



The Competitiveness of Global Port-Cities: The case of Hong Kong – China



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ABSTRACT

This working paper offers an evaluation of the performance of the port of Hong Kong, an analysis of the impact of the port on the territory and an assessment of policies in this field. It examines port performance over the last decades and identifies the principal factors that have contributed to it. The effect of the port on economic and environmental questions is studied and quantified where possible. The major policies governing the port are assessed, along with policies governing transport and economic development, the environment and spatial planning. Based on the report's findings, recommendations are proposed with a view to improving port performance and increasing the positive effects of the port of Hong Kong.

JEL classification: R41, R11, R12, R15, L91, D57

Keywords: ports, regional development, regional growth, urban growth, inter-regional trade, transportation

FOREWORD

This study is the ninth in a series of case studies within the *OECD Port-Cities Programme*, directed by Olaf Merk (OECD). This programme aims to identify the impact of ports on their territories and possible policies to increase the positive impacts of ports on their territories.

This working paper is part of a series of *OECD Working Papers on Regional Development* published by the OECD Public Governance and Territorial Development Directorate. The study on the case study was directed and written by Olaf Merk (Administrator OECD Port-Cities Programme) and Jing Li (Consultant OECD). César Ducruet (CNRS – Université de Paris I Panthéon-Sorbonne) also provided contributions to the study. Within the framework of this study, interviews with a series of actors and stakeholders have been conducted. Invaluable support was provided by Christine Loh, Under Secretary for the Environment in the Hong Kong Government.

The paper can be downloaded on the OECD website: www.oecd.org/regional/portcities

Further enquiries about this work in this area should be addressed to:

Olaf Merk (olaf.merk@oecd.org) of the OECD Public Governance and Territorial Development Directorate.

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EXECUTIVE SUMMARY

Hong Kong is the gateway to the world's manufacturing centre, the Pearl River Delta, which includes Guangdong province in China, and which accounted for 26.7% of Chinese exports in 2011. Ranked as the third-largest container port in the world in 2011, it is located in close proximity to the fourth- and seventh-largest container ports, namely Shenzhen and Guangzhou.

Hong Kong has lost market share, due to phenomenal growth rates in competing ports such as Shenzhen and Guangzhou. In the last decade, the former differences in quality have disappeared, with ports in mainland China spectacularly increasing their efficiency. At the same time, price differences remain: the Port of Hong Kong is relatively more expensive. Due to scarcity of land, Hong Kong has become one of the ports with the highest land productivity in the world (approximately 60 000 TEU per hectare per year). The focus of the port has shifted slightly towards trans-shipment functions. In this respect, Hong Kong is advantaged by the Chinese maritime cabotage law, which restricts domestic cargo handling to Chinese vessels, but from which Hong Kong is excluded. If this cabotage law was liberalised, other Chinese ports might capture part of Hong Kong's current trans-shipment cargo.

A major challenge of the port relates to hinterland accessibility. The costs of cross-boundary trucking between Hong Kong and mainland China are the single biggest element in the cost difference between Hong Kong and other regional ports in Guangdong.

The port-city of Hong Kong is a leading maritime cluster. Main factors underpinning this cluster are regulation and taxation favourable to global business, an active maritime community and incentives to attract and train manpower in the maritime sector. Competing ports, such as Shenzhen, have not been able to match this, but Shanghai has started to develop a similar maritime cluster. Quality of life is an important element that could underpin the competitive of Hong Kong as an international maritime cluster. This underlines the importance of air quality and an attractive harbourfront.

It is also a regional leader in green port policies. A voluntary fuel switch programme, the Fair Winds Charter, was initiated by major shipping lines in 2010. The government followed up with environmentally differentiated port dues in 2012, giving rebates for ships switching to low-sulphur fuel. The government is currently introducing legislation that will require all ocean-going vessels berthing in Hong Kong to switch to low-sulphur fuel ($\leq 0.5\%$). The goal is to create an Emissions Control Area (ECA) for the Pearl River Delta. Co-operation between Hong Kong and the Guangdong province has been increasing. Intensifying this co-operation and improving regional governance could be a source of opportunities for Hong Kong.

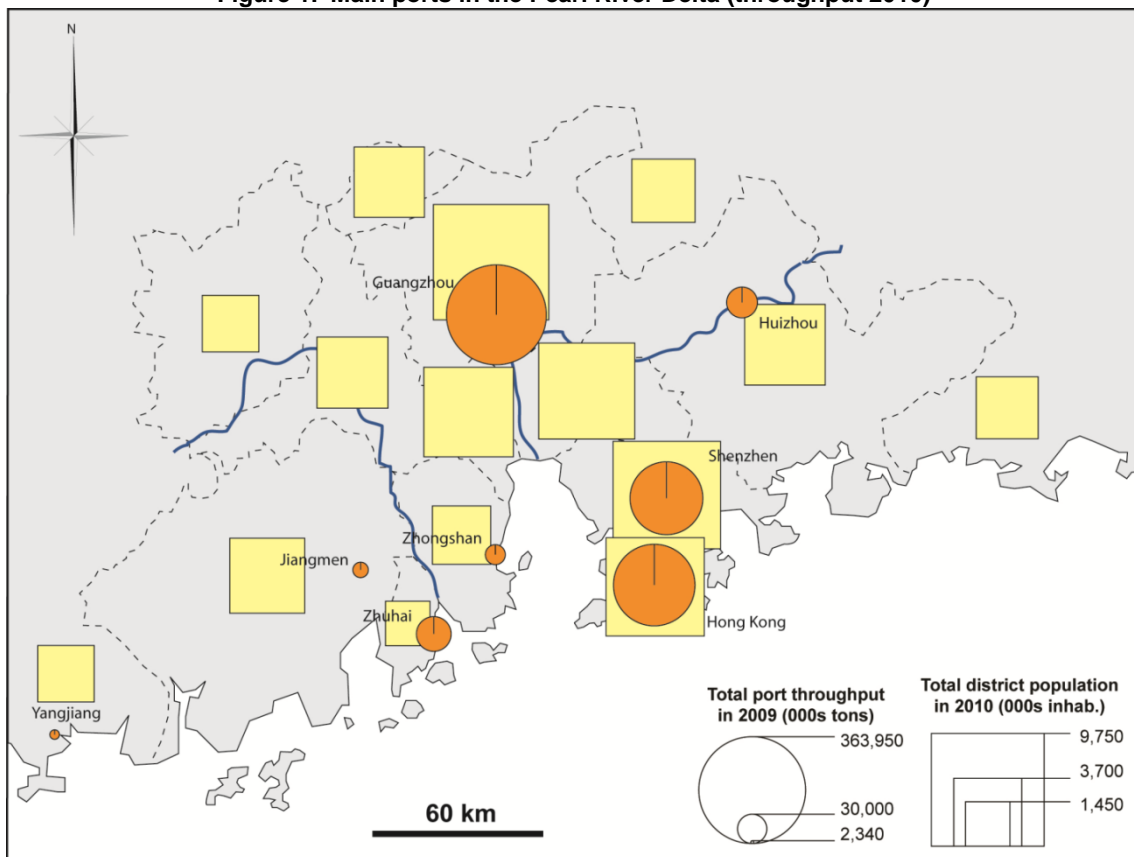
1. PORT PERFORMANCE

1.1 Port characteristics

Hong Kong can be considered the gateway to the manufacturing centre of the world: China's Pearl River Delta. The port of Hong Kong is not only serving the metropolitan area of Hong Kong itself, home to a population of 7 million inhabitants, but it also located just next to the Guangdong province, with 104 million inhabitants one of the most populous and densely populated Chinese province, home to large cities such as Shenzhen (11 million) and Guangzhou (14 million).

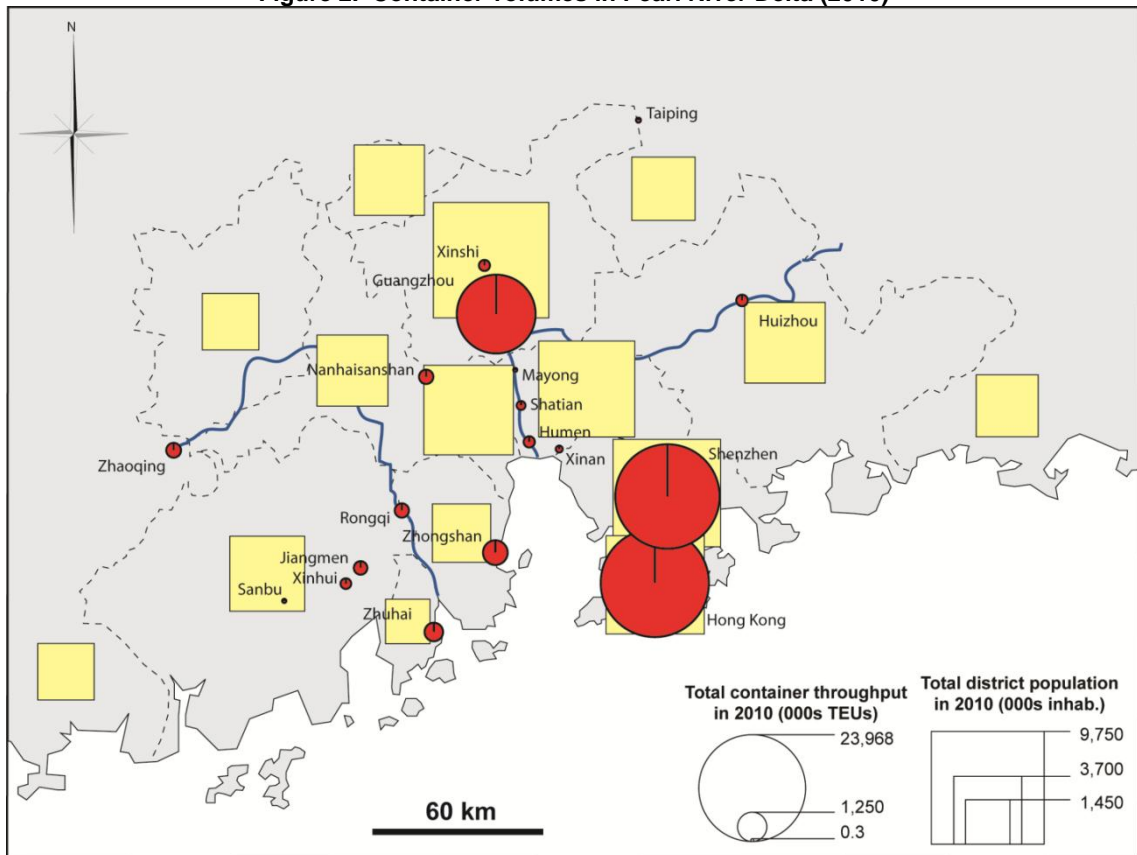
Hong Kong is a very large port located near other very large ports. It was the 3rd largest container port in the world in 2011 (10th in terms of tonnage). Once the undisputed leader in the region, the rise of China, in particular the Pearl River Delta, as a manufacturing power has brought with it the rise of Chinese ports associated with this increase in external trade, including Shenzhen (4th largest container port, 15th in terms of tonnage) and Guangzhou (7th largest container port, 5th in terms of tonnage). Other ports in the Pearl River Delta include Huizhou, Zhuhai and Zhongshan (Figure 1-2).

Figure 1. Main ports in the Pearl River Delta (throughput 2010)



Source: Own elaboration

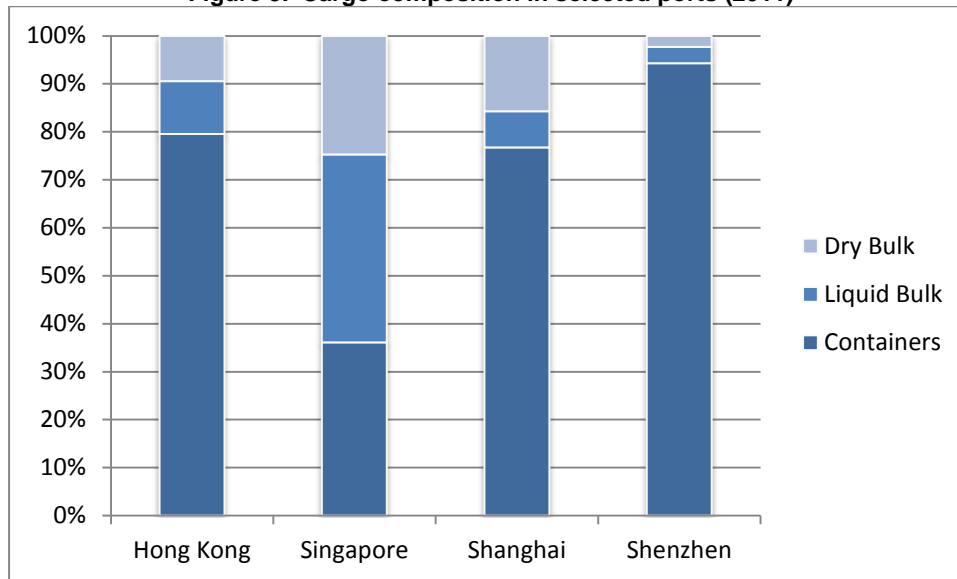
Figure 2. Container volumes in Pearl River Delta (2010)



Source: Own elaboration

Container traffic dominates total port traffic, but less so than its direct competitor Shenzhen. In this last port, around 95% of port traffic is related to containers, and only a marginal share to liquid and dry bulk. In Hong Kong the container share is approximately 80%, with around a tenth of port traffic related to liquid bulk and another tenth to dry bulk. This cargo composition is roughly in line with the one of Shanghai, where containers also represent approximately 80% of port traffic, but where the share of dry bulk is relatively larger and the share of liquid bulk relatively smaller. The cargo profile of the other very large Asian port, Singapore, is distinctly different, with liquid bulk representing 40%, containers a third and dry bulk a fourth of total traffic (Figure 3).

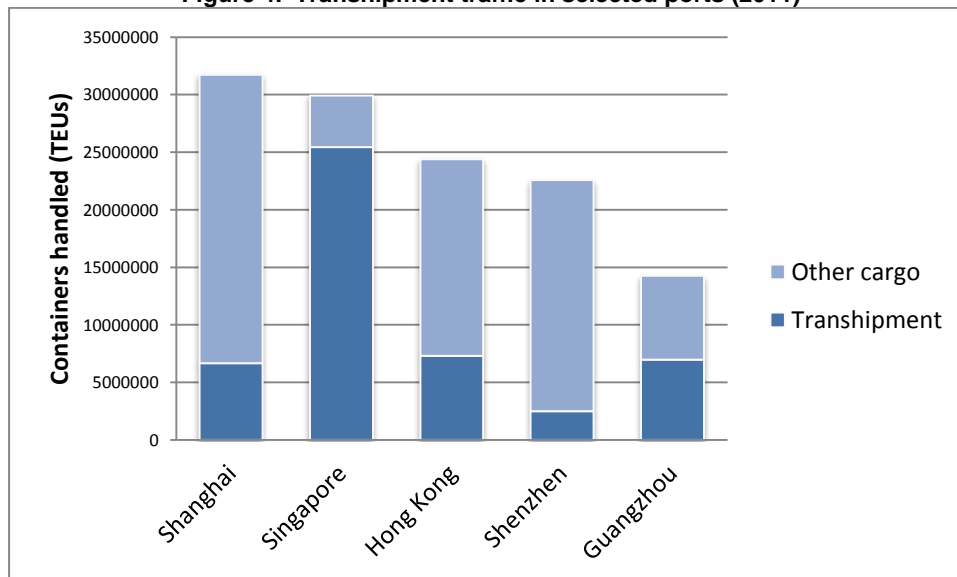
Figure 3. Cargo composition in selected ports (2011)



Source: own elaboration based on vessel movement data from Lloyd's Marine Intelligence Unit

Hong Kong can be considered a gateway port, even if it has certain transshipment functions. Its sea-to-sea transshipment rate is 30%, the rest of its traffic is gateway traffic related to the region. This transshipment rate is in line with the one of the port of Shanghai (21%), and is more than double the one of Shenzhen (11%). The profile of Singapore is again completely different with a transshipment rate of approximately 85% (Figure 4): this can be explained by its strategic location in the Malacca straits and its relatively small home market.

Figure 4. Transshipment traffic in selected ports (2011)



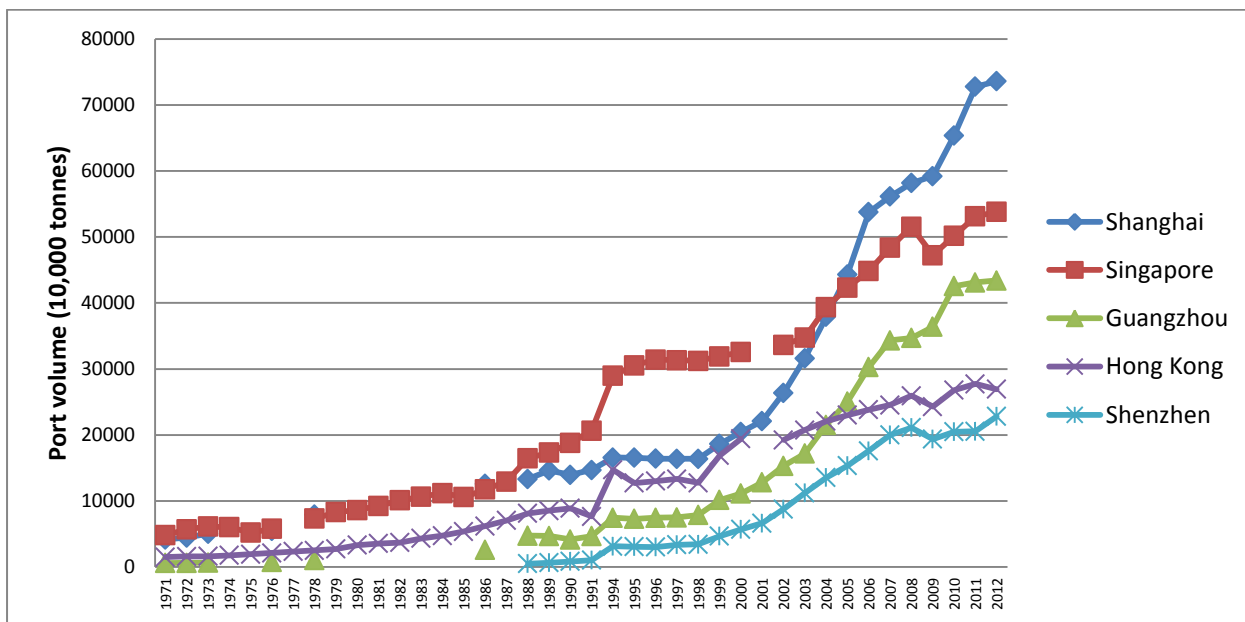
Source: own elaboration based on data from Drewry and own data collection

1.2 Port performance

Hong Kong has had sustained port growth over the last decades, but recent growth rates are relatively modest in comparison to those of the largest ports in mainland China. The growth of the port of Hong

Kong over 1972-2012 has been phenomenal: over these forty years it increased almost 18 times its original size, compared to a growth factor of ten in Singapore. However, growth rates have levelled off in the last decade, with growth rates of Guangzhou (average growth rate of 18% per year over 2002-2012), Shenzhen (16%) and Shanghai (18%) outpacing Hong Kong's (4%). As a result, the total tonnage of Shanghai port is now almost twice as much as the one of Hong Kong, and the port of Guangzhou has become larger than the one of Hong Kong (Figure 5).

