

The Competitiveness of Global Port-Cities:

The Case of Rotterdam/Amsterdam – the Netherlands





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ABSTRACT

This working paper offers an evaluation of the performance of the ports of Rotterdam and Amsterdam, an analysis of the impact of these ports on their territory and an assessment of policies and governance 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 ports on economic and environmental questions is studied and quantified where possible. The value added of the port clusters of Rotterdam and Amsterdam is calculated and its interlinkages with other economic sectors and regions in the Netherlands delineated. The major policies governing the ports are assessed, along with policies governing transport and economic development, the environment and spatial planning. These include measures instituted by the port authorities, as well as by local, regional and national governments. Governance mechanisms at these different levels are described and analysed. Based on the report's findings, recommendations are proposed with a view to improving port performance and increasing the positive effects of the ports of Rotterdam and Amsterdam on their territory.

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

FOREWORD

This study is the sixth in a series of case studies within the *OECD Port-Cities Programme*, which attempts to identify the impact of ports on their territories and possible policies to increase the positive impacts of ports on their territories. The report has been realized at the request of the Netherlands Ministry of the Economy, Agriculture and Innovation, the city of Rotterdam, the city of Amsterdam and the port authority of Amsterdam.

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. This paper was written by Olaf Merk (OECD) and Prof. Theo Notteboom (University of Antwerp). It was directed by Olaf Merk and it draws on the work of a number of other contributors, in particular César Ducruet (CNRS – Université de Paris I Panthéon-Sorbonne), Prof. José Tongzon (INHA University, Incheon), Walter Manshanden and Martijn Dröes (TNO, Netherlands) and Nicolas Winicki. Within the framework of this study, interviews with a series of actors and stakeholders have been conducted.

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:

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EXECUTIVE SUMMARY

This case study, forming part of the OECD Port-Cities Programme, assesses main challenges in port-city development in Rotterdam and Amsterdam, and provides recommendations to overcome these challenges. In many port-cities world-wide the relation between ports and their cities is a complex and evolving one: ports need less labour but have become more capital and space intensive, which naturally conflicts with space constraints in growing metropolitan regions. Various developments have also strengthened a global-local mismatch connected to ports, with positive spillovers across the metropolitan boundaries, but with negative impacts that are highly localised. This case study assesses this dynamic for Rotterdam/Amsterdam and suggests ways for improvement.

The ports of Rotterdam and Amsterdam have performed well on many port-related indicators. Being the first and fourth port of Europe, in a part of Europe with intense port competition from important competitors such as Antwerp and Hamburg, their average annual *volume growth* has been good: 4.4% for Rotterdam and 4.0% for Amsterdam over 2002-2011. Over the last decades Amsterdam managed to increase *market shares* in North-West Europe in bulk markets (e.g. doubling its liquid bulk share to 8.6% over 2003-2010) and Rotterdam showed a remarkable rebound in container traffic shares since 2006 (from 32.5% in 2006 to 35.1% in 2010). Over 2004-2011, Rotterdam sustained its position as second most central *cargo hub* in the world, after Singapore, using a variety of maritime connectivity measures. Moreover, it was shown to be among the *most efficient* ports with respect to containers and oil.

Both ports are considered to be best practice cases worldwide in key determinants of port performance. Rotterdam can be considered a best practice case in strategic port planning, port land use optimisation and extended gates, new terminal development (Maasvlakte 2), environmental management and climate change adaptation; as well as port communication. The case of Amsterdam is widely admired for the transformation and restructuring of former and existing port areas into attractive urban waterfront with a cruise terminal, expanding westwards and optimising traffic flows. Both the ports of Rotterdam and Amsterdam are two of the few examples in the world where barges represent a large share in the hinterland traffic modal split.

Rotterdam and Amsterdam can be considered ports that have significance for the whole of Europe. Rotterdam is unmistakably the main *hub* port in Europe for containers and dry and liquid bulk, whereas Amsterdam is a major hub for petrol, steel and cacao. Most of their hinterlands are located outside the Netherlands, with Rotterdam being the main port for large parts of Germany, as well as a major port for Central Europe and Eastern Europe, Switzerland and northern Italy. Exporting and importing firms in these regions benefit from the efficient operations of both the port of Rotterdam and Amsterdam.

These ports have substantial direct economic impacts, but their volume growth has not translated in more jobs. Port-related activities represent a considerable share of the regional *value added*:

approximately 4% for Amsterdam and 13% for Rotterdam.[1] This economic value added has grown with an average annual growth rate of 0.4% over 2002-2010 for Rotterdam and 2.3% for Amsterdam, well below the growth rates of port cargo, which grew with 4.2% and 5.6% respectively over the same period.[2] As our research has shown, there is a significant relation between port throughput and manufacturing *employment* in European regions: every additional million tonne of cargo throughput leads to around 300 additional jobs. This is considerable if one considers that the port of Rotterdam handled around 400 million tonnes in 2011 and Amsterdam and the other North Sea Canal ports approximately 93 million tonnes. However, this link has not manifested itself in Rotterdam and Amsterdam, where port-related employment growth remained flat over the last decade. This might be connected to the specialisation of both ports in liquid bulk, which was found to have lower employment effects in European regions. Considering the strategic function of ports, their presence in a region leads to different economic *specialisations* of that region: like port-regions in Europe, the Randstad – the region in which both Rotterdam and Amsterdam are located - is specialised in water transport, the petro-chemical industry, energy, power generation, steel, wholesale and retail trade; and it is, more than other port-regions in Europe, specialised in air transport and non-port-related sectors, such as publishing. Sectors in which the Randstad region, unlike most European port-regions, is not specialised are manufacturing of other transport equipment, real estate activities and manufacturing of food products. Finally, the ports of Rotterdam and Amsterdam are considerable sources of public revenue: EUR 106 million in 2010, which only includes the operating results that flow back to government and does not include the tax revenues from industries in the port area.

The indirect economic effects of the port cluster of Rotterdam are relatively small but – more than in other ports - clustered within the port. The multiplier calculated for the port of Rotterdam is 1.13; this means that one more euro spent in the port leads to 0.13 eurocents additional demand for suppliers to the port cluster. This indirect impact of the port of Rotterdam on the national economy is smaller than found for other ports in North-West Europe, notably Hamburg and Le Havre. This could be explained by the fact that Rotterdam is a very large port in a relatively small country, whereas Le Havre and Hamburg are smaller ports in much larger countries; so presumably a considerable part of the indirect economic effects of Rotterdam is taking place in other countries than the Netherlands and not showing up in the multiplier. Interestingly, the port cluster of Rotterdam has, in comparison to Hamburg and Le Havre, more inter-sectoral linkages within the port area, which points to locational synergies and clustering effects within the port. Similar inter-sectoral linkages have been found in research on the Amsterdam port cluster.

Both the port of Rotterdam and Amsterdam are potential drivers of innovation. This could be concluded from the patent applications in port-related sectors such as shipping, hoisting-lifting-hauling, constructions and food and food stuffs, all sectors in which world port-regions play an important role. These are also sectors in which Rotterdam is one of the top 10 regions in the world. Amsterdam is among the top 10-regions for patent applications in petroleum[3]. At the same time, the R&D-investments of the port-related and logistics industries tend to be fairly low, which suggests that the innovative character of the logistics sector could be further developed.

Many of these positive impacts reach far beyond the national borders. There are important good flows between Rotterdam and Antwerp (Belgium) and the indirect economic effects of the port cluster of Rotterdam are particularly large in Antwerp and Flanders. There are also many positive economic spillovers to Germany, being the main foreign hinterland of both Rotterdam and Amsterdam. As a result, the production costs of Germany industries are linked to the efficiency of both ports, with direct port costs estimated to be € 80 mln per year for German industries and with large benefits connected to a smooth global supply chain in which efficient ports play a key role. These positive economic spillovers also extend to other countries for which the port of Rotterdam is an important port, such as Central and Eastern Europe, and further improvements in German road and railway infrastructure could only increase these spillovers.

