure. The rest of 5 performance variables and 7 performance indicators imply the cluster performance on cluster structure. In sum, 15 cluster performance indicators are relevant for the chemical cluster performance measurement. However, there could be more cluster performance variables or performance indicators for chemical clusters in seaports. More performance indicators might be also feasible for cluster performance measurement. The performance variables can be measured from different perspectives and then by different indicators. Besides, the performance variables and indicators are found mainly based on the study of De Langen (2004[b]). There could be other studies that demonstrates different opinions. Therefore, more performance indicators could be relevant for this study.

The cluster population is defined as the 122 firms/organizations within SCIP and 101 firms/organizations within NPETD. According to its economic activities, the cluster population could be classified as manufacturers, Utilities & Service firms, logistics firms and government authorities. In the cluster population, the Utilities & Service firms and logistics firms are shortly discussed. Additional research is needed to investigate the effects of those firms on the chemical cluster performance.

In the final empirical research, 6 cluster performance variables and 7 cluster performance indicators are selected in the end. Respectively, they are 3 performance variables of cluster structure and 3 performance variables of cluster governance. Four variables are excluded from the empirical research in this paper, because of the industrial complexity and data limitation. Therefore, 7 relative cluster performance indicators are finally used for the performance measurement. The results are concluded in Table 10.

Table 10: The cluster performance of SCIP and NPETD

	Performance indicator	Cluster performance of SCIP and NPETD
Cluster structure	The percentage of higher educated employees	Shanghai has a greater labor pool with higher educated people. Two illustrative examples support the greater performance of SCIP on labor pool than NPETD.
	The diversity of cluster population in size	SCIP performs slightly better than NPETD on the diversity of cluster population in size. The existence of 11.9% large manufacturers in SCIP could generate some benefits, such as reputation, for the cluster.
	The diversity of cluster population in product	The cluster population of SCIP is more diverse than that of NPETD in product. The proportion of specialty chemical manufacturers in NPETD is relatively low.
	The diversity of patents	The patents of SCIP are less diverse than the patents of NPETD. This reflects that the knowledge and information resource in NPETD is more various.
Cluster governance	The membership of sector association	The membership rates of the four sector associations all are relatively low. The level of trust within SCIP and NPETD both should be improved.
	The number of patents	The number of patents was steadily increased over the last decades in SCIP and NPETD, although they approach different innovation regimes.
	The number of international firms	SCIP shows to be a more international cluster than NPETD. SCIP also performs greater than NPETD on encouraging the innovation of the international firms.

First, SCIP shows higher quality of labor pool than NPETD. The high quality of labor pool contributes to higher productivity. The education level of labor pool seems to be higher in SCIP. This could be resulted from the developed higher-educational industry in Shanghai. However, additional research is needed to determine more precisely the education level of employees in all enterprises or organizations within the cluster. Second, SCIP also has better performance on the diversity of manufacturers in size. The large-sized manufacturers could create reputation and expand the network. The large-sized manufacturers occupy an important proportion in SCIP, whereas NPETD is lack of large-sized player in the cluster. Third, the diversity of manufacturer in terms of product types also is greater in SCIP. This is beneficial for the manufacturers to enhance cooperation. NPETD has more manufacturers within the cluster than SCIP, but they concentrate on the production of commodities and fine chemical. In short, the industrial chain is more complete in SCIP. Hence, the vulnerability to external shocks is reduced in SCIP. Fourth, the diversity of patents is greater in NPETD. It implies that the knowledge and information resource is more diverse in NPETD than SCIP. Shanghai has more information and knowledge resource available than Ningbo, but the cluster of NPETD shows to have more diverse knowledge and information.

Fifth, the membership rates of the relevant associations all are relatively low. It reflects that SCIP and NPETD both perform poorly on the presence of trust. The low level of trust also influences the cluster performance on the collective action regime, since it is more difficult to collaborate with the cluster tenants and collect them for cooperation. Sixth, SCIP and NPETD have taken different measures to encourage innovation. There result shows that the number of patents is steadily increasing over the last decade. This demonstrates that the innovation regimes that SCIP and NPETD both have made sense. On the other hand, it is critical for SCIP and NPETD to facilitate innovation within the clusters, since innovation level of the cluster cannot reach the city level. Finally, SCIP is a more internationalized cluster than NPETD. The force behind could be the preference policies for foreign investors that SCIP has implemented. Additional reason deserves further study. In short, SCIP performs better than NPETD on internationalization regime. Especially, we found that SCIP has done better on encouraging international firms to be innovative.