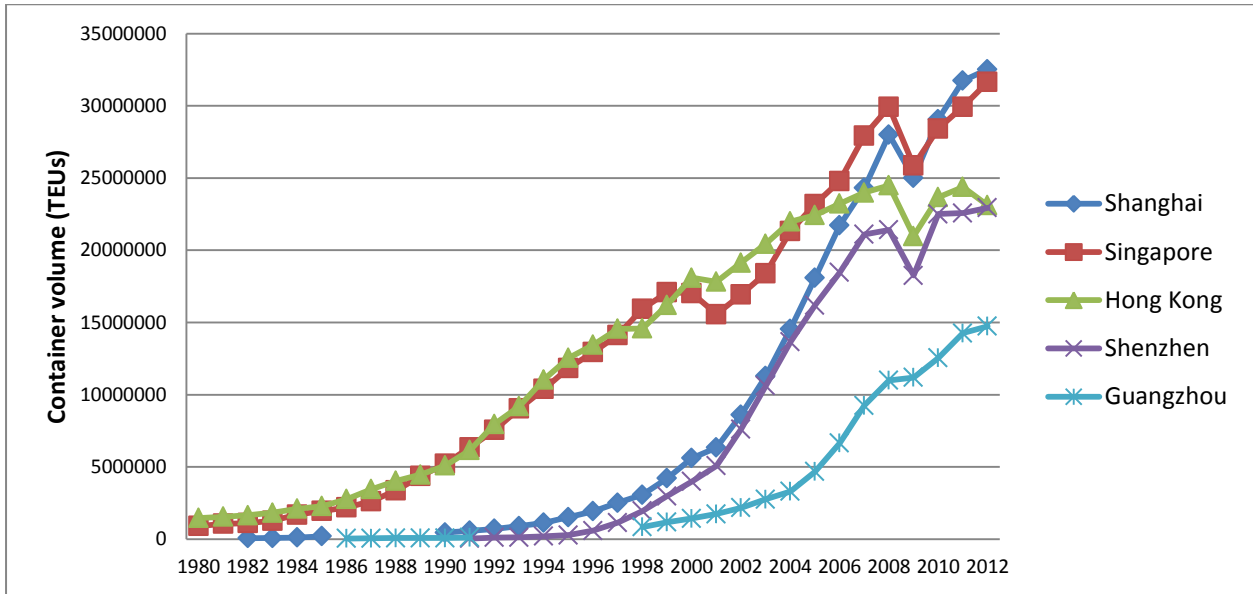
Figure 5. Port growth in selected ports (1971-2012)



Source: own data collection based on various data sources

Similar growth patterns in the container segment underline the decline of Hong Kong as the dominant regional port. The container throughput and growth rates of Hong Kong and Singapore were similar throughout the 1980s and 1990s, but Hong Kong lost pace in the second half of the 2000s. Impressive growth rates in container volumes took place in the ports of Guangzhou (average annual growth rate of 57% over 2002-2012) Shanghai (28%) and Shenzhen (20%), in comparison with 2% in Hong Kong. As a result, Hong Kong lost its position as largest port of the region and lost market share to the ports of Shenzhen and Guangzhou.

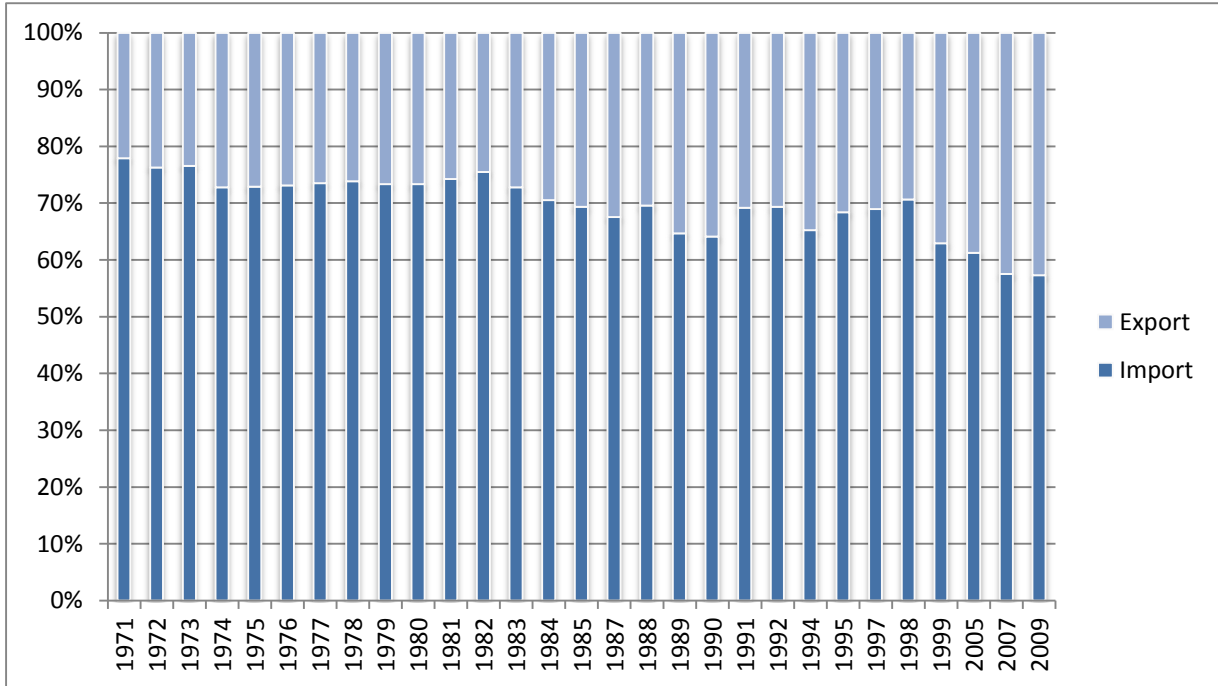
Figure 6. Container port growth in selected ports (1980-2012)



Source: own data collection based on Containerisation International database

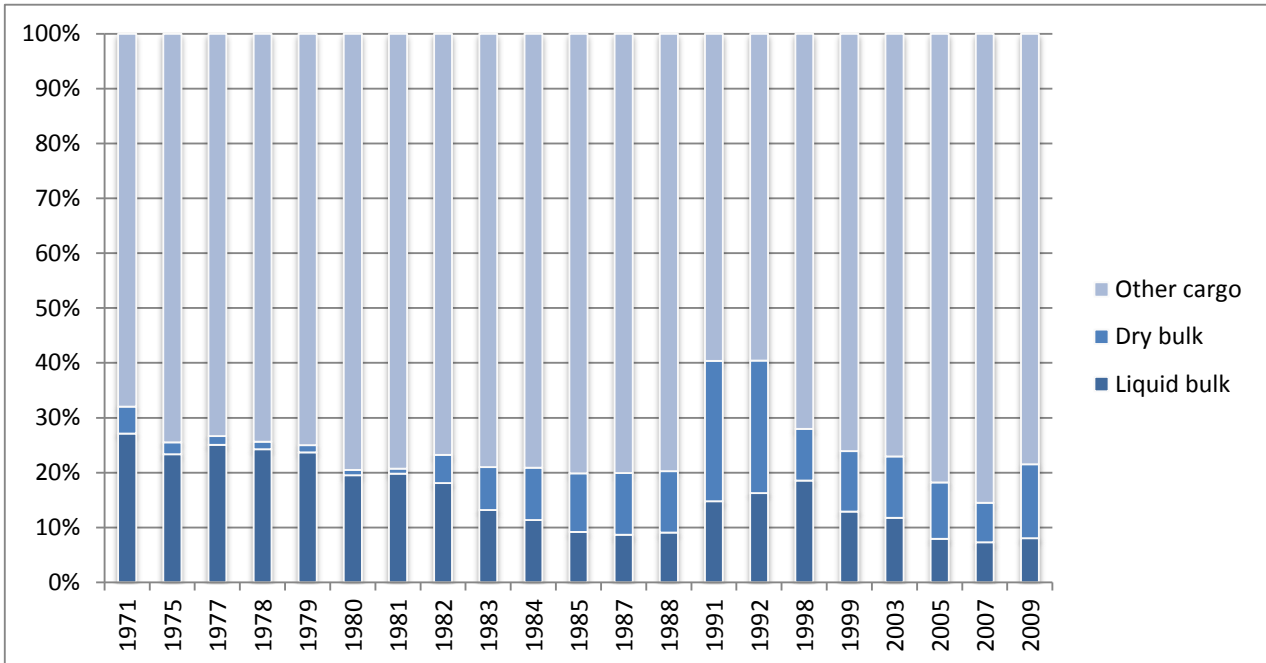
Over the last four decades, the relative export share has increased and the importance of liquid bulk decreased. In the beginning of the 1970s, the share of imports of total port volume almost reached 80%, this was less than 60% during the last years (Figure 7). This gradual decrease illustrates the emergence of the Pearl River Delta as a large exporting region; at the same time imports continue to be dominant in the port of Hong Kong; this could suggest that Hong Kong is frequently used as a gateway to the Pearl River Delta, whereas other Chinese ports in the region are more frequently used for exports. The share of general cargo (other cargo) in total port cargo has remained more or less stable at 80%, with a relatively decrease of liquid bulk in the 1970s and 1980s, and a relative increase of the importance of dry bulk since the 1980s (Figure 8).

Figure 7. Export/import-rates of port of Hong Kong (1971-2009)



Source: own data collection based on Journal de la Marine Marchande

Figure 8. Development of cargo types (1971-2009)



Source: own data collection based on Journal de la Marine Marchande

1.3 Determinants of port performance

The three main determinants for competitive ports, identified here, are: extensive maritime forelands, effective port operations and strong hinterland connections.

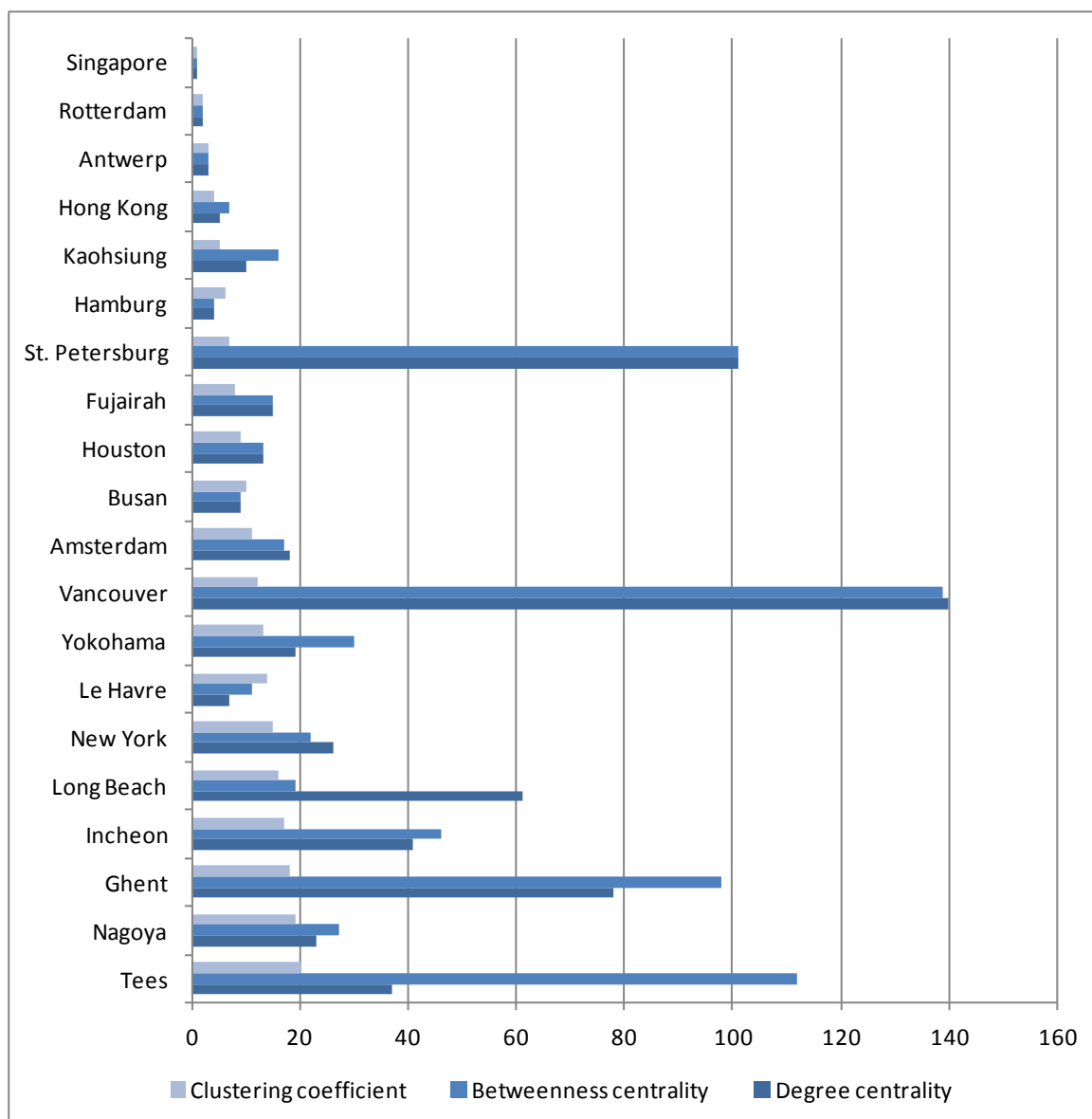
Maritime forelands

Maritime connectivity is essential for competitive ports as they determine the frequency of shipping services. Ports with more extensive maritime connections are more attractive to shippers as these ports can offer direct services and this speedier delivery of goods. If sufficient volume is shipped between these ports, frequency of shipping services and thus greater reliability can be guaranteed. If maritime forelands provide a competitive advantage for ports that can attract additional shipments, maritime connectivity is also a dependent variable: more competitive ports will be more attractive for various reasons (e.g. port efficiency or good hinterland connections), attract new traffic for that reason, and thus achieve more extensive maritime forelands. There are however also specific policy instruments to increase maritime connectivity, that will be discussed below.

Maritime connectivity not only refers to number of connections with other ports, but also the place of a specific port in networks (centrality). There are various indicators to measure port centrality, including degree centrality, betweenness centrality and clustering coefficient. Larger ports are generally more connected and more centrally positioned in maritime networks, which is logical, but there is not a perfect correlation between size and port centrality; some large ports manage to be much more connected than other ports of similar size.

Hong Kong is among the world ports one of the most central ports in port networks. It scores within the top 5 of all port centrality measures that we calculated (Figure 9). Although it is ranked behind Singapore, the most central port of the world, and the European ports of Rotterdam and Antwerp, it is far more central than Shenzhen or Shanghai, and thus be considered better connected to other ports. This can also be illustrated visually, by mapping ports and their dependent ports: that is, ports with their single most important link. Figure 10 illustrates that there are many ports directly and indirectly dependent on Hong Kong, as is also the case for the port of Singapore, and – to a lesser extent – for the Korean port of Busan.