Negative impacts from these ports, such as environmental harm are mostly localised. Local air pollution is higher in the Randstad than in other European regions, and particularly high in Rotterdam. This is related to emissions from industries in the port area and from port-related transport, as well as high population density, high shares of urban built areas and limited amount of green space. The same hinterland transport adds to the considerable traffic congestion in the region, which might only become more of a challenge when the Maasvlakte 2 will welcome the mega-vessels of the future (such as Maersk's Triple E vessels). Due to their large traffic volumes, the two ports of Rotterdam and Amsterdam concentrate 10% of the shipping emission in all European ports. CO_2-emissions per capita in Rotterdam are one of the highest among EU functional urban regions, whereas population exposure to $PM_{2.5}$ is 50% higher than in the average OECD port-region. Externalities of hinterland traffic were calculated to cost EUR 425 million in 2010, almost 80% more than in 2000. And in addition, there might be nuisance related to noise and dust. Several measures to mitigate these negative impacts are put in place, including environmental differentiation of port dues (based on an environmental ship index) in both Rotterdam and Amsterdam, modal split targets in the concession agreement for the Maasvlakte 2 port extension, on shore power supply for inland barges and ferries in Rotterdam – with a possible extension to ocean going vessels – and investigations into LNG bunkering stations. However, projected growth of cargo flows to the ports of Rotterdam and Amsterdam will arguably increase the environmental pressures and one could wonder if current environmental initiatives will be enough to halt a decline of environmental quality in both cities. With respect to metropolitan land use, the impacts are mixed. Although both port areas are large areas, representing approximately 33% of the city area in Rotterdam and 8% in Amsterdam, the port clusters of Rotterdam and Amsterdam have relatively high labour productivity, high job density and high GDP density in comparison with other port-cities in the world. However, the combination of urban development and port industrial development with several externalities in a densely populated metropolitan area is a complex and sometimes conflictuous one.

This combination of impacts leads to different perspectives for Rotterdam and Amsterdam. In spatial terms, port functions and urban functions have become increasingly disintegrated in Rotterdam, with the newest and most active port terminals now at more than 40 km from the city centre, and part of port activities taking place in inland terminals (extended gates such as Moerdijk). In Amsterdam, port functions have retreated to some extent, but a significant part of the port activity is still taking place relatively close to the city centre. As a result, the port-city challenges are different. In Rotterdam, the congestion and environmental impacts related to the port-industrial cluster can be felt, but most of the port jobs are now occupied by workers from outside the city and the connection of urban citizens and businesses to the port complex is becoming loose. Therefore, policy attention has increasingly focused on the city-port relation, such as the urban regeneration project "Stadshavens" and ways to get young people engaged with the port. In Amsterdam, there is a strong pressure on transforming parts of the port land in order to develop other urban functions, such as housing and office development, necessitating a regional port strategy, which has taken the form of an ongoing Masterplan for the North Sea Canal area, to determine where future port extensions would take place when some of the current port land would get other purposes. Simultaneously, the Ministry of Infrastructure and the Environment decided in July 2012, together with the city of Amsterdam and the province of North Holland, to continue the investigation into a new enlarged lock to be commenced in 2019.

There is however one common denominator: the challenge to link port and urban functions that have a very distinct logic. This is a challenge because successful ports are "club goods" where clustering is needed to share infrastructure among a few large industrial players, but where interaction is avoided because of competitive pressures; whereas successful cities are agglomerations that maximise the opportunities for interaction between a very large number of people mostly employed in service industries. Not all cities with successful ports have good economic performance. This is well illustrated by the case of Rotterdam: despite its impressive port performance, the city of Rotterdam has a mixed economic profile, with lower GDP per capita, growth rates and employment rates than the national average. Its limited urban

attractiveness – in comparison with other world port-cities – has made it difficult to attract high value added firms, headquarters and talent: despite it being a central node for physical flows, Rotterdam has not developed into a world leading services centre, not even for maritime services. The case of Amsterdam illustrates that cities with a more diversified economic profile naturally focus on stimulating a wide set of economic sectors, even if – or maybe because - the port functions well. The challenge for many port-cities is thus to find a way to use the port cluster as an asset for a wider urban economic development and a more high value added services economy, such as ship finance, maritime law, engineering, consulting, commodities trading, headquarter functions and energy.

Despite the presence of world-class ports, neither Rotterdam, nor Amsterdam (nor Antwerp) is a leading international maritime centre like Singapore or London. The port of Rotterdam is at the core of a maritime cluster with some very competitive sub-sectors, such as dredging and salvages services. Rotterdam is home to several maritime industries and services, certain port-related headquarter functions and a university that is one of the prime academic centres for port studies. However, it is not a complete maritime cluster like Singapore or London and of relatively minor importance with regards to ship owners, ship operation, ship brokers, maritime insurance and ship classification. This is even more the case for Amsterdam, where most of the metropolitan economy is relatively unconnected from maritime activities. Moreover, the position of the Rotterdam and Amsterdam in this respect is under continuous pressure, with certain maritime headquarter or staff functions going elsewhere, or other cities (Hamburg) being able to attract more new maritime headquarters. But there are also many other developments in this respect: the banking crisis and the Basel III regulations have changed the landscape for ship and maritime finance, the debt crisis in Greece and related policies might lead to an exodus of ship owners from one of the world's maritime services hubs - Piraeus, and emerging countries able to generate opportunities for new businesses and regional headquarters. All these developments offer opportunities for the Randstad to enhance its maritime services position.

The potential for Rotterdam/Amsterdam, in combination with Antwerp, to grow into one of the leading international maritime centres could be more coherently addressed in current policies. To the credit of the Dutch, the ports are well integrated in multi-annual spatial and transport planning frameworks and crucial policy conditions for port and port hinterland development, such as road bottlenecks, have been taken care of. In addition, the importance of the ports for important sectors in the Netherlands, such as agro-food, petro-chemicals and logistics, are recognized. However, ports are only to a limited extent used as assets for regional economic development, or for the development of an international maritime centre. The Dutch Top Sector policy has a narrow definition of the maritime cluster and although logistics and headquarters are considered to be top sectors, this does not translate in more support for maritime logistics or maritime headquarters. A much more holistic strategy on developing and sustaining the maritime cluster would be needed and a much wider set of instruments could be more aggressively used to further a maritime cluster, such as development assistance, export promotion, trade missions and anti-piracy policies. Success in developing a world leading maritime cluster will also depend on more generic policies needed to increase the metropolitan quality of life and to create a more favourable business climate, which would include solving bottlenecks with respect to housing, public transport and labour flexibility, stressed in other OECD publications on the Netherlands. In particular in Rotterdam, a long term and sustained strategy to improve urban quality would be needed to convince global maritime industry leaders that it could be an attractive place to locate corporate and headquarter functions.

The key for sustaining port performance and the development into a leading maritime services centre is regional cooperation, at different levels:

Cooperation at the level of the *city-region* is needed to sustain port growth in both Amsterdam and Rotterdam. In Amsterdam, cooperation is needed to agree on westward expansion of the port area on the territory of other municipalities than the municipality of Amsterdam. This requires long term planning, as

the current port areas close to the city centre are active and well functioning port areas, unlike port sites that were transformed in other cities (such as the Hafencity-area in Hamburg and the South and West Harbours in Helsinki) which were often no longer very productive. Transformation of these port areas in housing or mixed development areas needs to be carefully planned, especially the timing and phasing out in order to avoid capital losses. In Rotterdam, ongoing regional cooperation would be needed to sustain the existing port and industrial activity.

Cooperation between the *port clusters of Rotterdam, Amsterdam and other ports* could be extended to reap possible synergies between them. These seem to exist as they have limited overlap in specialisations and maritime forelands; and development of Amsterdam into an extended gate for some of Rotterdam's container traffic might help to avoid future congestion linked to the additional traffic generated by the Maasvlakte 2 port extension.