Except from the diversity of information and knowledge resource, SCIP has greater performance on the cluster structure than NPETD. The synergies will be created through the cooperation between SCIP and NPETD. This is a win-win scenario, where the weaknesses of the clusters could be complemented. First, SCIP and NPETD could share a labor pool. Then NPETD could also benefit from the high skilled labor of SCIP. Besides, they can work on some projects together to encourage the higher-educated workers or students in Shanghai to work for NPETD as well. Second, the cooperation will make the cluster population more diverse in terms of size, as well as product type. Therefore, the industrial chain could be more complete, and it will reduce vulnerability to external shocks. Third, SCIP and NPETD shows have various patents available. The cooperation will increase the diversity of patents. It gives more opportunities and potential for SCIP and NPETD to develop new products after cooperation, since they share the information and knowledge, and more diverse information and knowledge is available.

In addition, SCIP and NPETD could complement its weaknesses on cluster governance by cooperation. First, the innovation regime of SCIP is to encourage R&D centers and cooperation between institutions and manufacturers. The innovation regime of NPETD is to buy innovations from outside. The cooperation means that the innovation will be more accessible. The cluster of SCIP and NPETD will not only have the ability to develop their own R&D, but also have the innovations from the outside. The differently ways will also increase the innovation diversity. Second, cooperation is a great opportunity for SCIP to be international. The international tenants in SCIP could be the potential entrants for NPETD. Besides, the great international reputation that SCIP has created could help NPETD to be more attractive for international firms. Third, in order to successfully fulfill the synergies that cooperation between SCIP and NPETD can create, it is important to increase the level of trust in the cluster. The presence of trust within SCIP and NPETD both seems to be relative

ly low. It will hinder the cooperation between SCIP and NPETD, because the cluster tenants might not be convinced to cooperate with firms from the other side. If this is the case, the synergies will not take place. Therefore, it is critical for SCIP and

NPETD to increase the presence of trust. This issue of how to increase the presence of trust deserves further research. In sum, cooperation is a great opportunity for SCIP and NPETD to reinforce the cluster competitiveness. Particularly, when the central government removes partly financial support to the western part of China, to create additional cluster advantages is essential for SCIP and NPETD.

This paper explicitly discussed the cluster performance of SCIP and NPETD. However, there exist several limitations of this paper, which deserve further research. First, because only partly relevant performance indicators are selected for the research, it could result in bias in the paper. The chemical performance are not measured on a fully comprehensive level. This issue deserves further empirical study with other relevant performance indicators. Second, this paper only compare the cluster performance of SCIP and NPETD within a port delta. The proximity of cluster location could lead to the bias, since the resources within a port delta can be shared between SCIP and NPETD. Additional research can be developed to compare the chemical cluster in Shanghai-Ningbo port delta with chemical port delta, such as the chemical cluster in Pearl River Delta in China and the chemical cluster in Rhine-Scheldt Delta Port Region. Third, as mentioned in Section 2.4, the value added indicators are the most appropriate performance indicators. This is actually missing in this paper, because it is complicated and difficult to determine which indicators are value added. A challenging task for further research is to define the value added performance indicators for chemical clusters in seaports. All in all, those are the three suggestions for further research.