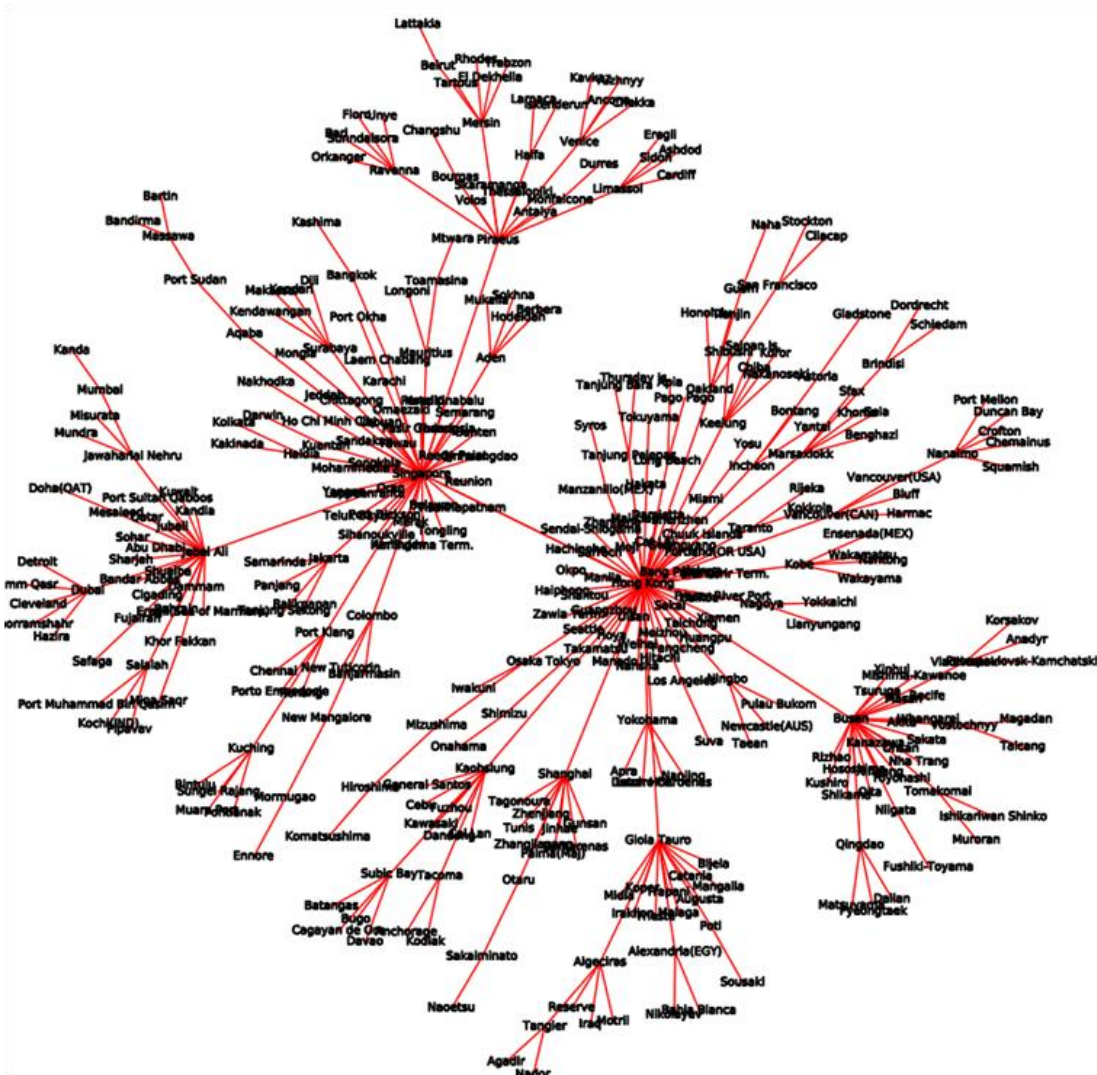
Figure 9. World port ranks on centrality measures (2011)



Source: Author's own elaboration based on dataset from Lloyds Marine Intelligence Unit (2011)

Note: the horizontal axis indicates the port rank on the three different indicators. Degree centrality expresses the number of adjacent neighbours of a node; it is the simplest and most commonly accepted measure of centrality. It often correlates with total traffic (more connections imply more traffic). Betweenness centrality expresses the number of shortest paths going through each node. The clustering coefficient estimates whether the adjacent neighbors of a node are connected to each other (i.e. "my friends are also friends"), thus forming triangles (triplets); the coefficient is the ratio between the number of observed triplets and the maximum possible number of triplets connecting a given node.

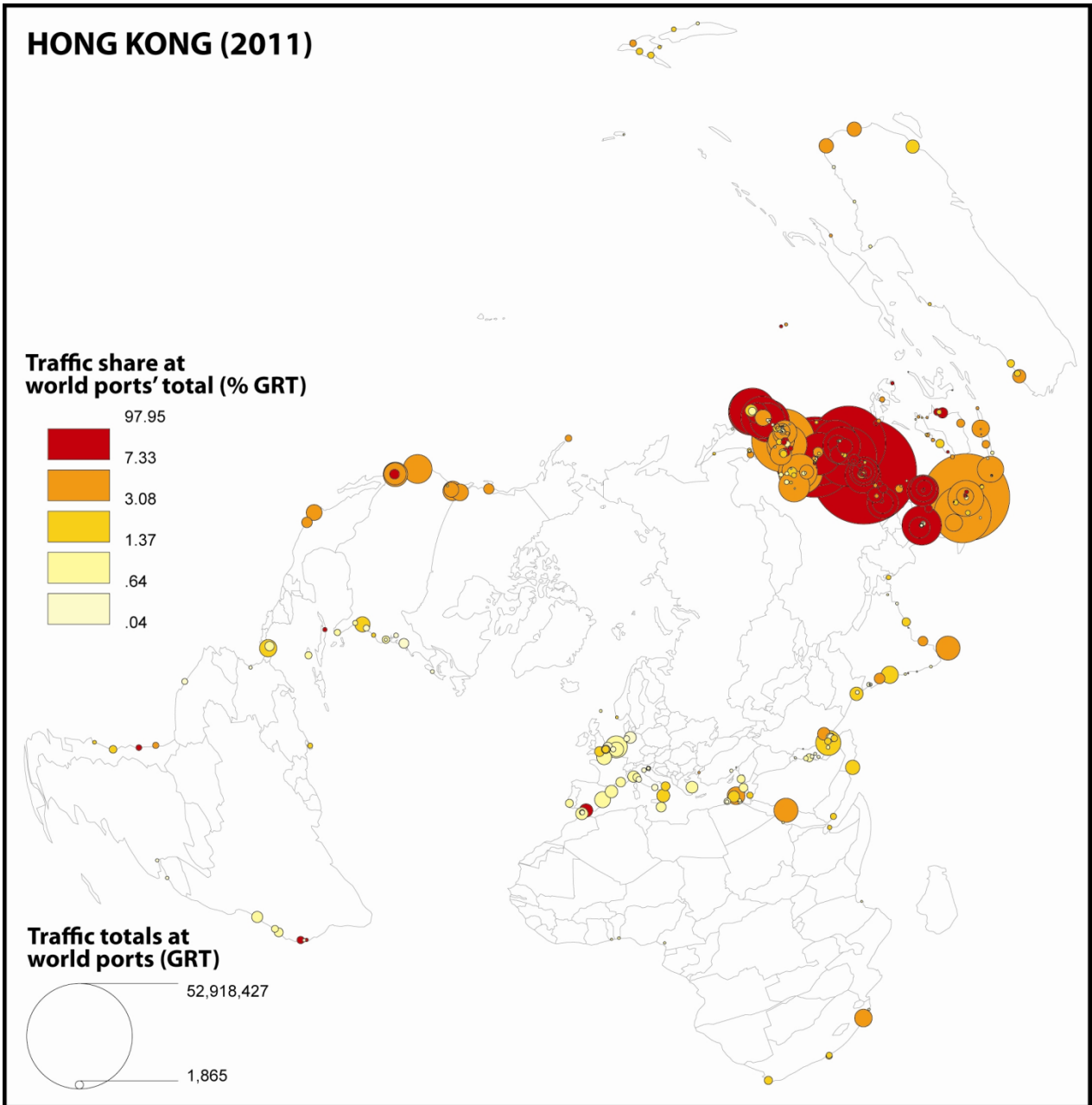
Figure 10. Container port hubs



Source: own elaboration based on dataset from Lloyds Marine Intelligence Unit (LMIU)

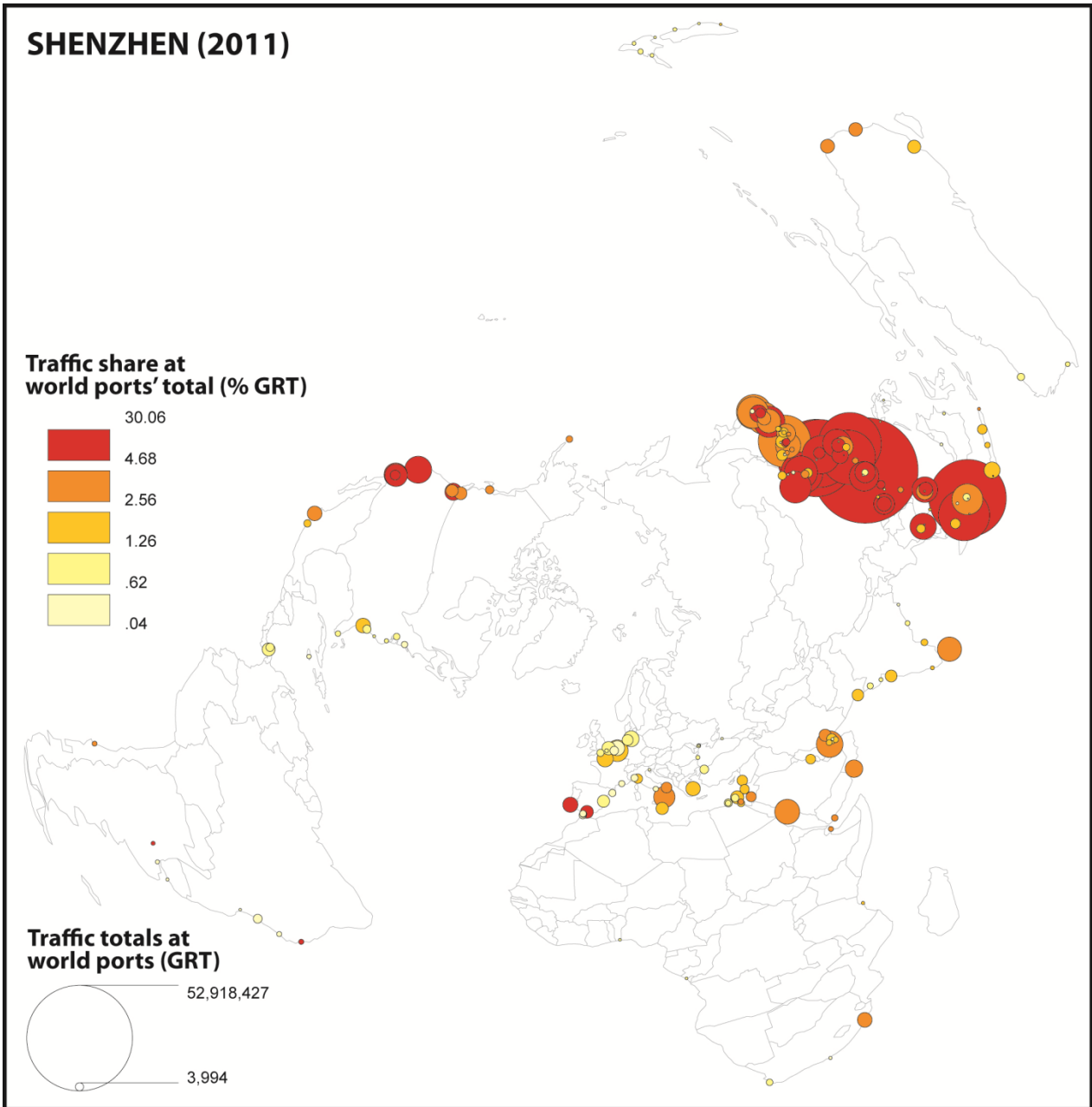
Despite Hong Kong’s central position, most of its maritime connections overlap with those of Shenzhen’s. This can be illustrated through mapping the intensity of the maritime connections of the ports of Hong Kong and Shenzhen. Figures 11 and 12 show that Hong Kong and Shenzhen share to a large extent the same maritime connections, as well as the intensity of these links. Although such overlaps are quite common for large seaports in close proximity, there are also cases where this is much less the case and where maritime connections are more complementary. For example, the port of Hamburg has strong maritime connections with Asia, whereas the nearby port of Bremerhaven has strong maritime connectivity with North America, which provides synergies between the two ports (Merk and Hesse, 2012).

Figure 11. Maritime forelands of Hong Kong port (2011)



Source: own elaboration based on dataset from Lloyds Marine Intelligence Unit (LMIU)

Figure 12. Maritime forelands of Shenzhen port (2011)



Source: own elaboration based on dataset from Lloyds Marine Intelligence Unit (LMIU)

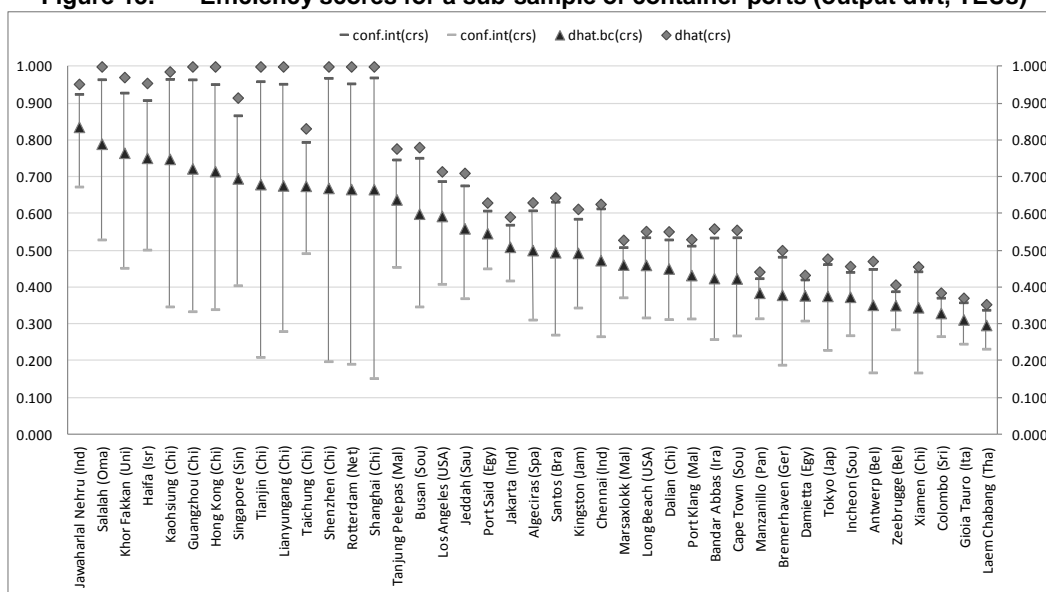
Port operational efficiency

There are various performance indicators for port operations, that all provide part of the picture of port performance. Main performance metrics exist on the level of cranes, berths, yards, gates and gangs, both in terms of utilisation rates (such as TEUs/year per crane, vessels/year per berth, TEUs/per year per hectare, and containers/hour per lane) and productivity (moves per crane-hour, vessel service time, truck time in terminal and number of gang moves per man-hour). These statistics are collected and sold by specialised consultancies; their databases indicate that on average in large port terminals the following performances

are reached: around 110,000 TEUs handled per crane, 25-40 crane moves per hour, a dwell time of import boxes of 5-7 days and export boxes of 3-5 days. Performance benchmarks on terminals other than container terminals are rarer. The port of Hong Kong scores generally well on most of these performance indicators, but this also the case of most Chinese ports.

Hong Kong is among the most efficient ports in the world. This can be concluded from our research (Merk and Dang 2012) that focused on port performance from the angle of port efficiency: how many throughputs (tonnes or TEUs) are reached using similar inputs (such as cranes, quay length and terminal surface). This study used Data Envelopment Analysis and various controls (as explained in annex 1). With regards to the efficiency of container terminals, Hong Kong is ranked among the most efficient ports, alongside Singapore and other Chinese ports such as Guangzhou, Tianjin and Shenzhen (Figure 13).

Figure 13. Efficiency scores for a sub-sample of container ports (output dwt, TEUs)

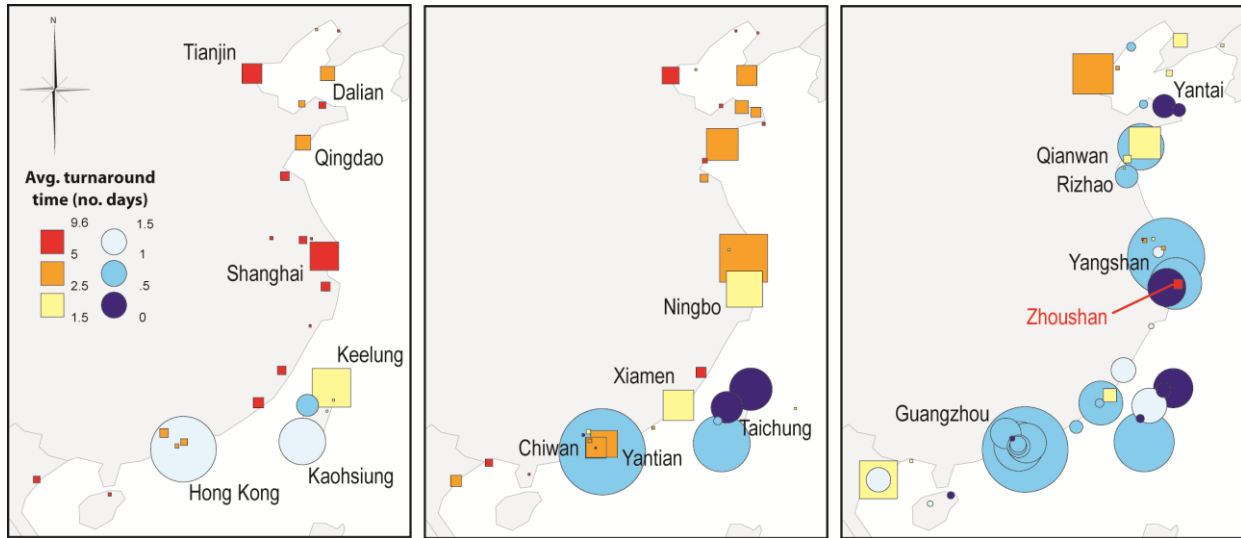


Source: Authors' own calculations.

Port performance can also be expressed by low vessel turn-around times in a port. This is the average time that a vessel stays in a port before departing to another port, which is known through detailed vessel movement data, as collected by Lloyd's Marine Intelligence Unit (LMIU). This turn-around time is generally considered to be an important determinant of port competitiveness as quick turn-around allows for reduction of port congestion and larger port throughputs. An overview of average turn-around time per port is provided in Ducruet and Merk (2013). The most time efficient ports can be found in East Asia, Europe and the Caribbean, whereas the least time efficient ports are located in Africa and South Asia (including India).

Hong Kong has positive scores on vessel turnaround time, but Chinese ports have caught up. Whereas in 1996, both the port of Hong Kong and Kaohsiung had a competitive advantage vis-à-vis mainland Chinese ports, this is no longer the case in 2011. An assessment of vessel turn-around times over time illustrates the rapid increases in time efficiency of Chinese ports; still very inefficient in 1996, these ports have become among the most time efficient ports in 2006 and 2011. Within the Pearl River Delta, all large ports now have an average turnaround time of ships of around half a day (Figure 14).