Cross-border cooperation could build on the strong inter-relation between the port and logistics clusters of Rotterdam and Antwerp (second port cluster in Europe) in terms of business and traffic relations, which would justify co-operation to sustain a joint petro-chemical cluster in the long term future. In addition, there is a potential to build on the vicinity and differences of three important port-cities (Rotterdam, Amsterdam, Antwerp) as a source of metropolitan, poly-centric quality of life that could attract maritime services and business to the area. With respect to port hinterland coordination, there is on-going cooperation of the port of Rotterdam with inland ports in the Netherlands, such as Moerdijk, Dordrecht and Tilburg, as well as foreign inland ports, such as Duisburg. At a wider geographical scale, port cooperation takes place with emerging market ports in Oman and Brazil.

POLICY RECOMMENDATIONS:

Sustain port growth through regional cooperation, directed towards larger regional economic benefits and reduction of negative impacts. This would imply a selective growth strategy by port authorities, focusing port growth on areas with highest positive regional impacts. Such a strategy could build and expand on existing concepts, such as "smart port" and "smart growth", but could also include a stronger focus on high value added services. For example, the port of Rotterdam could in addition to its ambition to be a world cargo hub and leading energy hub aim to be a world port city. Port land use might be intensified even further and development of green businesses and green port-related technology could become a core port activity. This strategic re-orientation should take place at different levels and between different actors:

- Develop a long-term strategic land use plan for the North Sea Canal area to plan the westward expansion of the port area, in cooperation between the municipalities and businesses along the North Sea Canal. Schemes could be implemented in which the port would be compensated for eventual land losses, similar to land swaps for the HafenCity-project in Hamburg.

- Facilitate cooperation between the port of Rotterdam, Amsterdam and other ports in the Netherlands and beyond. This could entail a search for synergies between the ports that goes beyond shared information systems, joint marketing efforts, joint lobbying and exchanges on policies; this could take the form of a joint vision on the complementarities of both ports and ways to increase value creation for the Dutch economy. The perspective of corporatisation of the port of Amsterdam should also open the possibility of common investment projects with the port of Rotterdam, e.g. in extended gates and inland ports. In the longer term, cooperation might be stimulated by an exchange of shares, similar to cooperation found in Chinese port clusters, such as the Yangtze River Delta.

Facilitate the emergence of cross-border region of Randstad-Flanders-Brabant, in close connection to the Rhine Ruhr area. This region has all the potential to become the prime mega-logistics hub for Europe, one of the largest industrial clusters world-wide, and is already organically growing via business and transport links, but policies could help to resolve recent policy obstacles and signal a profound willingness for constructive cooperation:

- Continue, concretise and expand the development of a common strategic development plan and vision on integrated and coordinated spatial development as well as joint investments, based on a common understanding of regional synergies in the Randstad-Flanders-Brabant area. This could build on current cooperative initiatives such as the Flemish Dutch Delta (VND) and the investigation into a multi-year framework for infrastructure and space Antwerp-Rotterdam (MIRT-VAR). All relevant national and regional governments could be involved in such a vision and development plan, as well as the European Union, considering the important role that such a cross border region could play for the whole of Europe.

- Jointly resolve some common outstanding issues with the German national and regional governments, such as the possibility of Rotterdam and Antwerp to acquire shares in inland ports in Germany; and the lack of fast tracks at the German side of the Betuwe line.

Focus on becoming a world leading international maritime centre. This would be the most direct way in which the ports could be used as an asset for a wider regional industry. This ambition could be expressed and implemented **by all government levels (in particular at the national, local and city-region level**), both through generic and specific policy measures:

- Define the ambition and develop a strategy to become a comprehensive international maritime services centre. This would mean to sustain the parts of the cluster that are already world-leading and to develop the parts of the cluster that are currently lacking. Part of such a strategy would be to attract ship owners, headquarters or European headquarters of carriers, and a range of maritime services providers in brokering, finance, consulting and other fields.

- The maritime services sector could be an explicit priority for business attraction (in trade missions, economic attaches at embassies); and more focused development assistance could be used as a tool to promote the maritime cluster.

- Links between the maritime cluster and the Dutch financial sector could be expanded in order to accommodate emerging practices where project developers that bring finance are preferred. Expand ship and maritime finance; the state could be more instrumental in this since its nationalisation of the ABN Amro Bank. Connections between the maritime cluster and pension funds should be stimulated to expand their port and shipping portfolio.

- The Rotterdam port area is one of the world leading sites for port-related production and innovation in sustainable energy. This position is to be retained and expanded through policies that aim at stimulating the biobased economy, carbon capture and storage, the use of LNG as fuel for seaborne and inland shipping and shore power.

- Develop a world-leading expertise centre for waterfront development, capitalising on the well-developed experience with port-related urban transformation and architecture in the Randstad. A maritime MBA and port-related executive education should be developed e.g. in cooperation between universities in Rotterdam and Antwerp, similar to cities such as Copenhagen.

- In addition, the anticipated shortage of skilled port workers and ageing should be addressed. Transport and port-oriented vocational schooling and training, well adapted to ports' qualitative demands, should be stimulated. The mismatch between shortage of skilled port workers and excessive unemployment among poorly skilled young people in the cities should be tackled.

- The ambition to become a world leading international maritime centre could require more focus and alignment of the current "top sector"-policy of the previous national government that prioritised a water cluster, logistics, as well as headquarters. This policy could for example explicitly focus on European headquarters of carriers and logistics firms and formulate concrete steps that would be needed to achieve this. More links to other fields would be needed, including on the ones mentioned above: foreign trade and investment policies, development assistance, finance, energy, education and research. In addition, more progress should be made in resolving bottlenecks in metropolitan quality of life and business climate, related to housing and labour market, identified in earlier OECD studies. In particular

in Rotterdam, a long term and sustained strategy by city leaders to further improve urban quality would be needed to convince global maritime industry leaders that it could be an attractive place to locate corporate and headquarter functions.

Stimulate funding models that take into account the positive and negative externalities of port development. Port development is very capital-intensive and investments are almost always needed to facilitate maritime access and hinterland connectivity; a considerable share of these investments is done by the public sector. Not all costs and benefits of port development can be monetized, so an assessment of the return on investments of these public investments is complicated. However, economic logic would require that negative externalities be internalised and that private rents from public infrastructure investments be recovered. Such a logic is all the more relevant to the ports of Rotterdam and Amsterdam with their large spillovers across national borders.

- Expand and fine-tune the environmentally differentiated port dues, preferably at a European level. The number of vessels that qualify for reduced port dues is relatively small, as only a limited number of vessels have favourable environmental ship index scores. The programme should be closely monitored on effectiveness and fine-tuned in order to improve its impacts. The port authorities of both Rotterdam and Amsterdam should consider – in addition to the current bonus-system – to introduce a malus-system as well, like in Sweden, were more polluting ships pay higher port dues.

- Introduce road pricing for trucks. This could reduce congestion, internalise some of the negative effects of port hinterland traffic, such as localized air pollution, and might be a way to make foreign industries utilising the port pay for publicly funded infrastructure. The Netherlands has a long history of planning for road pricing and congestion charging, but never managed to implement such a system. As a comprehensive road pricing scheme for all traffic categories has proved to be difficult to introduce in the Dutch constellation, priority could be given to introducing a scheme for truck traffic on highways and major roads, in the short run fine-tuning the Eurovignette-system and in the medium term to implement a user charge similar to the *Maut-tax* operational in Germany.

- Focus the European Union transport network funding system (TEN-T) on hinterland -related projects with real cross-border spillovers, using a more focused conception of core European ports. A European approach could also be developed for cost recovery of port infrastructure investments, in order to limit private rents from public investment in seaport infrastructure. More transparency and coordination in this respect might also help to avoid that public subsidies are used to lower (and thus distort) port tariffs, leading to unfair competition. In an area such as North West Europe with several ports with huge ambitions for expansion, there is a risk of overcapacity, and thus a waste of public money. European rules for port funding should help to minimise this risk.

- The European Union could also have a role in promoting standardisation and funding for on shore power supply and LNG fuelling in major European ports, the costs of which could be recovered on shipping companies using these ports. Such an approach might be particularly effective if linked to the Short Sea Shipping and Motorways of Sea-programmes, as these vessels remain in Europe so could be more easily covered by European standardisation.