Appendix

Table 1: List of manufacturers in SCIP

Budenheim Fine Chemicals (Shanghai) Co., Ltd	Bayer Integrated Site Shanghai (BISS)
Eliokem (Shanghai) Co.,Ltd	Shanghai Tianyuan (Group) Huasheng Chemical Co., Ltd)
Lucite International (China) Chemical Co., Ltd	Shanghai Tianyuan (Group) Tianyuan Chemical Factory
Lamberti Chemical Specialties (Shanghai) Co., Ltd	Shanghai Huntsman Polyurethane Co., Ltd
TCI (Shanghai) Development Co., Ltd	Shanghai Lianheng Isocyanate Co., Ltd
Sinopec Shanghai Gao-Qiao Company	Shanghai BASF Polyurethane Co., Ltd
Degussa Specialty Chemicals (Shanghai) Co., Ltd	Shanghai Sinopec Mitsui Chemicals, Co., Ltd
Shanghai Secco Petrochemical Co.,Ltd	Dishman Pharmaceuticals & Chemicals (Shanghai) Co., Ltd
SCHAETTI (Shanghai) Hotmelt Adhesive Co., Ltd.	3M Shanghai Specialty Materials Co., Ltd
Shanghai Shenxing Chemical Co., Ltd.	EOC Polymers (Shanghai) Co., Ltd
Shanghai Chlor-Alkali Chemial Co., Ltd.	Shanghai Huayi (Group) polymer Company
Shanghai 3F New Material Co., Ltd.	Mitsubishi Gas Chemical Engineering-Plastic Co., Ltd
Huachang Polymer Co., Ltd. Of ECUST	Shanghai Guxiang Coating Co., Ltd.
Sinopharm Medicine Holding Co.,Ltd. ,Sinopharm Chemical Reagent Co,Ltd.(SCRC)	Shanghai Tonghui Chemical Industry Co., Ltd.
CCS (Shanghai) Functional Films Industry Co., Ltd.	Shanghai Caide Chemical Co., Ltd
Hao Jin (Shanghai) Fine chemical Co., Ltd.	Shanghai Riduo Macromolecular Material Co. Ltd.
Shanghai Dongsheng Chemicals Co., Ltd.	Peter-Lacke Shanghai Co., Ltd
Shanghai Mao Chang Chemicals Co., Ltd.	Shanghai Caixing Chemical Co., Ltd.
Fujikura Kasei (Shanghai) Co., Ltd.	Air Products and Chemicals, Inc.
Shanghai Rong Jian Chemical Plant	Shanghai You Chuang Chemicals Co., Ltd.
Shanghai Boer Chemical Reagents Limited Company	SHANGHAI RAYCHEM INDUSTRIES CO., LTD.
shanghai Hai Zhou specialty gases co. ltd	Shanghai Zhuowei Chemical Industry Co., Ltd.
Shanghai Mao Yi Coating Co., Ltd.	Shanghai Yilun Fine Chemical Industry Co., Ltd
Shanghai Yi Ji Chemical Co., Ltd.	Au Mei Chemicals (Shanghai) Co., Ltd.
Shanghai Gushan Environmental Energy Limited	Shanghai Chenguang Macromolecular Material Co. Ltd.
Shanghai ShenGuang edible chemicals Co., LTD.	Lord Fine Chemical (Shanghai) Co., Ltd
Shanghai Greif Packing Co., Ltd	AmbioPharm, Inc. (Shanghai)
Shanghai Meiyi New Building Material Co., Ltd.	AMERICAN COLORS INC.
Shanghai Hengyi Polyster Fiber Co., Ltd	Shanghai Shengjia Pharmaceutical Co., Ltd.
Shanghai Qingshang Agriculture Technology Co., Ltd.	Shanghai Pei Yi Chemical Co., Ltd.
China Gateway Pharmaceutical Development Co., Ltd.	Shanghai Celludye Corlorrants Co., Ltd.
Shanghai Huiguang Fine Chemical Industry Co., Ltd	Shanghai Qing Song Pharmaceutical Co., Ltd.

Daicolor Shanghai Mfg. Co., Ltd.	Shanghai Cathay Star Packing & Sealing Co., Ltd.
Shanghai Semperit Rubber and Plastic Products Co., Ltd.	