Figure 14. Port efficiency in China 1996-2006-2011



Source: Own elaborations based on Ducruet and Merk (2013)

Land productivity

Modern port terminals require a relatively large amount of land. At the minimum, a functional container port terminal would need a few berths for handling various ships at the same time, a quay side for ship-to-shore operations, a container transfer area, a storage area, an area for delivery and receiving, connected to road and rail lines, a depot for empty containers, a customs area and a truck waiting area. In many cases, logistics activities, such as distribution centres, would also take place in or around the port area. In addition, various ports also locate industries that benefit from the proximity of the port. Most large modern ports take up thousands of hectares, depending on their exact functions and characteristics.

The land intensive character of ports is related to containerisation and increasing ship size. The history of shipping is characterised by a continuous search for reducing costs, resulting in economies of scale, containerisation and continuously increasing ship sizes¹. This has radically transformed ports and waterfronts over the last decades. Traditional port pier-structures became un-functional and were abandoned and left for other use, or were filled in to create larger terminals, with longer quay length and larger temporary storage space. In many cases new terminals are built further away from city centres, with less space constraints.

Hong Kong has a very rate of port land productivity, related to high urban density. Land productivity rates among ports differ widely, indicating the potential that exists for many ports to become more land productive. For example, the average number of TEUs per hectare per year was 49,005 in South East container terminals run by international operators, while this was 9,303 in North America (Drewry, 2010). Our own calculations indicate that the land productivity for Kwai Tsing Container Terminals in Hong Kong was over 60,000 TEU per hectare per year. These high rates of port land productivity have been reached through planning, regulation and the re-location of non-essential functions. In Hong Kong multi-storey warehouses have been erected in order to rationalise space. However, there is a complex co-existence of port and urban functions, with most of the port terminals closely located near highly densely populated areas.

Labour relations

The container terminals in Hong Kong are widely known for their exceptional productivity and reliability, however, a recent month-long labour dispute has put Hong Kong in the spotlight. On March 28th of 2013, a group of approximately 450 crane operators and stevedores from the Union of Hong Kong Dockers organized a 40-day strike against contracting companies that are outsourced by the Hong Kong International Terminals (HIT), which is a subsidiary of Hutchison Port Holdings Trust, to demand a 20% pay rise and better working conditions. The dispute ended when the strikers finally accepted the offer of 9.8% increase of wage for all workers and improved working conditions.

During the labour strike, Hong Kong Department of Labour intervened and worked as a mediator to facilitate the relevant parties to engage in direct dialogue and hold conciliation meetings for employers and employees. In a Press Release from a Legislative Council meeting on May 8th, the Secretary for the Labour and Welfare Bureau said the estimated amount of lost wages that were aggregated during the strike was more than \$10 million (HKSAR, 2013a). He also indicated that the labour relations in Hong Kong was generally in a stable condition over the past few years and such large-scale industrial actions were not common. The overall employment situation in Hong Kong is still favourable as the unemployment rate is relatively low as 3.5% (ibid.).

Behind the record-long strike, the fundamental problems of growing social divisions and widening income inequalities have also sharply surfaced to the public limelight. The strikers alleged that their salaries have not increased since 2003, while the property prices and other living costs have skyrocketed in the past decade in Hong Kong. The dock workers chose to target the local tycoon Li Ka-shing, Asia's richest man and the owner of the Hutchison conglomerate. They protested outside his downtown headquarter office and residence, and called for a boycott to Hutchison's other businesses. The worker's plight also received the support from many social groups. The Hong Kong Federation of Students organized donation and Hong Kong Confederation of Trade Unions provided daily subsidies for the workers. Financial contribution also came from the International Longshore and Warehouse Union (ILWU) longshore division, the International Federation of Transport Workers, and transport workers unions in Japan, Australia, and the Netherlands.

The dispute has brought consequences to the terminal operation at Hong Kong port. According to a local newspaper, the HIT reported that about 100 vessels were forced to divert to nearby port, to avoid the delay in cargo handling caused by the disruption (Sim and Lee, 2013). The April statistics of port container throughput suggested a 10% decline from the same month of 2012 in Hong Kong, and a 0.5% decrease of volume in Shenzhen. Although other reasons may also have contributed to the cargo loss in April, the impacts of the labour dispute have certainly worsened the performance of the Port. The terminal was said to have resumed 80 to 90 per cent of capacity during the stoppage but the strike has called into the question of how viable and efficient of the labour structure at the port since two thirds of HIT's workforce is hired through subcontractors.

Hinterland connectivity

Governance of port cities is increasingly influenced by the process of developing trade corridors. The goal is to integrate the port system in a multimodal transportation network in order to improve market access, fluidity of trade and the integration in an industrial network. In this context, a port must have interfaces between major oceanic maritime trade and economic activities of ports and inland terminals that provide intermodal structures and connections between the forelands and hinterlands (Klink and Geerke, 1998, Notteboom and Rodrigue, 2005). Obviously, business transactions require an adaptation to hinterland means. Conversely, the amplification capacity of transport modes may allow the expansion of

trade. These bonds of mutual causality are now present in the traffic of port cities. The quality and capacity of hinterland modalities, roads and relays are essential to any expansion of trade.

Strong hinterland connections require certain provisions within the port. This includes direct rail access to the quays, smooth interconnections with the railway network outside the port and canals linking berths with inland waterways. These provisions are far from universally applied. In many ports, several moves would be required before a container (or other cargo) arrives on a train wagon or barge; the more moves are needed, the less competitive these modes of transportation get in comparison to truck transport. In other ports, there is no direct link with inland waterways, which means that barges would have to get to the port terminal by sea, which is not allowed for many barges and would require special vessels or changes in ship design. These examples are in many cases related to fallacies in port design, which are not always easy to solve. The ports that have realised sustainable modal splits have extensive railway tracks on port terminals and might have dedicated river terminals and short sea terminals. In Hong Kong, port feeder barges are used to directly transfer cargo from sea-going vessels to barges, without needing quay access.

2. PORT IMPACTS

2.1 Economic impacts

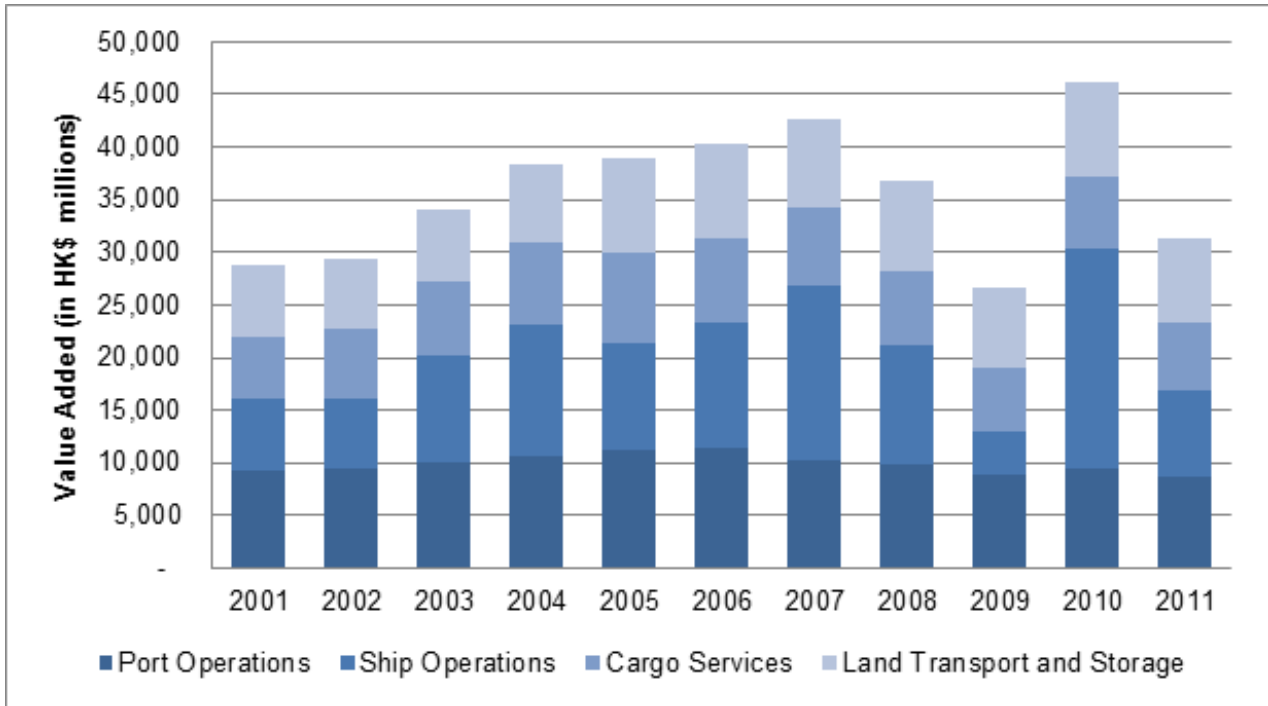
Modest growth in port-related value added

The Hong Kong port cluster generated HK\$31.4 billion (approximately USD 4 billion) of direct value added in 2011. This represents HK\$ 110 per million tonne of port cargo. The port cluster is here defined as consisting of four sub-sectors (Port Operations, Ship Operations, Cargo Services, and Land Transport), following roughly the same categories that were used for the economic assessment conducted for the Hong Kong Port – Master Plan 2020 (GHK 2002). The four direct port-related sub-sectors were all generating more or less similar amounts of economic value added in 2011, with cargo services just slightly less than the other sub-sectors. As statistical classifications changed in 2009, an effort has been made to reconstitute the categories applied in the 2002 study, using data provided by the Census and Statistics Department (C&SD).²

The growth rate of the direct port-related value added over the last decade has been moderate: on average 0.6% per year over 2001-2011. Especially ship operations show cyclical effects; the other components of the port cluster are more stable. Figure 15 shows the contribution of value added from all four main port industry sectors during the period from 2001 to 2011. The international shipping industry was heavily hit during the global financial crisis in 2008 and 2009, and many shipping lines suffered from huge losses in profits due to the falling trade volumes and declined freight rates. Operators of Sea-going Vessels, one of the groups in the Ship Operations sector, hence experienced negative growth in value added in 2009. This is the main reason for the big slump in the figure, representing a 27.5% decrease in the total value added from the previous year. The year of 2011 is also considered to be dismal for the industry as a result of the high fuel cost and the weak demand of trade.

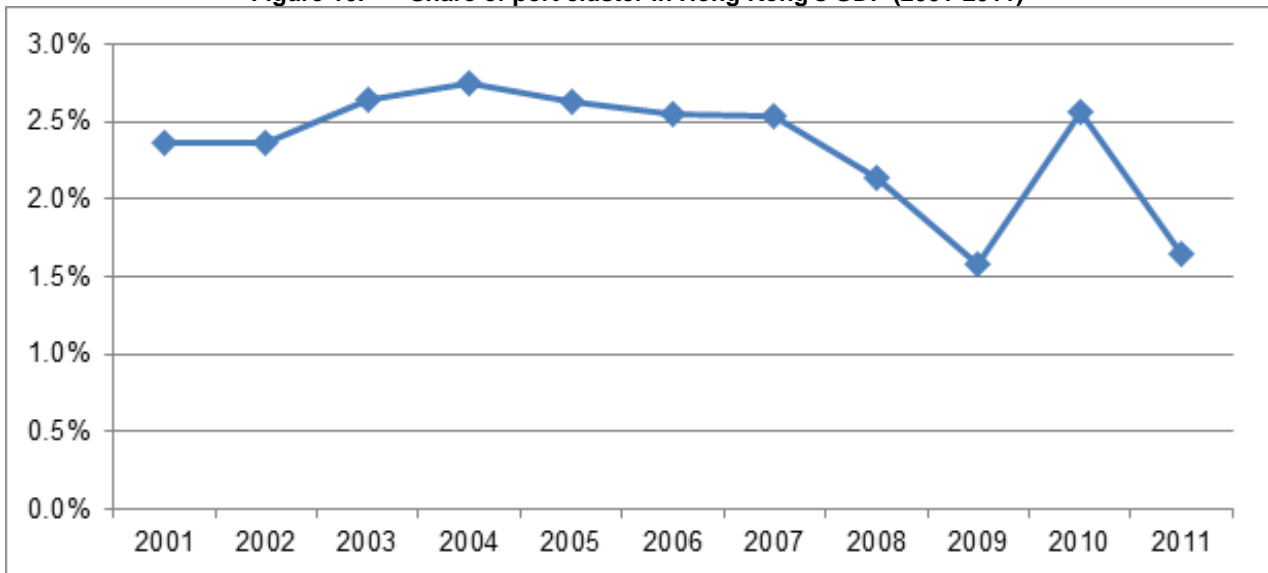
The port cluster represented 1.6% of Hong Kong's GDP in 2011, a share that has declined over the last decade from 2.4% in 2001 (Figure 16). It is not all together clear if this development over the last decade represents a sustained trend or just a cyclical event that will be corrected in the longer term. What is evident is the relative stability of the share in the first half of the decade and the large volatility following the global financial and economic crisis. With shipping being very vulnerable to cyclical developments, the decline of the port-related sector might well represent just a temporary decline. On the other hand, the shares of four key economic sectors in Hong Kong's economy (financial services, tourism, trading and logistics, and professional services and producer services) have been rather stable, except for the financial services sector, which increased to 16.1% in 2011 (Figure 17).

Figure 15. Direct value added of Hong Kong's port cluster (2001-2011)



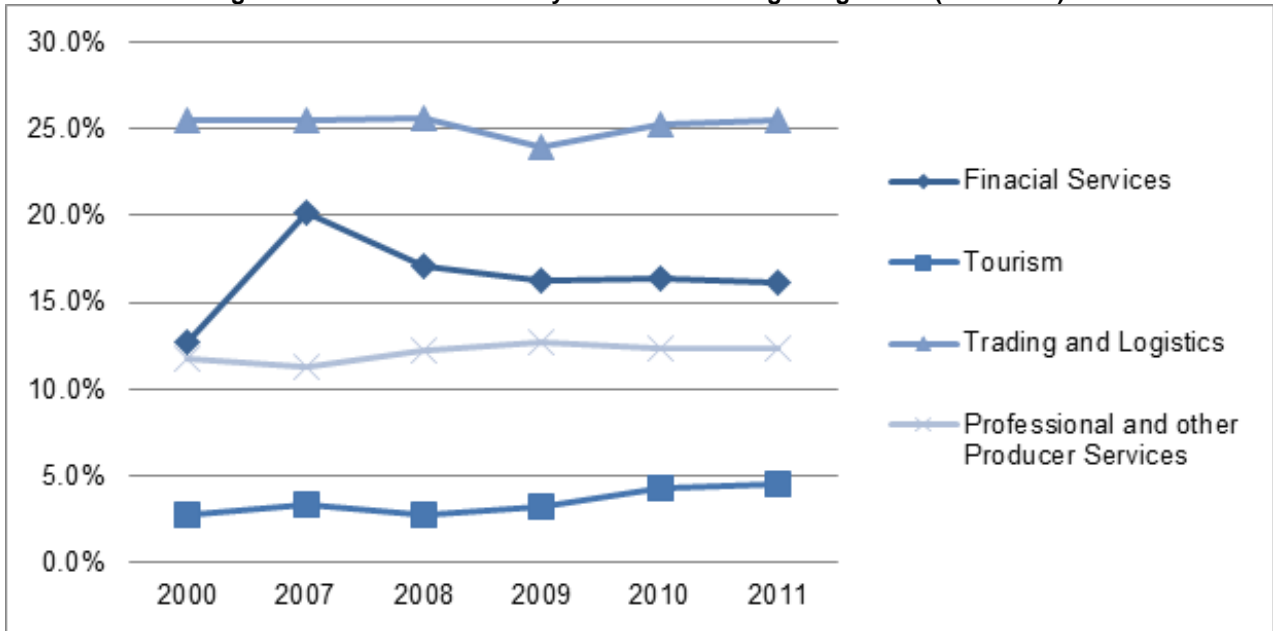
Source: own elaboration on the basis of data from the Hong Kong Census and Statistics Department. Note: constant prices

Figure 16. Share of port cluster in Hong Kong's GDP (2001-2011)



Source: own elaboration on the basis of data from the Hong Kong Census and Statistics Department.

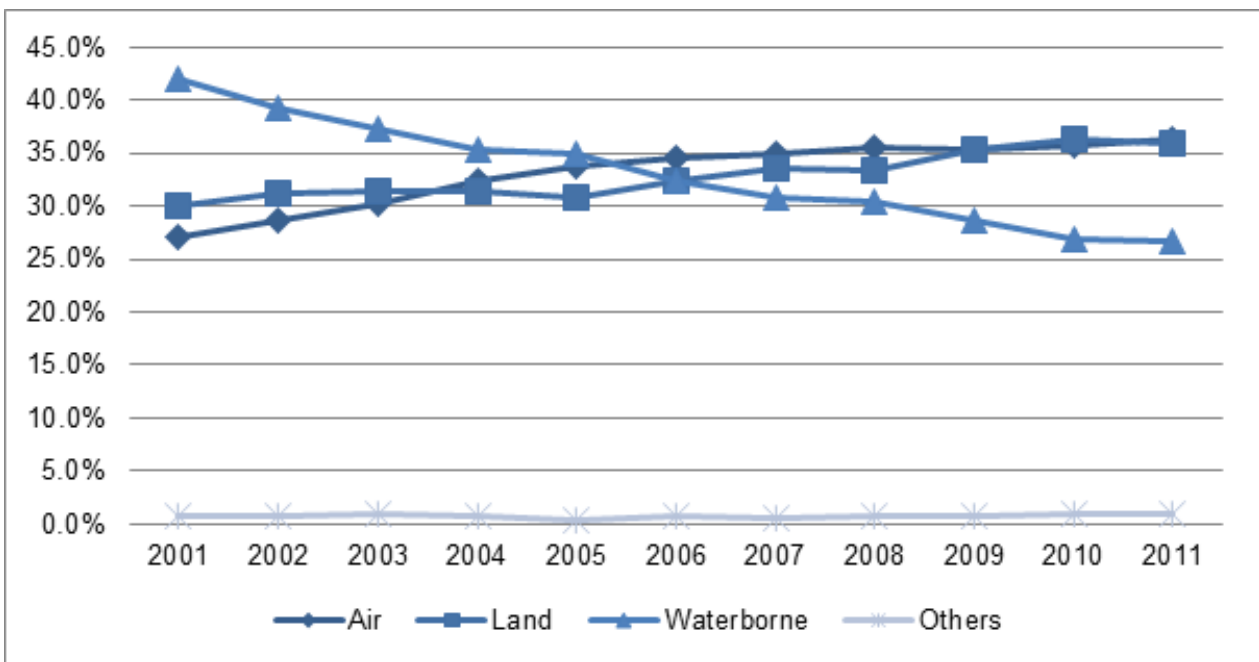
Figure 17. Share of four key industries in Hong Kong's GDP (2000-2011)



Source: own elaboration on the basis of data from the Hong Kong Census and Statistics Department.