INTRODUCTION

This OECD Port-Cities case study of Rotterdam and Amsterdam assesses main challenges in port-city development in Rotterdam and Amsterdam, and provides recommendations to tackle these challenges. Port-cities, such as Rotterdam and Amsterdam face challenges that are common in many port-cities throughout the world, and that are related to the evolving interaction between ports and cities. This relation is complex: ports need less labour but have become more capital and space intensive, which naturally conflicts with space constraints in growing metropolitan regions. Various developments have intensified a certain unbalance of benefits and impacts connected to ports, with benefits from ports spilling over across the metropolitan boundaries, but with negative impacts that are highly localised. This case study assesses this dynamic for Rotterdam and Amsterdam, by assessing port performance, port impact and port-city policies and governance. It also suggests ways for improvement.

Rotterdam and Amsterdam are located in the western, most urbanised part of the Netherlands (Figure 1), at the heart of what has once been labelled the "blue banana" of Europe, the curve-shaped area of Europe that is most densely populated, stretching from London, South East England, Netherlands, Belgium, western and southern Germany, Switzerland to northern Italy. This geographical position, in combination with determined and sustained policies, has contributed to Rotterdam and Amsterdam becoming the first and fourth largest port of Europe, despite being relatively small cities in a relatively small country. As this study shows, both ports have impacts that stretch far beyond their city and national boundaries. At the same time, these cities face the adverse impacts related to ports. The challenges related to this unbalance of port-related benefits and impacts for cities, is at the heart of this report.

Both ports are studied and assessed in their regional context. Neither Rotterdam nor Amsterdam are coastal cities, and their ports originally developed as estuary ports that then expanded towards to sea, taken to the largest extreme in Rotterdam where the most recent parts of the ports are on land reclamation in the sea. Their location at the banks of the rivers Rhine-Meuse (in the case of Rotterdam) and the North Sea Canal (in the case of Amsterdam) remains crucially important for their existence and shapes the context of their functional realities, with Rotterdam having intensive relationships with other Rhine-Meuse ports, and Amsterdam being the largest port in a cluster of North Sea Canal ports (Figure 2 and 3). This regional context necessitates a variable geometry approach in this report, assessing impacts both at a local and more regional level.

This case study has benefited from cooperation and exchange with the Netherlands Ministry of the Economy, Agriculture and Innovation, the Ministry of Infrastructure and the Environment, the city of Rotterdam, the city of Amsterdam, the port authority of Amsterdam and the port authority of Rotterdam. These stakeholders provided access to data, feedback on drafts of the report and responses to a questionnaire on port-city development in the Netherlands. As part of this case study a study visit to the Netherlands took place, which included interviews with a variety of port-city related actors.

Figure 1. Localisation of Rotterdam and Amsterdam

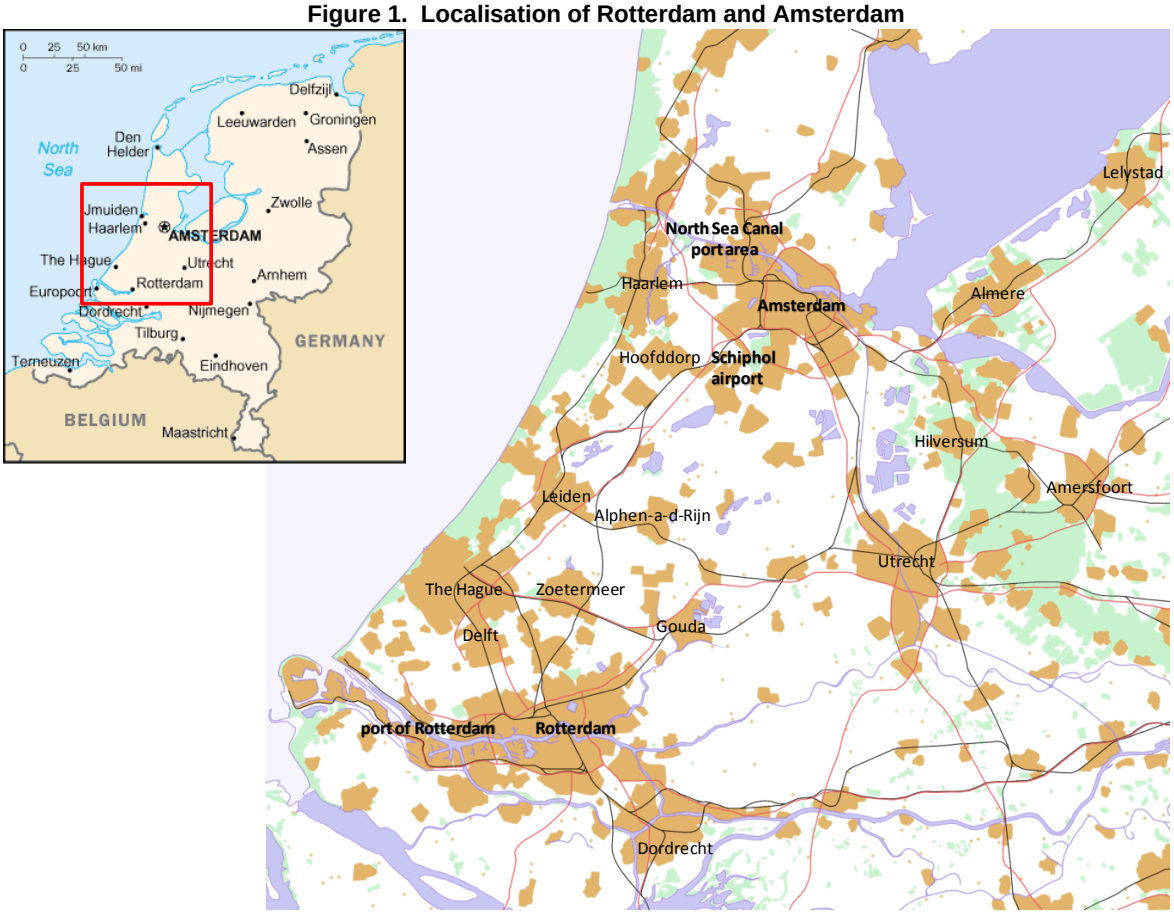
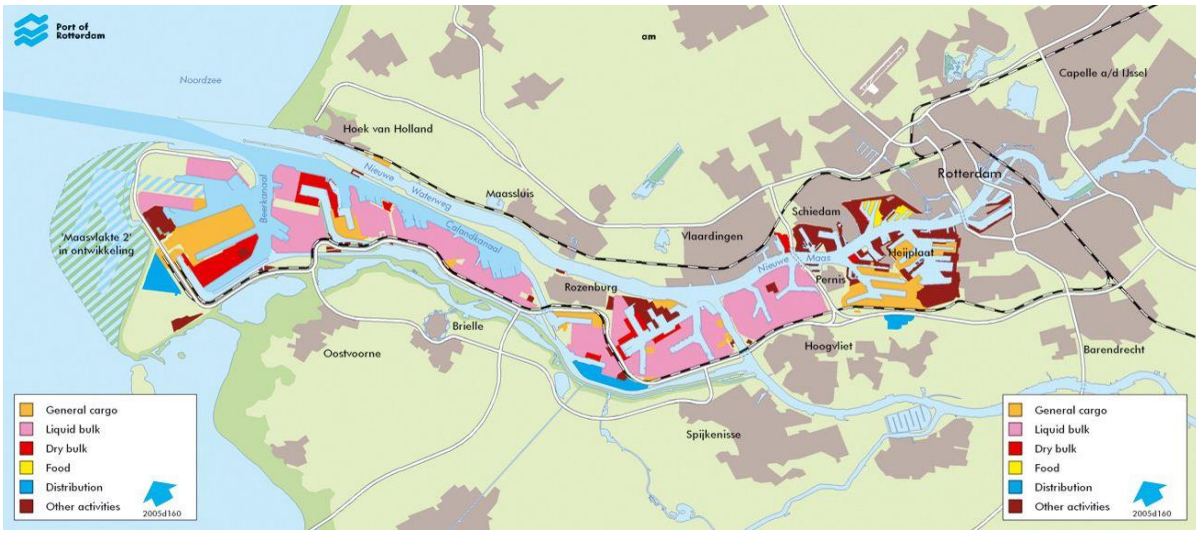
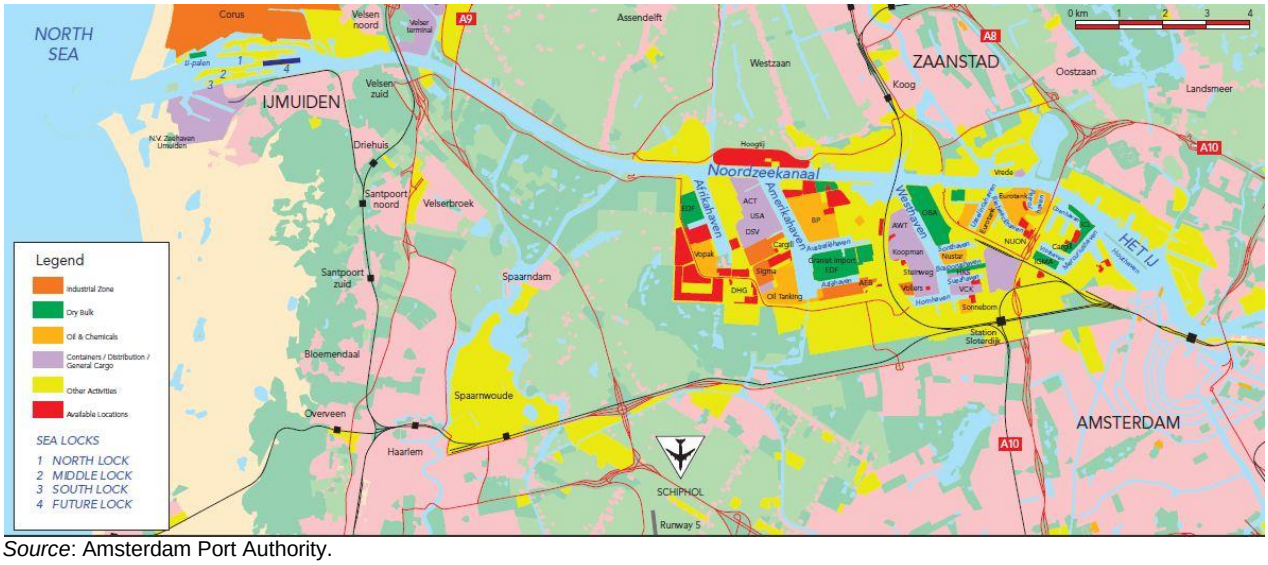