Table 2: List of companies in Utilities & Service sector in SCIP

shanghai pujiang specialty gases co. ltd	Shanghai Industrial Co., Ltd
Shanghai Da Dong Hai Incorporation Corporation	Shanghai Hua Lin Industrial Gases. Co., Ltd
Sinopec Shanghai Petrochemical Engineering Research Center.	Shanghai Chemical Industry Park Properties Co., Ltd
Shanghai Tian Hao Chemicals Packing Co., Ltd.	Shanghai Chemical Industry Park Employee Technical Association
Shanghai Hengqiang Coil Pipe Accessory Co., Ltd.	Shanghai Chemical Industry Park Import & Export Co., Ltd
Shenglong Electro Plating (Shanghai) Co., Ltd.	Shanghai Chemical Industry Park Technical Consulting Co., Ltd
Shanghai Junan Safety Equipment Co., Ltd	Shanghai Chemical Industry Park Declaration&Inspection Co., Ltd
Bayer Technology and Engineering (Shanghai) Co., Ltd	Shanghai Chemical Industry Park Property Management Co.,Ltd
KAEFER Insulation (Shanghai) Co., Ltd	Shanghai Chemicals Exchange Market Co., Ltd
Shanghai Chemical Industry Park Industrial Gases Co., Ltd	Shanghai Chemical Industry Park Gas Station Co., Ltd
Shanghai Chemical Industry Park Cogen Co., Ltd	Shanghai AMEC Engineering & Construction Services Co., Ltd
Shanghai Chemical Industry Park Sino French Water Development Co., Ltd	Shanghai Feng Jin Auto Reparation Co., Ltd
Shanghai Chemical Industry Park Swire SITA Waste Services Co., Ltd	Fluor (China) Engineering and Construction Co.
Shanghai Chemical Industry Park Common Corridor Co.,Ltd	Hagemeyer N.V.
Schutz Container Systems (Shanghai) Co., Ltd	SGS-CSTC Standards Technical Services Co., Ltd Shanghai Branch

Table 3: List of logistics firms in SCIP

Shanghai Tianyuan Logistics Co., Ltd.	Shanghai Zhongyuan Chemical Logsitcs. Co., Ltd
Youyue Storage (Shanghai) Co., Ltd.	Sinotrans & CSC Holdings Co., Ltd.
Shanghai Tianqi Logistics Co., Ltd.	China Jinshan Petrochemical Logsitcs Co., Ltd.
Shanghai Jun Hao Logistics Co., Ltd.	Vopak Shanghai Logistics Co., Ltd
Shanghai Bei Fang Storage Co., Ltd.	Shanghai Chemical Industry Park Logistics Co., Ltd
Shanghai Xincao Logsitcs Co., Ltd.	Shanghai Chemical Industry Park Storage and Transportation Co., Ltd
Shanghai Port Chemical Freight Co., Ltd.	CITIC Logistics SCIP branch
Sinotrans Chemical International Logsitcs, Co., Ltd.	Shanghai Wei Ming Logistics Co., Ltd

Table 4: List of Government Authorities in SCIP

SCIP Administration Commission Comprehensive Affairs Office
SCIP Administration Commission Planning & Construction Department
SCIP Administration Commission Economic & Trade Department
SCIP Administration Commission Planning & Finance Department
Shanghai Foreign Investment Commission
Shanghai Environmental Protection Bureau
Shanghai Supervision Bureau of Safety Production
Shanghai Maritime Safety Administration
Shanghai Port Authority

Table 5: List of manufacturers in NPETD

Sinopec Zhenhai Refining & Chemical Company (ZRCC)	Ningbo Donglai Chemical Industry Co., Ltd.
Ningbo LG Yongxing Chemical Co.,Ltd	Ningbo Jinyi Alloy Material Co., Ltd.
Ningbo ZRCC Lyondell Chemical Co., Ltd.	Ningbo Yongxing Chemical Co., Ltd.
Zhenhai Petrochemical & Industrial Trade Co.,Ltd	Ningbo Detai Chemical Co., Ltd.
Zhejiang Hangzhou Acrylic Co., Ltd.	Sinochem Ningbo Chemicals Co., Ltd.
Ningbo Jinhai Deqi Chemical Industry Co., Ltd.	Ningbo Renjian Pharmaceutical Co., Ltd.
Aekyung Petrochemical Co., Ltd.	Ningbo Shunze Rubber Co., Ltd.
Zhejing Henghe Petrochemicl Co., Ltd.	Ningbo Jialian Plastic Technology Co., Ltd.
Ningbo Xinfu Titanium Dioxide Limited Company	Zhejiang Xinyong Biochemical Co., Ltd.
AkzoNobel Ethenylamine (Ningbo) Co., Ltd	Ningbo Siming Chemical Co., Ltd.
Ningbo Zhenhai Taida Chemical Industry Co., Ltd.	Ningbo Longxin Fine Chemical Co., Ltd.
Ningbo Oceanking Chemical industry Co., Ltd.	Ningbo Yonghua Resin Co., Ltd.
Ningbo Juhua Chemical Industry Technology Co., Ltd.	Ningbo Xiandai fine chemicals Co., Ltd.
DAICEL (Ningbo) Chemical Industry CO.,LTD.	Ningbo Jinhui Chemical Co., Ltd.