In addition, the economic significance of the Hong Kong Port as the trade engine to the city has also declined over the last decade. Freight movement in and out of Hong Kong no longer relies on water transport as the primary mode, but is increasingly replaced by air and road transportation. The ratio of waterborne cargo as a mode of transportation dropped significantly from 42.1% to 26.7% in terms of the total value of Hong Kong's external merchandise trade, while air cargo and land cargo both grew to 36.4% and 35.9%, respectively (Figure 18).

Figure 18. Values of Hong Kong's external merchandise trade by mode of transport



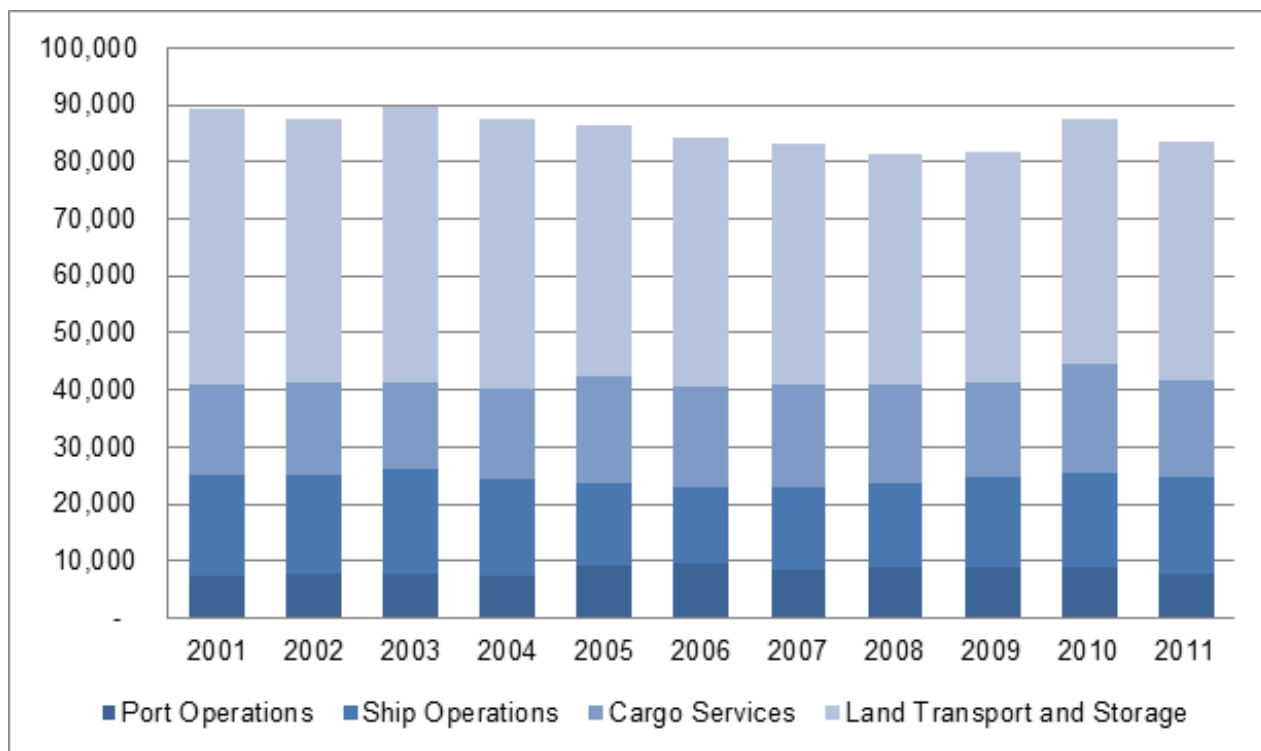
Source: own elaboration on the basis of data from the Hong Kong Census and Statistics Department.

Port-related employment

The port cluster in Hong Kong employed approximately 83,700 persons in 2011. Contrary to economic value added, generated to a more or less similar extent in the four sub-sectors, employment is more unevenly spread over the sub-sectors. Half of the port-related employment is generated in the sub-sector of land transport and storage, a fifth in ship operations, a fifth in cargo services and around a tenth in port operations (Figure 19). Within the land transport and storage sector, the two largest sub-group categories are freight transport by road (excluding tractors) and sea cargo forwarding services, representing 30.7% and 18.4% of port-related employment in 2011.

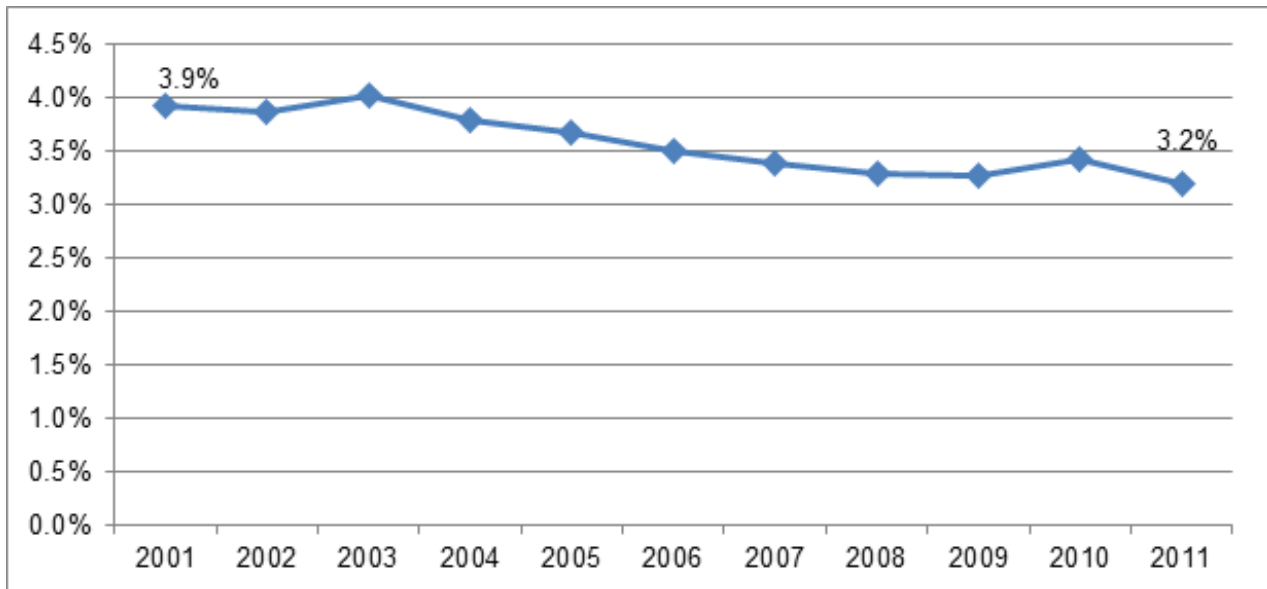
Direct port-related employment has declined over the last decade. The number dropped from 89,454 in 2001 to 83,702 in 2011, representing a 0.64% average annual decrease (Figure 20). This decline is gradual and sustained, with only 2010 being an exception. The most significant contraction is in the land transport and storage sector. This absolute decline also translated into a relative decline of port-related employment in Hong Kong. Over 2001-2011, port-related employment as share of total employment decreased from 3.9% in 2001 to 3.2% in 2011 (Figure 20). In addition, to illustrate the declining labour intensity in the port cluster: one thousand tonnes of port throughput was associated with 0.3 jobs in 2011; while this ratio was 0.5 in 2001. Port-related employment declined while the volume handled at the port has grown by 56% from 2001 to 2011. This may reflect high operating efficiency and productivity at the Hong Kong Port as fewer people are needed to support large volumes, which is consistent with the observations from the HKP2020 (GHK, 2002).

Figure 19. Persons engaged in Hong Kong's port cluster (2001-2011)



Source: own elaboration on the basis of data from the Hong Kong Census and Statistics Department.

Figure 20. Share of port cluster in total Hong Kong employment



Source: own elaboration on the basis of data from the Hong Kong Census and Statistics Department.

Indirect economic impacts

Port clusters can have substantial indirect economic effects. Port clusters can attract other industries that are to some extent dependent or attracted by the port, including in logistics and a variety of industries and services sectors. There can be backward and forward linkages between the port and other economic sectors: there are suppliers to port sectors and the port sectors also supply goods and services to other sectors in an economy. In addition, many port impact studies also calculate induced economic effects, meaning the effects of workers in direct and indirect port sectors spending their salaries. Indirect and induced effect of port clusters are often calculated using input/output-tables that assess the extent of the inter-relations between sectors in an economy. Such I/O-tables are not available (in the public domain) for the Hong Kong economy, which makes it difficult to estimate the indirect economic impacts of the port cluster in Hong Kong. Our estimation of indirect economic effects is based on assumptions used in GHK (2002), which should be used with caution.

The indirect economic impacts of the Hong Kong port cluster could be estimated to be HK\$ 18.8 billion and 29,300 jobs in 2011. These outcomes are based on the assumption of a value added multiplier of 1.6 and an employment multiplier of 1.3-1.4, as used in the economic assessment study made for the Hong Kong Port Master Plan 2020 (GHK 2002). These assumptions were made by analysing the labour market conditions, cargo traffic type and level of direct shipment at the Hong Kong Port, and comparisons with studies on multipliers of other ports like Singapore, Rotterdam, Los Angeles and Oakland. One important assumption of the estimates is that additional productivity would lead to more direct impacts like output and value added but without a net increase in labour supply given the close to full employment labour market situation in Hong Kong. Our own assessment of port-related multipliers, as summarized in Merk (2013), is in line with these scores, giving no a priori reasons for doubting the assumed multipliers.

Total economic effects of the port cluster in Hong Kong amount to HK\$ 50 billion in value added (2.6% of Hong Kong GDP) and 113,000 jobs (4.3% of total employment in Hong Kong).

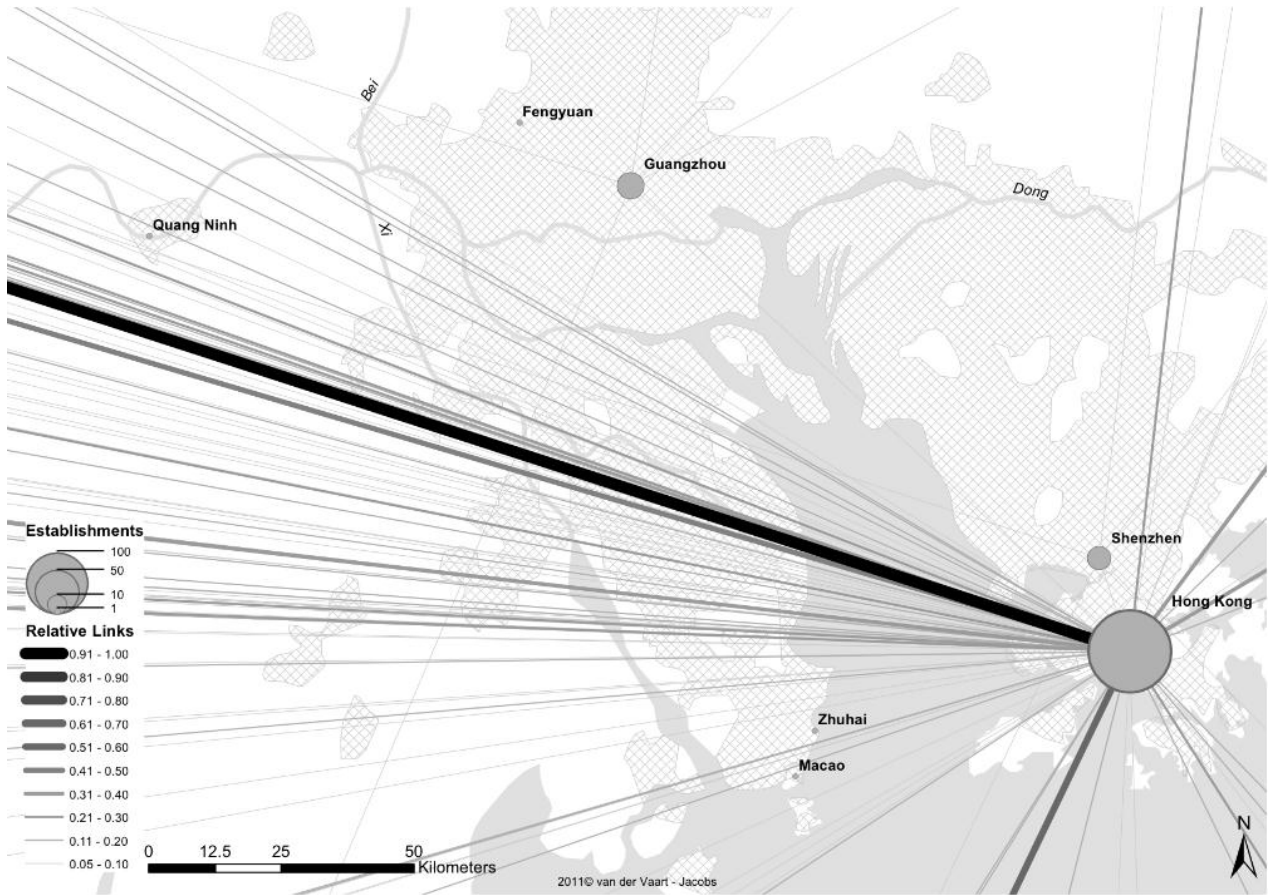
A leading international maritime centre

Ports can be the drivers for advanced maritime service industries, such as ship insurance, brokerage, ship financing, maritime arbitration and so on. Being a free port and an international trading centre, Hong Kong enjoys abundant resources and naturally attracts many businesses. Driven principally by the private sectors, a fast growing number of ship owners and managers came to Hong Kong to register their ships and establish their trade routes, especially since the 1940s. The presence of the vast number of ship owners has been the impetus to attract a host of shipbrokers, ship managers, ship financing banks, ship surveyors, marine insurers, maritime lawyers, arbitrators and other related professionals. According to the Hong Kong Shipowners Association, its members own or manage over 9% of world's total commercial fleet (HKTDC, 2012).

Existing studies almost, unanimously, consider Hong Kong to be one of the leading international maritime services centres in the world. One of the existing studies looks at the leading cities in advanced maritime producer services, defined as multi-office firms for maritime insurance, law and consultancy (Jacob et al. 2011). In this study, Hong Kong is ranked at the fourth maritime services centre in the world, after London, Singapore and New York. Another study identifies main cities from which container shipping companies operate, and analyses the global office structures, selecting from the largest 35 container shipping liners and global terminal operators (Verhetsel and Sel, 2009). Based on the global connectivity of these cities in terms of multi-office networks, six levels of world maritime cities were identified. Hong Kong and Hamburg are the two world maritime cities that are categorized in the first level. Another recent analysis conducted by Menon Business Economics (2012) looked at 12 global cities and compared them by some main indicators, including shipowners and shipping operation, maritime finance, maritime law and insurance, maritime technology and competence, as well as the overall rank. Hong Kong scored in the top five of all the categories except for the maritime technology and competence sector, where it was only ranked eighth. Overall, Hong Kong was considered to be the 5th leading maritime capitals of the world, along with Singapore, Oslo, London and Hamburg.

With regards to this international maritime services-function, Hong Kong is unrivalled in the Pearl River Delta. Both in terms of the number of establishments active in global maritime advanced producer services (APS), and in the connectedness of these establishments with other offices in the world, Hong Kong easily outpaces the other cities in the region. Guangzhou and – to a lesser extent – Shenzhen both host a certain number of these global maritime APS, but much less than Hong Kong. They have a few international links, but these are very limited in comparison with the international links of Hong Kong (Figure 21). Important international links of Hong Kong in this respect are with London, Singapore and Tokyo (Figure 22).

Figure 21. Global Maritime APS nodes and links in Pearl River Delta



Source: own elaborations

Figure 22. Global maritime services in Pearl River Delta



Source: own elaborations

2.2 Environmental Impacts

The environmental impacts of shipping on Hong Kong are substantial, representing up to half of the city's air emissions. According to the Hong Kong Environmental Protection Department (HKEPD, 2013), marine vessels became the largest emission source for respirable suspended particulates (RSP), nitrogen oxides (NO_x) and sulphur dioxide (SO₂) in 2011, accounting for 37%, 33% and 54% of the total emission, respectively. Apart from these pollutants, marine vessels also represent 12% of the total volatile organic compounds (VOC) emissions and 18% of the total carbon monoxide (CO) emissions in 2011. Table 1 shows the emissions from ships by their vessel type. In particular, the 2013 Policy Address also pointed out that the emissions of OGVs at berth constitute for about 40% of their total emissions within Hong Kong waters. According to Kilburn et al, 2012, the marine sources of SO₂ emissions account for 519 premature deaths per year in the Pearl River Delta Region. Their findings also showed that by implementing an Emission Control Area (ECA) in the area that mandates the use of low sulphur fuel (<0.1%), the deaths could be reduced by 91%. Furthermore, three other less comprehensive control measures that are identified would also reduce OGV emissions and associated public health impacts by 41% to 62%, such as switching to 0.5% sulphur fuel at berth for OGVs, switching to 0.1% sulphur fuel, as well as slow steaming, which means OGVs have to slow down their speed to 12 knots per hour in all Hong Kong waters (ibid.).