Figure 2. The port of Rotterdam



Source: Rotterdam Port Authority.

Figure 3. Ports along the North Sea Canal area



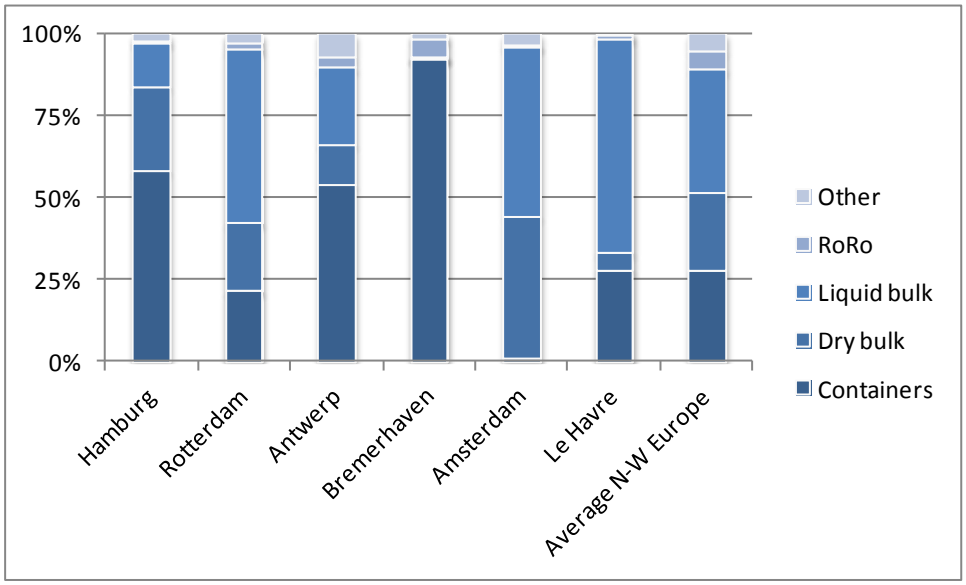
Source: Amsterdam Port Authority.

1. PORT PERFORMANCE

Ports cannot be drivers of economic development unless they are competitive and perform well. This chapter will thus provide an assessment of port performance of the two main seaports in the Netherlands, Rotterdam and Amsterdam. The main performance indicators applied here are port-related and are centered around port volume growth and market shares, as well as the main determinants of port competitiveness, including maritime connectivity, port efficiency and hinterland connectivity. Port performance can evidently have a much wider connotation that relates to the value added it provides to a metropolitan and national economy. These port performance indicators are treated in the second chapter of this report, on port impacts.

An assessment of port performance has to do justice to the very different nature of the ports of Rotterdam and Amsterdam. These differences of the ports can be quickly grasped by comparing the types of cargo handled in these ports. Generally very diversified, the dominant cargo categories of the port of Rotterdam are liquid bulk and containers, with more limited shares of dry bulk and general cargo. The port of Amsterdam is strongly specialized in liquid bulk and dry bulk and has only very limited container traffic; this profile remains more or less similar if all the North Sea Canal ports would be taken together. Amsterdam is in this respect very different than the other large European ports, for which container traffic is a very important activity, representing more than 50% of port volume for Antwerp and Hamburg and up to 90% in the case of Bremerhaven (Figure 4). These differences necessitate a multi-faceted approach to port competitiveness, which will be undertaken in this chapter. The difference in port profiles in Rotterdam and Amsterdam also raises the question of possible synergies between the two ports, which is a question that will be addressed at the end of this chapter and will be broadened to include possible synergies with the port of Antwerp and the Amsterdam Schiphol airport.