Ningbo Yongshun Fine Chemical Co., Ltd.	Ningbo Bishui Chemical Co., Ltd.
Ningbo Bohui Petrochemical Co., Ltd.	Ningbo Medicine Technology Research Co., Ltd.
Ningbo Zhengguang Resin Co., Ltd.	Ningbo Shunfan Water Purifier Co., Ltd.
Ningbo Zhenhai Biochemical Technology Co., Ltd.	Ningbo Poly-Chem Co., Ltd.
Ningbo Xinlongxin Chemical Co., Ltd.	Ningbo Shino Cosmetic Cotton Co., Ltd.
Ningbo Hyde knitting dye co., LTD	Ningbo Kylin Craft Article Co., Ltd.
Ningbo Liwah Plant Extraction Technology Co., Ltd.	Ningbo Xinming Chemical Industry Limited Company
Ningbo Wofuu Plastics Limited	Ningbo Yuan'ou Fine Chemical Co., Ltd.
Ningbo Dahongyin Bio-Engineering Co., Ltd.	Ningbo Xingda Chemical Industry Materials Co., Ltd.
Ningbo Rubber Co., Ltd.	Ningbo Donghai Plastics Limited Company
Ningbo Bofan Bathroom Co., Ltd.	Ningbo Yingfa Boron-natrium Co., Ltd.
Ningbo Barunte Petrochemical Co., Ltd.	Ningbo Qiushi Chemical Industry Co., Ltd.
Ningbo Oretel Polymer Co., Ltd.	Ningbo Shuanglida Chemical Co., Ltd.
Ningbo Noali Chemical & Technology Co., Ltd.	Zhejiang 929 Chemical Co., Ltd.
Ningbo Majesta Chemicals Co., Ltd.	Ningbo Kangpu Chemical Co., Ltd.
Ningbo Fuhai Environmental Protection Technology Co., Ltd.	Ningbo Yinxun Mechanical Chemical Co., Ltd.
Ningbo Sanda Chemical Industry Co., Ltd.	Ningbo Zhenhai Zhongcheng Chemical Co., Ltd.
Ningbo Yonggu Chemical Co., Ltd.	Ningbo Yakeli Chemical Co., Ltd.
Ningbo Dingtai Chemical Co., Ltd.	Ningbo Jufen Chemical Co., Ltd.
Ningbo Haili Chemical Co., Ltd.	Ningbo Zhongjin Petrochemical Co., Ltd.
Jieshijie Engineering plastics limited company	Ningbo Heyuan Chemical Co., Ltd.
Ningbo Tianli Petrochemical Co., Ltd.	Ningbo Jiangning Chemical Co., Ltd.
Ningbo Zhongmao New Wall Material Co., Ltd.	Zhejiang Huatai Chemical Co., Ltd. (Ningbo)
Ningbo Hubang Chemicl Co., Ltd.	Ningbo Yuantai Chemical Co., Ltd.
Ningbo Dada Chemical Co., Ltd.	Ningbo Liansheng Dyeing And Finishing Co., Ltd
Zhejiang Golden Suntown Chemical Limited	Ningbo Huali Petrochemical Co., Ltd.
Ningbo Yilong Packing Material Co., Ltd.	Ningbo Donghua Carbon Dioxide Co., Ltd.
Ningbo Huana Chemical Co., Ltd.	

Table 6: List of companies in Utilities & Service sector in NPETD

Ningbo Jiufeng Cogen Co., Ltd.	Ningbo China Science Green Electricity Co., Ltd.
Ningbo Zhenhai Thermomax Limited	Ningbo Chemical Industry Research Design Institute
Ningbo Bihai Water Co., Ltd.	Ningbo Aipu Environmental Protection Co., Ltd.
Ningbo Dadi Chemicl Engineering and Environmental Protection Co., Ltd.	Ningbo Zhenhai Haijingrao Corrosion protection Co., Ltd.

Table 7: List of government authorities in NPETD

Ningbo Chemical Industry Park Management Association
Social Affairs Management Centre
Supervisory Bureau (Auditing Bureau)
Construction and Management Authority
Economic Development Authority
Invesment and Cooperation Authority
Administration of Work Safety
Finance Bureau
Administration Service Centre

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