Table 1. Shipping emissions in Hong Kong in 2011

Vessels	RSP		NO _x		SO ₂	
	tonnes	share	tonnes	share	tonnes	share
OGVs	1,583	25%	16,187	14%	13,563	42%
River	309	5%	9,654	8%	1,993	6%
Local	418	7%	11,893	10%	1,632	5%
Total	2,310	37%	37,734	33%	17,187	54%

Source: Hong Kong Environmental Bureau (A Clean Air Plan for Hong Kong, 2013)

In addition, emissions of cruise ships have started to raise concerns. The first berth at Kai Tak Cruise Terminal opened in June 2013, and 16 cruise ships are expected to visit Hong Kong within the next 10 months after its operation. It is estimated that these ships would bring another 42.6 tonnes of SO₂ and other pollutants to the air in Hong Kong (Ng, 2013). It is however noted that the total at-berth emissions at the Kai Tak Cruise Terminal in its first year of operation will amount to less than 0.02% of the total emissions of all ocean-going vessels in Hong Kong, or 8-9% of the total at-berth emissions of cruise vessels in Hong Kong. But such emissions could scale up quickly when the Terminal develops to its full capacity..

Land use and harbour front development

As the functions of ports evolve over time, the spatial relationships between the port and urban centres are also changing, where port activities are removed from their old sites, which normally occupy prime waterfront locations, to be taken places in areas that are distant from the city core (Notteboom and Rodrigue, 2005). Therefore, port-cities often face the challenges of accommodating the growth for both port uses and urban development that require more land and space. In Hong Kong, where the city is geographically constrained on limited land resources, the government has reclaimed about 2,830 hectares from the Victoria Harbour for over a century in order to meet the needs from growing population and urbanization (Lam, 2012).

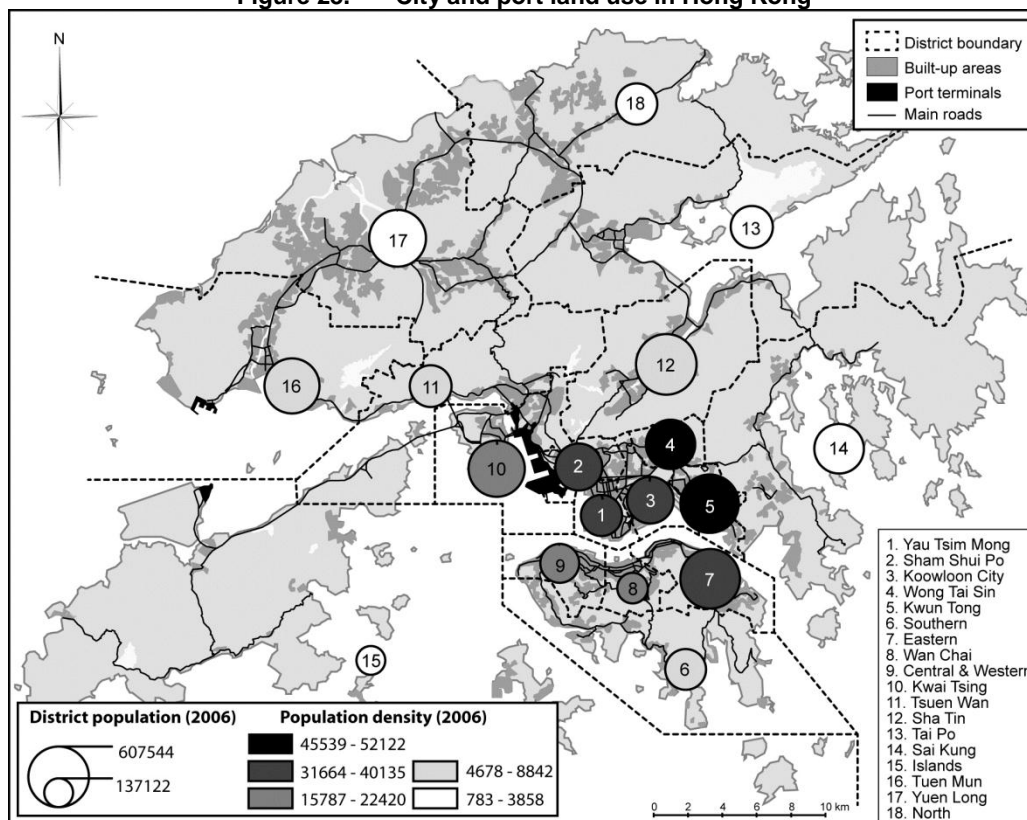
However, this solution to address the land shortage has caused many drawbacks, such as the environmental problems, including severe traffic congestion due to the concentrated business development in the harbour areas, and the associated air and noise pollution. Moreover, it led to public concern of the harbour losing its shape as a historical and cultural asset to the city. Several harbour protection groups organized protests. Followed by a series of public lawsuits filed against the government on land

reclamation, the public requested for strict oversight on harbour front planning. Such reactions from the community have since made future reclamation projects more difficult with complex processes under public scrutiny.

The Harbour has its core functions in serving the city as a commercial port, a tourist attraction, and a public enjoyment destination. There are on average 200,000 ocean and river vessel calls for both cargo and passenger traffic every year, bringing in an estimated 6 million tourists to visit Hong Kong and the Victoria Harbour. The harbour is vital to Hong Kong's economy, but in the same time, the waterfront resource is also crucial to the spatial planning and development of the port-city. As land resource is in particular scarce, the use of coastline space becomes intensively controversial between commercial development, industrial development and recreational areas for the public. On top of that, the city is facing housing needs from population growth while limited land is available for developing residential properties.

In order to increase the capacity of the port and accommodate the future growth of cargo throughput, the discussion of building a new container terminal in Hong Kong has been on-going for many years. Although several selected land sites are proposed, the decision, however, has been shelved and is subject to further study and government approval. In March 2009, the Government selected the site at Southwest Tsing Yi for preliminary feasibility study. However, due to the receding port volume and the sluggish maritime industry, port expansion in Hong Kong is still under a lot of uncertainty. Figure 23 indicates port land use, in relation to urban density. It is clear that due to the rapid urbanisation of Hong Kong and scarce land resources with competing uses, most port-related activities are in close proximity to the urban area with limited scope for future expansion and development..

Figure 23. City and port land use in Hong Kong



Source: own elaboration

2.3 Marine traffic impacts

All of the containerized cargo to the hinterland is currently transported through trucks and barges. The lack of efficient railway access to the Hong Kong terminals as opposed to the progressive efforts on increasing the intermodal share on rail transportation at Shenzhen ports in recent years has imposed a real threat for sustaining its position regionally and its gateway status on a continental level (Loo and Hook, 2002). The development of freight rail requires scrutinized evaluation of the market demand and investment returns. Due to the continuously dropping in cargo volume, rail freight at the Hong Kong Port was wended down in 2010 as the MTR (the successor of the Kowloon-Canton Railway Corporation after a merger) decided to optimize the use of its sources for business reason (HKSAR, 2010).

The increase of transshipment goods has presented some challenges to the Hong Kong Port, in particular barge congestion. Kwai Tsing (KT) is the main container handling facility, and also the only facility that is suitable to accommodate large ocean-going vessels (OGVs). Therefore, the space to receive barge cargo is limited as most of the berths are allocated for OGVs. This has caused barge congestion at the terminals and led to additional dwell time. Although the midstream operation at the anchorages can also handle barges carrying containers and offer significant cost advantage (50% or less), the nature of its offshore operation has affected the speed of cargo loading and unloading, with particular instability under certain weather conditions (Fu et al, 2010). The Government recognises the importance of mid-stream operations as part of efficient transshipment hub functions, but places at the same time a lot of emphasis on strengthening marine safety in these operations, which takes the form of regular safety seminars, steeping up safety inspections, and updating the Code of Practice regularly to incorporate best practices.

The River Trade Terminal (RTT) is built in 1998, for the very purpose of catering the growing demand of river trade to and from the manufacturing bases in the PRD. However, the land lease conditions have restricted the functions of the RTT to be unable to handle OGVs but only serve as a transshipment point to support the operations at the KT and midstream operation (Fu et al, 2010). This means that transshipment cargo would have to be transported via trucks or barges to either the KT or the midstream operation then loaded on to OGVs after they arrive at the RTT. This process creates additional container handling and transportation time and cost, which would add to the expense burden of the shipping liners and operators. Thus, their unwillingness to fully utilize the RTT for transshipment cargo also contributes to the berth congestion at the main container terminals in Kwai Tsing. In addition, the barge operators would need to reserve large margins for terminal visits at the KT conterminal to ensure reliable transport services due to the long waiting time (Fu et al, 2010). The delay at the barge terminals could impact the downstream operation of the supply chain, which in turn would lead to longer transit time and additional costs for barge transport in Hong Kong.

The competitiveness of barge services in Hong Kong might be further undermined by the fast development of feeder collaboration network in Shenzhen. In 2001, led by Shekou Container Terminals Corp. (SCT) and Chiwan Container Terminals Corp. (CCT), the South China Shuttle Barge Service was launched to connect Western Shenzhen feeder ports with main river ports along the Pearl River to ensure more convenient and cost-effective barge transport services. So far, the service has connected 30 terminals in 14 cities with Western Shenzhen by regular and some irregular barge services. Although the contribution of the barge network only accounts for around 10% of the total cargo volume at Shenzhen ports, the direct access to the cargo sources and the expansion for hinterland markets enables Shenzhen to attract more business. As the manufacturing bases slowly migrate from the eastern PRD to the western side, Shenzhen will become more competitive for its close distance and frequent barge services. Hong Kong, on the other hand, will need to solve the congestion problem for barge berthing and improve the conditions to compete for the potential cargo from Western PRD region.

Due to the extensive high volume of vessel movements in the Hong Kong waters, marine traffic safety is critical for the government to stay constant vigilant in order to ensure safe operation. More than 32,000 oceanic ships and 170,000 river vessels arrive in Hong Kong annually, in addition to barge, ferry, fast launch, recreational, cruise and fishing boat activities on a daily basis. Some of the key characteristics of the Hong Kong's marine environment include the high traffic volume, a wide variation of vessel size and types, high proportions of speed crafts and ferries, as well as close proximity of marine facilities within a small geographic area (Yip, 2008). The Hong Kong Marine Department has historically managed to keep a detailed record of reporting marine accidents: approximately 340 accidents every year over 2001-2012. Marine collision is identified to account for about two-thirds of all the types of accidents. On October 1st in 2012, a ferry boat crashed with another passenger boat that carried employees from Hong Kong Electric and their families to watch the firework display for the National Day. The deadly accident took away 39 lives and injured more than 100 people, making it one of the worst maritime disasters in Hong Kong since 1971. A Commission of Inquiry was appointed to carry out a thorough investigation on the collision. The Commission report was publicised in April 2013, findings of which have drawn acute public attention, such as non-enforcement of regulations on provision of child life jackets on board. The Government has taken immediate follow up actions and re-inspections of vessels were conducted to ensure safety compliance. A comprehensive review is being undertaken to enhance safety compliance and standards, as well as governance and organisation structure of the Marine Department. A study indicates that accidents involving passenger-type vessels, such as high speed ferries, sampans and party boats, are more likely to result in injuries (Yip, 2008).

3. PORT-CITY POLICIES AND GOVERNANCE

3.1 Strategic port development

Long term strategic planning

Port strategic planning

The long term strategic orientations of the port of Hong Kong are expressed in the Hong Kong Port Master Plan 2020 (HKP2020). In a context background of competition from neighbouring ports in South China, improving cost competitiveness is considered to be the largest challenge in this strategic document. In particular road haulage costs and terminal handling charges (THCs) are considered as the principle competitive weaknesses of the Hong Kong Port (GHK, 2004). Because of the close proximity to each other and the gradually maturing services and infrastructure provided in mainland ports, the port choice focus is increasingly on total through cost minimization. It is indicated that it costs on average nearly \$300 more for a forty-foot equivalent unit (FEU) to be shipped through Hong Kong to the U.S. West coast than via Shenzhen (GHK, 2004).

Getting inland connectivity right is the critical strategic imperative to sustain the port's economic potential, as well as maximizing the efficiency and productivity of existing port assets. According to the HKP2020, the main challenge for the Hong Kong Port is to capture market share of the direct cargo segments in the first instance and transshipment in the second. Therefore, an immediate priority was proposed as the so-called Super-connectivity Initiative (SCI). This initiative includes several action items such as improving container circulation in the region, reviewing licensing fees, improving barging services and electronic document systems. Other initiatives include the Power Port Initiative focused on supporting port productivity improvements with an enabling framework created by the Hong Kong Government for the terminal operators, such as providing additional land for containers and related uses. The Port Rationalisation Initiative emphasized the government's role as a facilitator working with the terminal operators to address the land issues related to fragmentation of the Kwai Tsing Container Terminals and to identify possible long-term berth rationalisation measures.

Port expansion is considered as a long-term strategic priority both in the HKP2020 and the newest Policy Address by the Transport and Housing Bureau of the HKSAR (HKTHB, 2013). The HKP2020 compares the pros and cons of the two potential sites for the future container terminal 10 (CT10), namely Southwest Tsing Yi (SWTY) and Northwest Lantau (NWL). The Master plan finds that NWL to be the better option but also suggests to further conduct an ecology study to better assess the risks associated with the site, such as the potential permanent loss of Chinese white dolphin habitat and alterations to landscape character of the area. The Government conducted an Ecological, Fisheries and Water Quality Impact Assessment for the NWL site, and concluded that there would be significant loss of water areas important to Chinese White Dolphin habitat. In March 2009, the Government commissioned a preliminary feasibility study for CT10 at Southwest Tsing Yi. The study is due for completion this year, and the results would help the Government decide if CT10 should be built at Southwest Tsing Yi.

In order to better position itself to accommodate the new generation of ultra-large container vessels and maintain its competitiveness, the government has just commenced a dredging project that will deepen the KT container terminal basin and its approach channels from the current navigable depth of 15 metres to 17 metres to meet the draught requirements of the new generation of ultra-large container ships at all tides (THB, 2013). Currently, the Government is due to complete a study on the Strategic Development Plan for Hong Kong Port 2030, which seeks to update the port cargo forecast. Together with the findings of the Preliminary Feasibility Study, they will shed light on the need and development for CT10.

City strategic planning

The city has also developed a strategic plan that provides a roadmap for its long-term development goals. It is called the Hong Kong 2030 Planning Vision and Strategy (HK2030), co-conducted by the Planning Department and Development Bureau in 2007. This Plan outlined the long-term vision for Hong Kong is to strengthen its position as Asia's world city for sustainable development. The comprehensive city plan developed goals in various aspects like environment, housing, transportation and logistics, land use, infrastructure development and cultural. It also emphasized on the strategic importance to have closer links to the Mainland through communication and interaction under the CEPA framework (HKSAR, 2007b). In the port service sector, the HK2030 study identified the needs and also provided long term strategies in port infrastructure, industrial use land and logistics facilities based on the conclusions from previous conducted reports. Future port development is one of the key areas for achieving the economic competitiveness of Hong Kong and the recommendations of the Hong Kong Port 2020 Study were taken as given in the formulation of the preferred development option in the HK2030 Study. Future port expansion and port back-up uses will continue to have major bearing on future updating of HK2030.

In the 2013 Policy Address, the newly appointed HKSAR Government is committed to consolidating Hong Kong's leading position as an international aviation and maritime centre and a regional logistics hub. It emphasized on its role to enhance the maritime services, collaboratively working with the industry, as to ensure that the port and its supporting infrastructural facilities are provided in a timely manner with regards to the growth in cargo throughput and maintain the competitiveness of the Hong Kong Port (HKSAR, 2013b). Stimulated by this commitment from the Government, several new initiatives will be carried out to provide strategy and recommendations in order to achieve the goal. The Chief Executive announced that an Economic Development Commission (EDC) would be established to explore and identify growth sectors that present potential opportunities for Hong Kong's economic growth from a holistic and strategic point of view. There will be a number of working groups set up under the EDC, including the Working Group on Transportation.

Regional and national strategic planning

The regional development of the Pearl River Delta (PRD) was elevated to the national strategic level and the cooperation among Guangdong, Hong Kong and Macao is considered as an indispensable part of the overall national development strategy. This is laid out in the "Outline of the Plan for the Reform and Development of the Pearl River Delta (2008 to 2020)" (the Outline) approved by the State Council of China in 2009. To further implement the CEPA with its supplements, the HKSAR Government and the Guangdong Provincial Government signed the Framework Agreement on Hong Kong/ Guangdong Co-operation (Framework Agreement) in 2007. The Framework Agreement covers a wide range of areas, sets clear development positioning for the two regions, and outlines specific policies and measures. Specifically, the division of functions for ports in the PRD is stated as "Hong Kong being the international shipping centre, Shenzhen and Guangdong port being the hub ports and the others being feeder ports" (The Outline, 2009).

Hong Kong's sustainable and healthy economic growth is vital to ensure the long-term prosperity and stability for the regional and national economy and development. In China's newest 12th-Five-Year-Plan (2011-2015), a chapter is dedicated to Hong Kong and Macao, and elaborates on the significant functions and positions of Hong Kong in the entire development strategy of the country. Once again, it clearly demonstrates the Central Government's intention to deepen the integration with Hong Kong, support its international trading centre role, and cultivate a mutually beneficial regional cooperation.

Besides the substantial impacts brought by CEPA and other major policy frameworks on the economic integration between Hong Kong and Mainland China, the two governments have also been

striving to facilitate this process and forge closer relationships in the past years through various forms of cooperation. A series of work sub-groups have been set between Hong Kong and Guangdong in areas like modern services, manufacturing, technology innovation, intellectual property, air pollution, marine water quality, education and training. The two government authorities also have regular meetings to discuss on the progress for projects, studies, policy initiatives and improvements.