Figure 4. Profile of the main North-West European ports, 2010

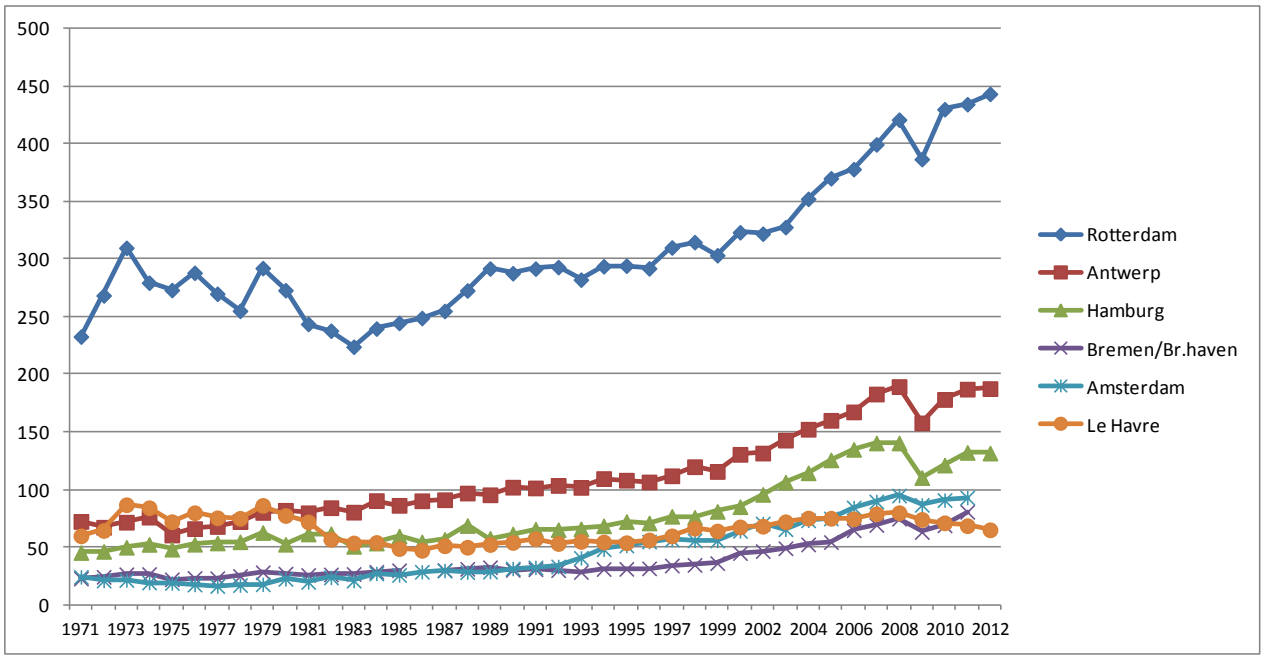


Source: Author's own elaboration of Eurostat database

1.1. Port performance of Rotterdam and Amsterdam

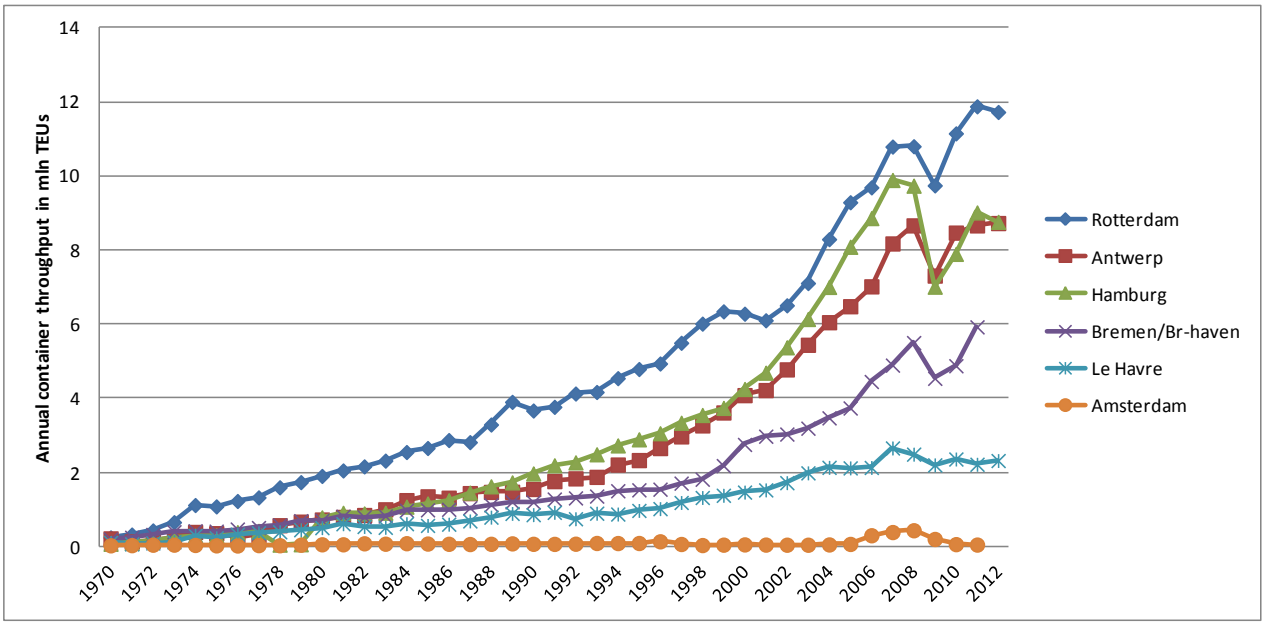
The overall development of port volumes and market shares has been satisfactory over the last decade for both Rotterdam and Amsterdam. The ports of Rotterdam and Amsterdam are first and fourth European port, located in the busiest European port region: the Le Havre-Hamburg range. Total cargo throughput in the ports of Rotterdam and Amsterdam (North Sea Canal area) reached 430 million tons and 89 million tons respectively in 2010. In throughput terms Rotterdam is by far the largest port in Europe, followed by Antwerp (178 million tons), Hamburg (121), Amsterdam (89) and Marseille (86). Overall port growth rates have been good for both Rotterdam (on average 4.4% per year over 2002-2011) and Amsterdam (North Sea Canal ports) (4.0% over the same period). As a result, the development of the market share has been positive. The market share of Rotterdam in the H-LH range gradually fell from an elevated 40% in 1990 to 32.5% in 2006 but then saw a strong recovery to reach 35.1% in 2010. Amsterdam realised a moderate increase of its market share to 7.3% in 2010. Over the last decades Amsterdam managed to increase market shares in North-West Europe in bulk markets (e.g. doubling its liquid bulk share to 8.6% over 2003-2010) and Rotterdam showed a remarkable rebound in container traffic shares since 2006 (from 32.5% in 2006 to 35.1% in 2010).

Figure 5. Total cargo output in main NW-European ports (mln tonnes, 1971-2012)



Source: own compilation based on data from Journal de la Marine Marchande (JMM)

Figure 6. Container throughput in main NW-European ports (mln TEUs, 1970-2012)



Source: own compilation based on data from Journal de la Marine Marchande (JMM)

1.2. Determinants of port competitiveness

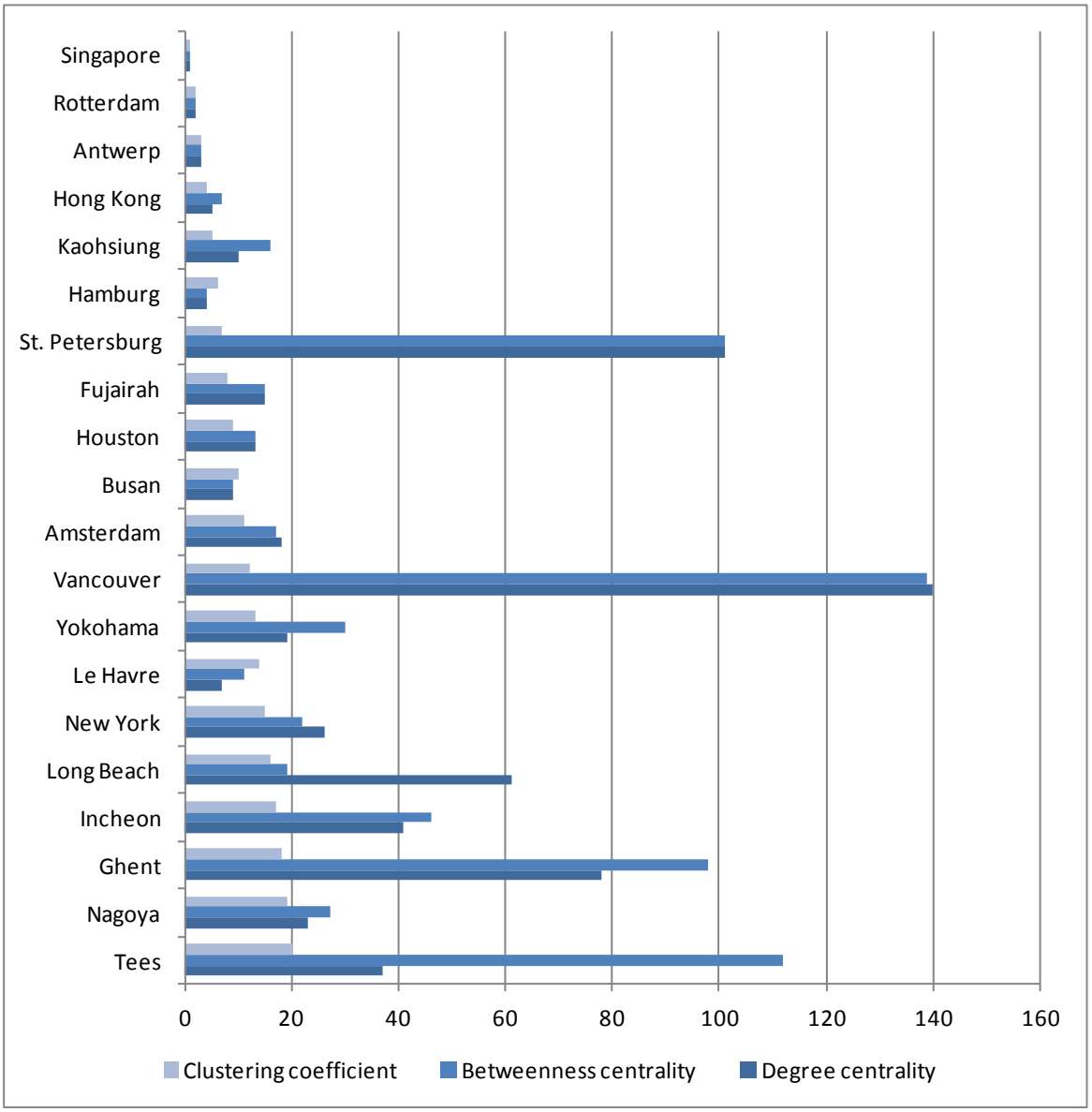
There is a large literature on determinants of port competitiveness and port choice. Although the indicators applied in these studies are varied, there appears to be consensus on three main indicators that are of prime importance for the competitiveness of ports: foreland (maritime connections), port operations (efficiency) and hinterlands. These determinants will be assessed here for the ports of Rotterdam and Amsterdam, based on own calculations and elaborations.