The overall policy background indicates an inevitable trend of more cooperation and communication that would occur between the two governments. Loughlin and Pannell (2010) have suggested that governments of Hong Kong and Shenzhen to make a coordinated plan for port development that would avoid expensive excess capacity, allow each port to specialize in its strengths, and equilibrate trucking. The dual existence of the two ports in the same region has created a strong competitive business environment, but it could also generate more benefits to both ports by utilizing their own different strengths and compensating each other in their deficiencies such as land and services. From a regional perspective, it is in the common interests for both governments to achieve mutual growth in port development and maritime industry.

Improve inland connectivity

After over two decades of rapid economic growth and explosive increase in exports, the speed of China's growing pace has appeared to slow down. Although the economic crisis in 2008 had less fatal impacts to China, it was greatly affected by the global fall in demand for Chinese products. As the rest of the world's market becomes unable to absorb China's exports, the world's second economy has entered into a transition era where a new growth model – that is domestic and consumer-oriented and driven by the expansion in service sectors – is desired in the 12th-Five-Year-Plan (2011-2015) and will be implemented by the new leadership who took power in late 2012.

This change in imports and exports pattern would pose significant impacts on shaping the trading landscape in China. Hong Kong Port still enjoys the traditional advantages as having a sound legal system, a mature maritime market, reliable and efficient custom services, as well as a highly skilled workforce base. But in the meantime, the ports in Southern China are improving their services and infrastructures and climbing up the value ladder to raise their competitiveness. These ports are also closer and better connected to inland markets through waterways and rail lines. It is in this sense, mission critical, as pointed out in the HKP2020, to reduce cross-boundary transport costs and improve inland connectivity that will enable the Hong Kong Port to further extend its economic hinterland and attract direct cargo from South China and even West China.

Under the CEPA, the Outline and Framework Agreement, a number of critical transportation infrastructure projects have been completed over the recent years to provide faster and more convenient connections for passenger and freight traffic between Hong Kong and Mainland China, such as the Lok Ma Chou Spur Line and the Western Corridor. Several major infrastructure projects are expected to start operation in the coming years, including the Guangzhou-Shenzhen-Hong Kong Express Rail Link (XRL) with target completion in 2015 and the Hong Kong-Zhuhai-Macao Bridge (HZMB) by end 2016. Furthermore, the Government is also in the process of reviewing and updating its Railway Development Strategy 2000, of which the Hong Kong-Shenzhen Western Express Line (WEL) that links the airports in two cities and the Northern Link (NOL) are being studied. The strategic importance of these projects are widely conceived and recognized by both the Hong Kong and Guangdong governments, as reflected in the HK2030 study and Guangdong's 12th-Five-Year-Plan.

Additionally, the safety and productivity of the existing midstream operation could be potentially improved through a new type of harbour vessel – Port Feeder Barge (PFB) (Malchow, 2012). The current midstream operation barges in Hong Kong have limiting capacity and very obsolete cargo handling

technology. Therefore, the associated safety issues is one of the most important factors that constraints the midstream operations. The innovative PFB is designed to substantially increase the safety, efficiency, speed and accessibility of ship sizes for such operations. The application of PFB could also be extended to ease feeder operation within the multiple terminal ports, to improve intermodal connectivity of inland navigation, and to serve as an emergency response vessel given its light ship draught, sufficient capacity for over-dimensional containers and excellent manoeuvrability (ibid.). At the Port of Rotterdam, a shuttle crane barge is already employed to provide intra-terminal cargo transport, which can avoid road haulage by trucks, increase efficiency and reduce emissions. Moreover, the PFB can be operated with LNG as a fuel source, which would eliminate the emissions that would have been produced by using bunker fuels. Such concept of this “green logistics innovation” could be considered by the Hong Kong Port as it provides an alternative to upgrade the midstream operations and improve the safety, thereby enhance the utilization of the operations and help de-concentrate the ocean-to-ocean transshipment cargo flows that are now seen congested in the main KT container terminals.

While the connectivity problem might be alleviated after the completion of the scheduled transportation projects, the job to tackle the cost disadvantage is a continuous endeavour. Out of the aforementioned \$300 difference, one third is due to the high THC fees are that charged by shipping lines to shippers. The private ownership mechanism at the Hong Kong Port determines that the THCs are of little control or influence by the Hong Kong Government but in the hands of shipping lines and terminal operators. Operators have to pay high land premium up front and the extensive capital investments in building facilities, which leads to the collection of high tariff charge from the shipping lines in order to recover their expenditure spent in the early stage. In addition, the private terminal operators receive no subsidy from the government, which also contributes to the high THCs. Another factor is that the major terminal operators such as HIT and MTL at the Hong Kong Port are reluctant to lower their charges to recapture their customers as a reflection of their regional strategy and investment interests (Wong, 2007). HIT holds over 65% stake of the nearby Yantian Port in the east of Shenzhen, while MTL is also the majority shareholder of the Da Chan Bay Terminal One in Western Shenzhen. Thus these terminal operators are inclined to preserve their positions in the regional market as opposed to adopt a purely local development strategy, in this case, in Hong Kong.

A transshipment hub

Hong Kong is no longer the unique gateway to Southern China. The pre-eminence of Hong Kong gradually decayed after China’s large-scale port facilities upgrading that started in the 1990s. Hong Kong witnessed its Chinese hinterland market shrink to include only the PRD region resulted by the rapid growth in port development in the mainland (Wang and Slack, 2000). In recent years, with the improved infrastructure facilities, combined with the closer geographic distance to the inland manufacturing bases and cheaper transportation costs, Shenzhen port has attracted a large portion of the container cargo that is generated in South China. On the contrary, as mentioned earlier, the statistics indicate that the volume of transshipment cargo in Hong Kong has grown over the years while the direct shipment has been reduced.

Its transshipment hub functions might come under pressure when Chinese cabotage rules would be liberalised. One of the favourable conditions that Hong Kong Port currently possesses, and one of the reasons that facilitated the burgeoning transshipment cargo, is the cabotage restrictions in mainland China. Similar to the situation in the United States, foreign shipping lines are banned from transporting domestic cargo under the current cabotage regulations. The rules also forbid the foreign carriers from moving international containers from one domestic port to another for onward shipment overseas. With Hong Kong being the closest port to the vast mainland market in Southern China and not considered as a Chinese domestic port, a large portion of the cargo would be sent to Hong Kong first then transhipped to their final destinations, especially intra-Asian cargo. Because the liberalisation of China’s cabotage rules would increase operating efficiencies and cost-savings for shipping lines, the relevant stakeholder groups have

been lobbying the Chinese Government on easing the regulation. It would enable the liners to provide more services, set up more hubs in China as opposed to tranship cargo in Hong Kong for cost and distance rationalisations. In that case, Hong Kong would face more competition from other ports in the region to battle over main line calls. Nevertheless, certain domestic carriers have successfully managed to stall possible reform, according to industry experts. Although the liberalization of the rules may not happen in the foreseeable future, it is necessary to consider the potential negative impacts on transshipment traffic in the Hong Kong Port.

In general, the revenue generated from transshipment is smaller compared to direct cargo. Therefore, an essential element of a successful transshipment hub is to have a dense network of line services and the economies of scale generated by volume. Hong Kong and its competitors both have the location advantage and deep-water depth to accommodate larger size vessels; but more frequent calls are also added at the ports in Shenzhen. The emphasis should be focused on how to better utilize the strengths of the Hong Kong Port on its matured law and judicial system, streamlined customs and clearance, high productive and reliable operation, and efficient logistics supply chain.

3.2 Port as a metropolitan asset

Remain a leading international maritime centre

Despite being widely recognized as one of the leading international maritime centres in the world with well-established maritime services clusters, there is no overall comprehensive maritime cluster strategy and government policy support. The Government first conducted a study on how to strengthen Hong Kong's role as an international maritime centre (IMC) in 2003 (Maunsell Consultants, 2003). The report concluded with recommended strategy proposals in four elements, which are institutional aspects, promotion, personnel and education, as well as financing. Various other IMCs in the world have a better reputation of attracting the appropriate calibre of people to the industry and actively developing best practices internationally, for instance, London and Singapore. To adopt and execute the policy recommendations proposed by the 2003 IMC study, two government advisory bodies were established in the same year to replace the former Hong Kong Port and Maritime Board (HKPMB), namely the Hong Kong Port Development Council (HKPDC) and Hong Kong Maritime Industry Council (HKMIC). Prior to this organizational restructuring, Hong Kong Logistics Development Council (HKLDC) was also separated its functions from the PMB to assist the Government specifically on improving logistics and supply-chain services.

The regulatory system in Hong Kong provides a favourable environment for companies to locate and operate in the city. Hong Kong provides a dedicated taxation provision for the calculation of shipping company profits. Tax exemption for revenues from international cargoes is also uplifted in Hong Kong. In terms of attracting port-related headquarters, Hong Kong has a Territorial Tax policy that specifies income generated outside Hong Kong is not subject to tax. Except for container and bulk cargo shipping, cruise lines, ferry, and passenger transportation are also the main commercial business at the Hong Kong Port that composes its diversified economic portfolio.

Because shipping is an extremely capital intensive industry, companies are even more susceptible to double taxation than other industries. Hong Kong government has signed multiple bilateral agreements with its trading partners for the avoidance of double taxation on income derived from international shipping operation, such as reciprocal tax exemption (RTE), double taxation relief agreements (DTA) for shipping income and comprehensive DTAs that cover all types of income. By far, it has negotiated double taxation relief arrangements that cover shipping income with 37 tax administrations around the world (Hong Kong Maritime Industry Council, 2013). Nevertheless, Hong Kong's performance in terms of signing DTAs still lags behind other major IMCs in Asia, namely Singapore and Shanghai (McKinnon,

2011; CTTFS and OCTSRI, 2013). Singapore and Mainland China have each secured 50 DTAs with other trade partners, outnumbering Hong Kong, who has only signed with about half of the top 20 trading partners for DTA.

Led by the Hong Kong Ship owners Association (HKSOA), nearly all the industries in the maritime cluster have formed their own groups to advocate the interests of their stakeholders. In order to reinforce Hong Kong's status as an IMC, the management and coordination capabilities are essential for the Government to manoeuvre the relationships among these different interest groups and create better synergies within the maritime cluster. In this sense, consistent and effective dialogues with the industries would be the key to comprehend the various roles of each sector and develop the strategies for promoting the entire maritime cluster. In addition, an abundant reserve of maritime-related talents is also essential. The Hong Kong Government has been working on supporting maritime manpower training through the HKMIC. It provides scholarships and incentive schemes for training maritime services professionals, sea-going officers and ship-repair technicians; so far, over 850 persons have benefited from the programs (HKTHB, 2013).

Furthermore, the Hong Kong Maritime Industry Council (MIC) has commissioned a consultancy study on "Enhancing Hong Kong's position as an International Maritime Centre". The consultancy is in its final stage. This study could potentially be a major step to guide Hong Kong in positioning itself as a premier international maritime centre to achieve long-term prosperity. In addition, a study initiated by the industry named "How to Position Hong Kong as a Maritime Centre for the Asia-Pacific Region" was released in March 2013, of which the findings and recommendations are expected to be carefully reviewed by the government. The Study compares Hong Kong's strengths and challenges to other maritime centres in the world, such as Singapore and Shanghai, identify the best practices for policies and measures and analyse the development potential of maritime services in Hong Kong, as well as make recommendations on future development strategies. The findings and recommendations have been shared with the MIC.

A regional logistics hub

Hong Kong is undoubtedly a regional transport and logistics hub. Logistics has been one of the pillar industries in Hong Kong as it handles about 70% of the cargo that is related to South China. 40% of the cross-boundary container cargo is transported by trucks and the rest is by barge (HKTHB, 2009). Faced by the fierce competition from the neighbouring port in Shenzhen, improving value-added logistics services is seen as the key to the survival of Hong Kong as maintain its major international transportation centre (Cheung et al, 2003). Another study was conducted to analyse the structural issues of the logistics industry and assess the internal problems that the industry faces in the process of transitioning Hong Kong from a freight transport hub city to a knowledge-based global supply chain management centre (Wang and Cheng, 2010). One of the findings from the questionnaire survey in the study is that neither the shippers nor the logistics service providers that are based in Hong Kong have much loyalty to the port when other gateways are becoming more competitive (ibid.). Therefore, it is imperative to strengthen the existing advantages and improve its competitive edges of the logistics industry in Hong Kong.

The biggest challenge facing Hong Kong's land logistics industry for future development, as being widely recognised, is to enhance regional competitiveness by contributing to reduce total transport costs for container cargos. Cross-boundary trucking costs are the single biggest element in the cost difference between Hong Kong and other regional ports in Guangdong, which is estimated as \$200 per FEU (GHK, 2004). According to a report written by a Focus Group on Maritime, Logistics and Infrastructure (HKSAR, 2007b), several action items are proposed to urge the Government on taking initiatives to enhance the cost-effectiveness of cross-boundary freight transport, optimize the road and river transport network in the PRD region, and strengthen Hong Kong's position as an international and regional hub.

Since then the Hong Kong Government has been working both internally and externally to increase the efficiency of cross-boundary cargo movements, if not to compete with the pricing directly. It launched a Digital Trade Transportation Network in 2006 that provides an open, neutral and secure e-platform for efficient and reliable information flow along the supply chain. The Transport and Housing Bureau also worked with the Hong Kong Productivity Council to implement a pilot project on an On-Board Trucker Information System (OBTIS). In addition, the Government has also sponsored industry organizations to conduct “A Feasibility Study for Cross-Border Supply Chain Visibility across Guangdong, Hong Kong and Asia”. The objects of the study include examining the economic benefits brought by enhancement in cross-boundary supply chain visibility, the technical feasibility and business model (HKTHB, 2013).

In order to increase the cross-boundary drayage productivity of Hong Kong’s trucking industry, Hong Kong Logistics Council has been diligently lobbying the Guangdong Government in relaxing trucking related regulations. For instance, the previous policy was “4-up-4-down”, which means that a quadruple of driver-tractor-chassis-container is considered as one single resource and required to be bundled together during transportation between Mainland China and Hong Kong. The “1-truck-1-driver” rule was also relaxed later, which enables the truckers to operate more flexibly and efficiently by allowing a supplemental driver to the same truck.

Besides the installation of additional ‘one-stop’ kiosks for faster and simpler custom clearance at the border-crossing points, several inland custom checkpoints have also extended their operating hours, with some opening up 24-hour counters, to ensure the efficiency of road freight and enable truck drivers to make more trips between the different locations on a daily basis. But more could be done to improve the free flow of goods and passenger in and out of Hong Kong. In 2008, the two governments approved to develop a new boundary control point (BCP) at Liantang/Heung Yuen Wai in the north-eastern New Territories with the purpose to further enhance the transport network and promote the integration of Hong Kong in the PRD region. The construction is expected to commence in 2013 and the facility is to be operational in 2018.

But the cost is not the only, if not the most difficult issue to resolve, another major challenge for modern logistics industry in Hong Kong is the space. Over the recent years, the market transition in Hong Kong’s logistics industry has been gradually moving towards the provisions of storage, distribution and transit services for high value goods. These third party logistics (3PL) services providers, thus, are in great need of industrial land for warehousing to carry out inventory management, packaging, labelling, and other value-added operations. In 2004, the Government set up a committee team that is responsible for the plan to construct a modern Logistics Park in North Lantau in order to boost Hong Kong’s transport and logistics capabilities and consolidate its role as a leading hub. It is designed to provide an ideal operating environment for modern logistics services providers, value added in particular, and cope with their growing needs for more space. The project was scheduled to be in operation by 2010 but the financial turmoil in 2009 brought gloomy prospects to the logistics industry. The Government announced that the Logistics Park would be regarded as a long-term plan for future consideration. It said it would keep in view the proposed development in the context of new reclamation sites and new development areas currently under examination by the various planning and engineering studies, the future cargo throughput, the industry’s land demand etc.

Due to the land constraints in Hong Kong, land use rezoning is rather critical in the development of logistics and port operations. During 2010-2013 three logistics sites in Tsing Yi with a total area of 6.9 hectares were released, with the provision to be used only for 3PL services. The Government has further earmarked 10 hectares of land in Tuen Mun West for modern logistics facilities. In respect to Port Back-Up land (PBU), the HKP2020 predicted that its total demand would increase in accordance to the cargo throughput growth, but the trend of such uses to move over the boundary close to the cargo bases in the PRD region would also continue (GHK, 2004). The prediction and recommendation were also reiterated in

the HK2030 study, as it referred to the PBU land demand and supply in 2020 being 309 and 480 hectares, respectively (HKSAR, 2007b).

Although the cargo flows at the Hong Kong Port have yet shown any clear indication of the future growth trend, the industry's need of more PBU land adjacent to the container terminals is still pressing for the Hong Kong Government at the moment. According to the latest data from the Hong Kong Port Development Council, in 2012 there are 425 hectares of land being used for port back-up facilities, and over 100 hectares are located within the KT area for container storage and vehicle parking (HKPDC, 2012). However, it is still not sufficient for the uprising demand of PBU land. In a Press Release by the Government in later 2012, it plans to release sites of about 14 hectares in KT in phases and it will also continue to identify and provide suitable land for PBU uses.

3.3 Mitigate negative impacts

Measures have been taken to reduce shipping-related air emissions, both by the Hong Kong government and the maritime sector. Annex VI to the International Convention for the Prevention of Marine Pollution from Ships was adopted in 2008, which regulates, among others, the sulphur content of marine fuel and the NO_x emission standard of marine engines. Other measures are implemented to set emission cap for power plants, to impose a 50ppm sulphur on industrial diesel (which applies to non-road vehicles and machines operating within port areas), and to replace old diesel vehicles with new ones meeting updated emission standards. Ships are also required to limit their speed in Victoria Harbor, Ma Wan Fairway and Western Fairway. In addition, a large impetus to improve air quality was given by the maritime sector in Hong Kong. Led by 17 shipping companies, the Hong Kong Shipowners Association (HKSOA) and the Hong Kong Liner Shipping Association (HKLSA), the Fair Winds Charter (FWC) is a voluntary program initiated in 2010 by the shipping industry to switch from high sulphur bunker oil to 0.5% or lower sulphur fuel when berthing in Hong Kong. According to the spearhead of this initiative, Civic Exchange, the goal is to cut the SO₂ emission from individual ships while berthing by 80%, which will have a significant impact on the overall air quality in the city. In 2011-2012, about 6,300 vessel calls switched fuel under the Charter and reportedly reduced SO₂ emissions by about 1,560 tonnes.

The efforts from the industry have prompted the Government to implement an incentive scheme that echoes the green practice adopted by the FWC. Started in September 2012, OGVs that switch to low sulphur fuel (no more than 0.5%) would enjoy 50% reduction in port facilities and light dues. This policy will last for three years. Recent report indicated that the scheme is having difficulty in achieving the anticipated scale of participation because only 13% of OGVs berthing in Hong Kong were registered under the scheme (Cited in Lamplough, 2013). The additional costs for fuel switching could be one reason that impedes ship owners to join the scheme. Currently, the cost of heavy fuel oil is about US\$650 per tonne while burning low sulphur fuel would cost US\$1050 per tonne. According to Maersk, the discount provided by the incentive scheme only covers 40% of the additional cost, and the shipping lines still need to spend \$2 million every year for switching to low sulphur fuel (Lamplough, 2013). Moreover, the participants are also concerned that the voluntary scheme did not address the competitive imbalance between them and non-participants. Establishing a level playing field for all the shipping companies is crucial so that those ones who are actually reducing their impacts do not bear the costs alone while others continue to pollute without paying the price. As the FWC will expire at the end of 2013, the industry has been urging the Government to introduce tighter legislations to continue to reduce ship emissions.

In January 2013, the Hong Kong Environmental Protection Department announced its intention to introduce legislation that will mandate all the OGVs to switch to low sulphur fuel ($\leq 0.5\%$) when berthing in Hong Kong. They are also conducting a feasibility study on installing onshore power facilities in Kai Tak Cruise Terminal and will upgrade the quality of local marine diesel. In addition, the Hong Kong Government is actively exploring with the Guangdong Province on the establishment of an Emission

Control Area (ECA) in the PRD Region. As the ship pollution extends into the waterways in the PRD Region, it is essential to build a synergetic and cooperative relationship among all the ports and stakeholders to provide a level playing field for the sake of effective implementation and the benefits for the residents in the greater region. Whereas the recognition for cross boundary cooperation is instrumental, the challenge is how to balance the policy priorities of different jurisdictional agencies. This would require a joint effort and strong commitment from both authorities to establish common goals and ensure a consistent and integrated policy formulation in improving regional air quality.

With regards to climate change, the Port adopted the Clean Air Charter in 2006, and then set up the Government Fleet and Dockyard Environment Management System Committee in 2007. Additionally, the Port helped institute public education and debate on GHG and climate change and consequence for inaction to Hong Kong sea levels and areas in case of no action. It also initiated the Action Blue Sky Campaign. The Marine Department Environmental Reports are also publicly available on the agency's website.

A vibrant and dynamic harbour

Many port-cities with natural harbours enjoy not only the geographic advantage of being a preferred location for goods transport, but also embrace these harbours as they represent the heritage to a city's rich history and culture. Apart from its commercial port functions, a harbour could be pivotal to support the tourism industry, impel economic development such as real estate and catering services, as well as provide its urban residents with waterfront recreational space. For instance, Sydney, Singapore, and New York are some of the world's famous port-cities that are known for their vibrant coastlines with creative urban design. The Victoria Harbour in Hong Kong has, arguably, one of the most spectacular skyline views in the world that attract millions of visitors every year.

How to best utilize the prime waterfront land, manage the use of the harbour, and retain its image as an icon of the city has always been a challenge to the Hong Kong government. In view of the community aspiration for a world class harbour and against further reclamation in Victoria Harbour, the government established the Harbourfront Enhancement Committee (HEC) in 2004 to tender advice to Government on the planning and development of the harbour. The HEC further developed the "Harbour Planning Principles" (HPPs) and Harbour Planning Guidelines (HPGs) to guide the planning, development, urban design and management of Victoria Harbour and its waterfront areas. The HEC then was succeeded by the Harbourfront Commission (HC) in 2010 to continue advising the government on waterfront planning, design, management and other issues that aim to foster and facilitate the harbourfront development and improve its accessibility. The HC set up three Task Forces based on their geographical locations, namely the Hong Kong, Kai Tak and Kowloon Task Forces. Later on, a fourth Task Force on Water-land interface was also established to assist the Commission in advising the Government on issues related to water-land interfaces in Victoria Harbour. A dedicated Harbour Unit was set up within the Development Bureau in 2009 to champion harbourfront-enhancement initiatives and provide secretariat support to the HC.

The concerted efforts from HC and Government have resulted in various harbourfront enhancement projects that have been completed and opened for public enjoyment. Several mega projects planned by Government around the harbour, such as the 320-hectare Kai Tak Development, the New Central Harbourfront covering 20-hectare reclaimed land and the 40-hectare West Kowloon Cultural District, will also provide extensive scope for harbourfront enhancement.

Despite the progressive enhancements made to the harbourfront over the years, HC considered that having a dedicated body to develop, design, construct, operate and manage the harbourfront in a holistic manner would be the key to achieve the vision of creating an attractive, vibrant, accessible and sustainable harbourfront for Hong Kong. Hence it submitted a report to the Government in October 2012,

recommending the establishment of a dedicated and statutory Harbourfront Authority. The Government welcomed the proposal and collaborated with the HC to jointly launch a public engagement exercise recently in October 2013 to gauge public views on the proposal. If the proposal is supported by the public, the Government will take forward the legislative work and provide the financial support. This will be a key milestone to create a Victoria harbourfront for the people.

ANNEX 1: EFFICIENCY OF PORTS

In this report the efficiency of ports is analysed using the data envelopment analysis (DEA) technique. This empirical methodology derives efficiency scores for each decision-making unit (DMU) involved in a homogeneous production process such as firms or seaports. An efficient port is defined as one maximising output level for the same level of inputs across all observed ports (efficient output-oriented DMU) or minimising quantity of inputs for a given level of output (efficient input-oriented DMU). The efficient production frontier is delineated by a set of efficient DMUs referred to as the benchmark of most performing seaports. The potential gains for less efficient ports (*e.g.* located below the efficient production frontier) are measured by their distance, both from an output- or input-oriented approach, relative to the efficiency frontier. This methodology has been widely used in the most recent mainstream literature³⁴(Cheon, *et al.*, 2010; Wu and Goh, 2010; Martinez-Budria, *et al.*, 1999; Wang and Cullinane, 2006; Al-Eraqi, *et al.*, 2007; Tongzon, 2001).

The DEA approach has advantages as well as limitations. Among its positive characteristics, DEA does not impose any functional form to the production function or on the shape of returns to scale (*i.e.* non-parametric), such as when adopting a Cobb Douglas production function. For seaports, in particular, it is very difficult to guess or impose whether returns to scale should be increasing or decreasing. Dealing with multiple output processes is another useful property of DEA, especially when addressing port multi-activities and when a certain degree of homogeneity in the production process is observable across ports. DEA also has some negative characteristics, including its deterministic property, which does not allow random noises or measurement errors to be isolated from the measure of pure inefficiency⁵. However, use of the Bonilla (2000) and Barros (2007) bootstrapping⁶ technique can help limit this effect.

This sampling technique enables generation of a stochastic distribution and intervals of confidence around the estimators (Simar and Wildon, 2000). The efficiency estimates derived from using this technique are often lower compared to DEA estimates derived from a standard sample. In addition, atypical efficient ports (characterised by low density of observations in the region of the frontier) are characterised by higher degrees of uncertainty. However, because efficiency is a relative measure, depending on observable seaports and inputs considered, any omission may affect the results. A sample excluding potentially efficient seaports or including outliers would respectively shift downward/upward on the efficient production frontier and affect (upward/downward) the relative efficiency scores. To the same extent, omitting input factors or including them with non-documented values (zero or not available [n.a.]) may yield higher efficiency scores for ports that are using high quantities of the omitted input factor or those producing output with “no” input.

There are three different types of efficiency that can be distinguished: *i*) overall efficiency, *ii*) technical efficiency, and *iii*) scale efficiency.

i) Overall efficiency. This general indicator, derived from a model assuming constant returns to scale (CRS), provides a measure of overall port efficiency. This DEA-CCR indicator, developed by Charnes, Coopers and Rhodes (1978), assumes that all observed production combinations could be scaled up and down proportionally. Varying production sizes or scales are considered to have no effect on efficiency scoring, which means that small or large ports can equally operate in an efficient way. Efficient ports are both technically and scale efficient. Conversely, inefficiencies (efficiency gap measured in per cent of most efficient port scores) reflect both technical and scale inefficiencies.

ii) Technical efficiency. Pure technical efficiency is estimated by relaxing the constraint on scale efficiency, allowing output to vary unproportionally more or less with a marginal increase in inputs. This

DEA-BCC indicator, developed by Banker, Charnes and Cooper (1984), is derived from a model assuming varying returns to scale (VRS), and recognises that smaller ports may face disadvantages caused by production scale effects (Cheon, 2008). By taking into account and neutralising scale inefficiencies, relative gaps in efficiency between ports would thus only reflect differences in operational inefficiency, so-called pure technical inefficiency.

iii) Scale inefficiencies. Scale inefficiencies arise when the scale of production is inappropriate, being above or below optimal levels and generating production wastes. Formally, they are identified when a difference appears between efficiency achieved at technical and overall levels, as measured by the following ratio (Cooper, *et al.*, 2000; see also Fare, *et al.*, 1994).⁷

$$SE = CRS/VRS \text{ and where } SE < 1$$

In the equation, CRS and VRS are the efficiency estimates derived from respectively assuming constant and varying returns to scale. When $SE < 1$, ports face scale inefficiency, driving higher overall inefficiency compared to pure technical inefficiency. By contrast, when $SE = 1$, ports are operating at efficient scales, producing at the optimal level for which they were designed. However, the appropriate direction in scale adjustments can be identified only with the nature of returns to scale, that is, increasing (IRS) or decreasing (DRS). For ports operating at IRS (output rises proportionally more than the increase in inputs), production level should be expanded. This is usually the case for ports operating below optimal levels as long as current business traffic, while building up gradually, remains below the optimal capacity of port infrastructure. By contrast, when ports operate at DRS (output rises proportionally less than the increase in inputs) they should scale down their production toward lower optimal levels to limit inefficiencies lead, for example, by bottlenecks. In a long-run perspective, however, the alternative of raising the optimal level of production through investing in higher port infrastructure capacity should also be considered.

Defining and identifying appropriate output and input variables for port production function is crucial. The input/output variables must reflect the main objectives of a port, which in this study is about maximising cargo throughput and productivity while efficiently using infrastructure and equipment. Along the economic theory, output as measured by handling cargo throughput (loaded/unloaded) depends to the same extent on labour and capital inputs. In port literature, labour input is known as the most challenging issue due to lack of data reliability and comparability. One of the main reasons is that port labour organisation is particularly complex, consisting of different types of full- and part-time contracts and contracts partly managed by private, public and port authorities, which make it difficult to collect complete and consistent data. Proxies are often used along the argument that labour is usually closely and negatively correlated to handling equipment: equipment is thus considered to be a proxy for labour. As such, for this study the number of loading/unloading equipment from ship-to-quay and quay-to-shore is collected per port for container terminals and the different dry and liquid bulk cargo terminals (oil, coal, iron ore and grain). Capital inputs, on the other hand, are more readily available as long as they concern land and infrastructure. Such inputs mainly include terminal surface, quay length or storage capacity.

The aim of this study – to extend the assessment of port efficiency beyond container terminals and container ports – brings with it major complexities with regard to data collection of port output. Earlier studies focusing on container ports have benefited from relatively comprehensive existing datasets on container port output, with output measured in twenty-foot equivalent units (TEUs), being the equivalent to a small container. This measure is widely accepted and administered, which allows for comprehensive analysis. Such a comprehensive and comparative dataset does not exist for other port cargo categories. Most port authorities publish their total annual throughput in metric tonnes, often differentiated by containerised, bulk and general cargo, but rarely in more specific categories. While this study aims to give port efficiency scores for bulk categories, it acknowledges the major differences that exist in the equipment

needed for the different bulk categories such as coal, iron ore, grain and oil. Not surprisingly, almost all large ports dealing with bulk have one or more specialised terminals in these different bulk cargo categories. This makes it possible to collect input data per port for these cargo categories (*e.g.* by adding up the equipment for all grain terminals in that port). However, the corresponding output data (*e.g.* grain throughput per port) are in many cases lacking or not in the public domain. Despite considerable efforts to collect comprehensive port throughput data per cargo category, this proved to be impossible

In order to overcome this complexity, this study uses a new output dataset, based on a volume output measure: aggregated ship volume in deadweight tonnes (dwt) calling each port. These data can be derived from existing comprehensive databases of vessel movements, which include detailed information on ship types (including volume), as well as arrival and departure times at the different ports. This approach assumes that the volume of a ship calling a port is correlated with the number of metric tonnes loaded or unloaded from that ship. This assumption will hold especially for cargo categories with point-to-point deliveries, as in most bulk cargo categories, but probably less so for cargo categories or containerised cargo with service loops in which several ports are called (as it would be likely that some ports in the loops, serviced by the same vessel, will load/unload more cargo than others in the same loop). For this reason, in this study the number of TEUs, where available, is also considered as an output indicator. The availability of information on different ship types in the database, most of these specialised in carrying one specific cargo type (*e.g.* ore carriers, crude oil tankers, etc.), makes it possible to estimate the aggregated ship volume per port and per cargo category. While “total dwt calling the port” (output measure) is not perfectly correlated with actual throughput, it is no more imperfect than throughput as reported in metric tonnes and TEUs. Both methods risk double counting due to variations in port calculation of throughput. For example, in instances of transport from an inland to a deep-sea terminal (counted as an incoming and outgoing container in the river terminal and then incoming and outgoing for the deep sea terminal) one container could end up being counted four times.

For the purpose of this study, a database was built to analyse port efficiency across worldwide ports at aggregated and disaggregated activity levels, gathering data for the most recent available year (2011). The database covers approximately 100 ports, including all major container and dry and liquid bulk ports in a wide range of ports located in almost all OECD and non-OECD countries. Most of the input data are drawn from Lloyd’s Port of the World 2011 Yearbook, whereas the Lloyd’s Marine Intelligence Unit’s (for May 2011) comprehensive database of vessel movements was used to derive output data. Given limitations in the data and the DEA methodology, a number of aggregations/approximations were performed in order to ensure estimate reliability. The input and output variables used to derive efficiency indicators are described in the following paragraphs on the efficiency per cargo type. The database reflects existing heterogeneity across equipment and ports into the differences in productivity and thus technology efficiency.

Containers

The sample used includes the 63 largest container ports around the world. The regional profile broadly reflects the worldwide geographic distribution. About half of the container ports are found in Asia (*e.g.* 34% in eastern/south-eastern Asia and 19% in western/southern Asia), while the remaining half is equally split between Europe and America (*e.g.* respectively 20% each). In terms of traffic volumes, the sub-sample covers a total of 687 million dwt in 2011 and 287 thousand TEUs in 2009 based on the latest data available.

Output variables for container ports consider two distinct measures: the volume estimates in deadweight tonnes and the number of TEUs. The use of multi-output measures is meant to reconcile both standard analysis based on TEUs (as seen in the literature review) and the methodology specific to this analysis (inclusion of dwt). While output measures are not strongly correlated (the rank correlation coefficient is equal to 0.77), the sensitivity analysis shows that the benchmark group remains broadly the

same: among the 15 most efficient ports identified by different output measures, about 10 common ports are found in both groups. Score estimates and the ranking associated to individual ports, however, differ to some degree.

Identified input variables are specific to container terminals. Capital inputs are proxied by the infrastructure of container terminals, such as total quay lengths, terminal surface and the number of reefer (or plugging) points for refrigerated container ships. Storage capacity, both in TEUs and ha (hectare), has not been taken into account due to incomplete data. Inputs collected at terminal levels are thus aggregated at the port level. Labour inputs are proxied by equipment, such as the number of container cranes (*e.g.* type of large dockside gantry cranes for loading/unloading intermodal containers from container ships), including both quay cranes and yard cranes which differ depending on whether the supporting framework can traverse the length of the quay or yard. The size of container cranes (specific to the size of container ships such as Panamax, post-Panamax, super-post-Panamax) and handling equipment (*e.g.* straddle carriers, sidelifers, reach stackers, or container lorries used to manoeuvre underneath the crane base and collect the containers) were taken into account.

Table 2. Descriptive statistics of input and output variables of the container ports sample

Container terminal sample	TEUs 2009	Output May 2011	Quay length	Surface terminal (ha)	Reefer points	Quay cranes (no)	Yard cranes (no)
Average	4,639	10,944,765	4,814	229	1,875	45	97
Max	25,866	61,351,881	19,410	854	5,444	208	522
Min	723	34,202	540	13	24	4	1
Total sample	287,601	678,575,427	298,476	8,691	82,501	2,602	4,383
Normalised standard deviation	1	1	1	1	1	1	1
N (non missing)	62	62	62	38	44	58	45

Source: own data collection

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NOTES

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- ¹ With the possible exception of the super oil tankers
- ² C&SD replaced the Hong Kong Standard Industrial Classification (HSIC) Version 1.1, which was adopted in the HKP2020 report, with the newer Version 2.0 starting in 2009.
- ³ However, according to the review by Trujillo and Gonzales (2008) there are about an equal number of studies exploring efficiency via estimating a stochastic frontier production with a predefined functional form, suggesting the absence of consensus vis-à-vis the best approach to be used.
- ⁴ Cheon, *et al.*, 2010; Wu and Goh, 2010; Martinez-Budria, *et al.*, 2009; Wang and Cullinane, 2006; Al-Eraqui, *et al.*, 2007; Tongzon, 2001
- ⁵ This mainly legitimates stochastic frontiers and econometrics approaches though they impose a functional form to the production.
- ⁶ Bootstrapping is a re-sampling method consists in constructing a number of resamples of the observed dataset, and of equal size, where each of these is obtained by random sampling with replacement from the original dataset.