Maritime connectivity

Various ports in the world claim to be regional hubs or gateways; our study quantifies these functions using three different indicators of port centrality. These measures include degree centrality, betweenness centrality and clustering coefficients. *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. The ratio goes from 0 (no triplets observed) to 1 (all neighbors connected). When it comes to hub-functions in a transport system, in theory the "pure hub" will have a clustering coefficient near zero because it serves as a pivotal platform redistributing flows to/from satellite platforms (spokes), which are only connected to the hub (star-shaped network). Conversely, values close to 1 depict a denser pattern with more many transversal (and thus less hierarchical) links. In a maritime network, transshipment hubs should have low clustering coefficients as opposed to other configurations where links are more evenly distributed among ports (e.g. absence of hubs such as in the Baltic Sea or in the USA).[4]

According to these indicators, Rotterdam is clearly the central port hub for Europe, with Amsterdam having a secondary but also important position. The three main European ports (Rotterdam, Antwerp and Hamburg) are all three very highly ranked on the three indexes. Rotterdam ranks second on all three indicators (behind Singapore), Antwerp ranks third, and Hamburg ranks fourth on the centrality indexes (degree centrality and betweenness centrality) and sixth on the clustering coefficient. Amsterdam does not have similar scores, but nevertheless plays a central role in maritime networks, ranked as the fourth European port on the cluster coefficient and fifth on the other indexes (Figure 7).

Figure 7. World port ranks on centrality measures (2011)

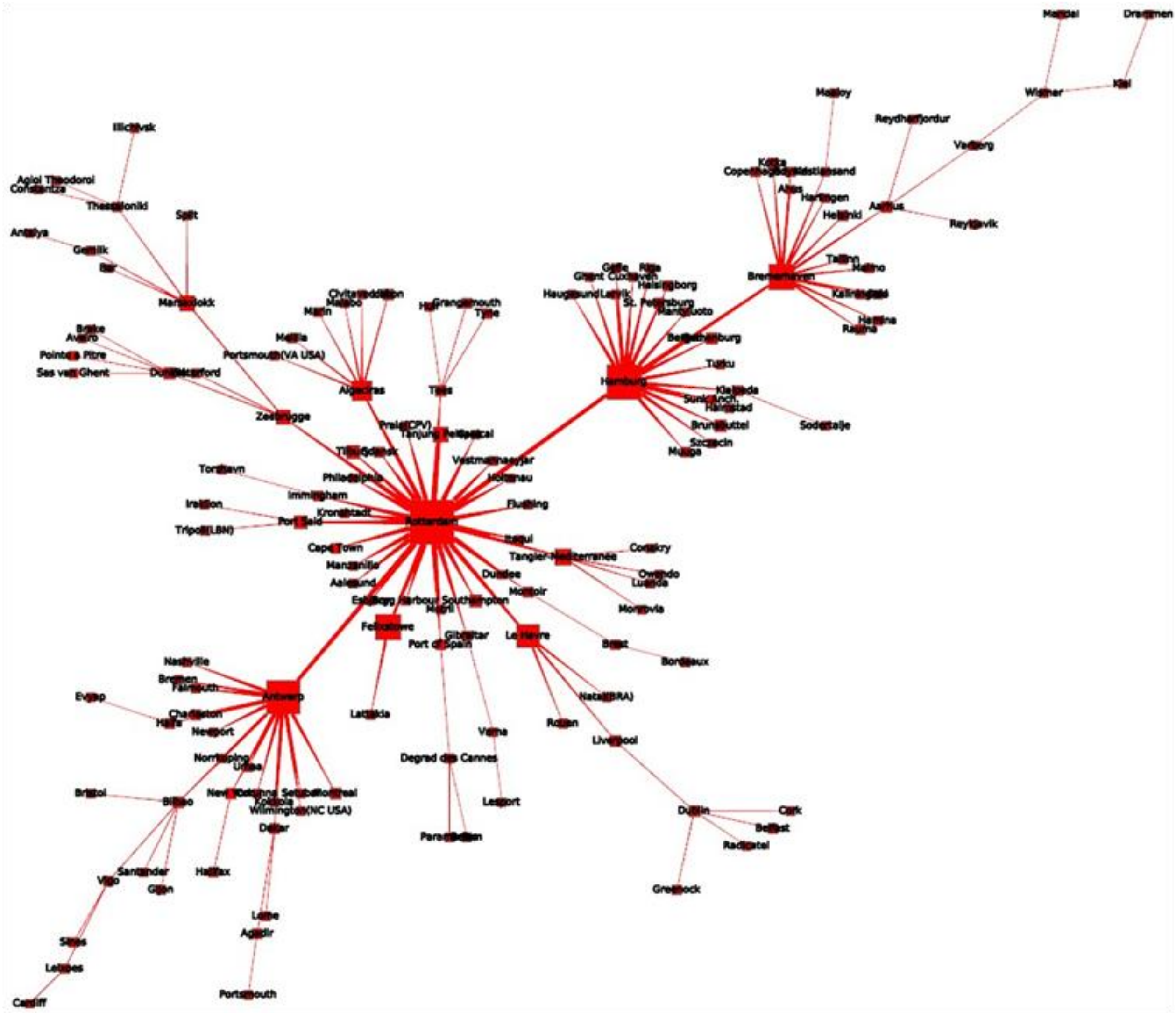


Source: Author's own elaboration based on dataset from Lloyds Marine Intelligence Unit (2011)

Rotterdam's hub functions become very visible when mapping port networks. These networks consist of the strongest link that each port in the world has with other ports in the world. Rotterdam is connected to

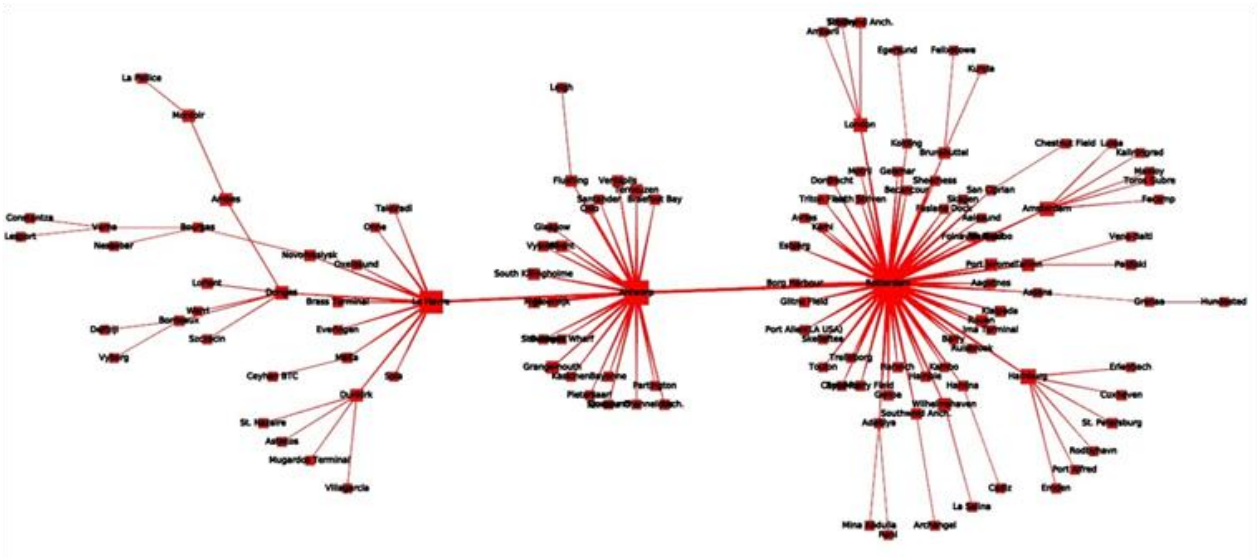
a large number of ports, and dominant in a large number of these links: there are 40 ports whose strongest direct traffic link is with Rotterdam (84 ports indirectly). Rotterdam is one of the most central and accessible turntables in the global container liner service network, as well as liquid bulk (Figures 8 and 9). Amsterdam is fairly well connected with regards to solid bulk (Figure 10).

Figure 8. Position of main ports in North-West Europe in containerised good flows (2011)



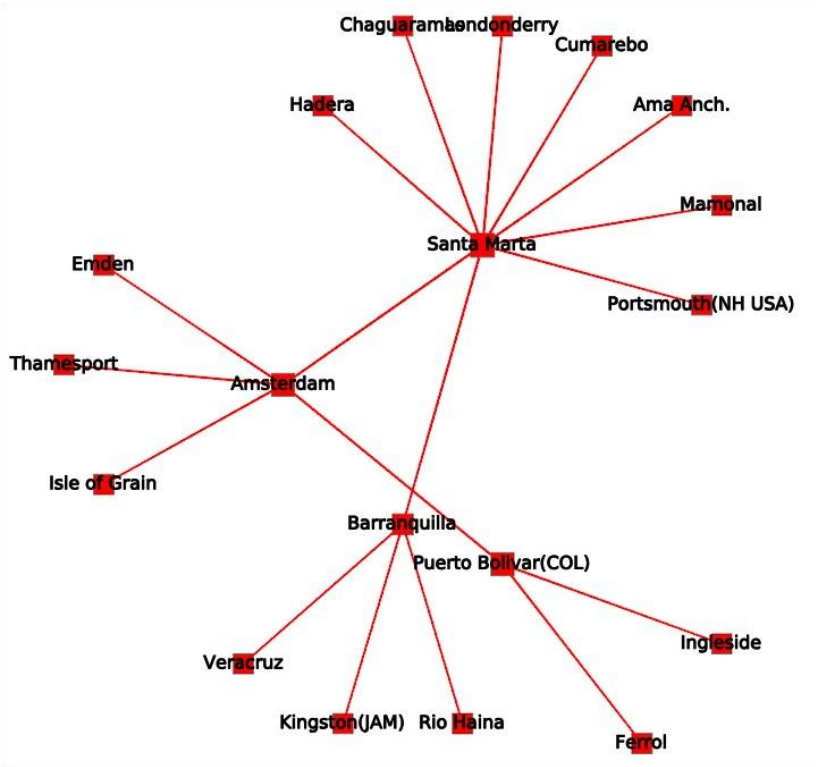
Note: only the dominant connections are indicated: per port only the link that represents the most important goods flow for that port.
Source: elaborations César Ducruet based on data of Lloyd's Maritime Intelligence Unit (LMIU).

Figure 9. Position of main ports in North-West Europe in liquid bulk flows (2011)



Note: only the dominant connections are indicated: per port only the link that represents the most important goods flow for that port.
Source: elaborations César Ducruet based on data of Lloyd's Maritime Intelligence Unit (LMIU).

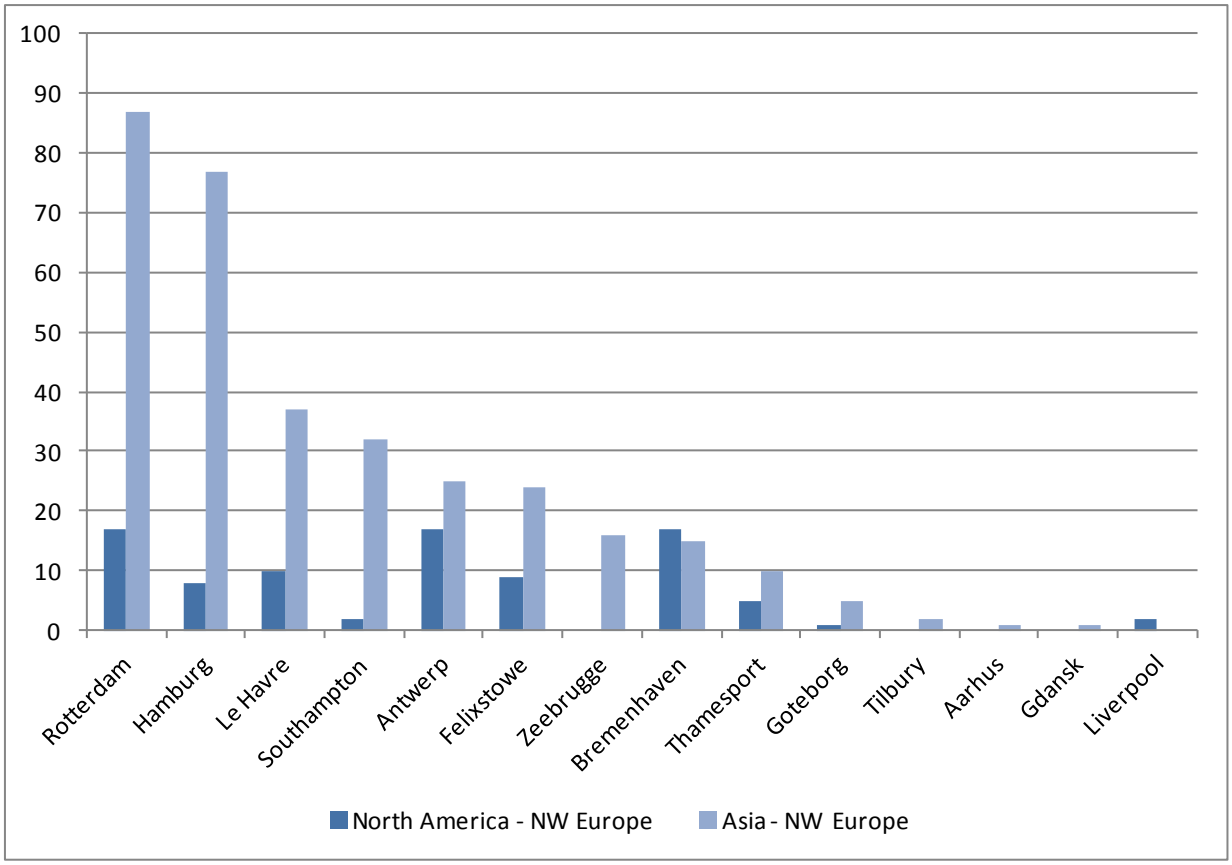
Figure 10. Position of Amsterdam in solid bulk good flows (2011)



Note: only the dominant connections are indicated: per port only the link that represents the most important goods flow for that port.
Source: elaborations César Ducruet based on data of Lloyd's Maritime Intelligence Unit (LMIU).

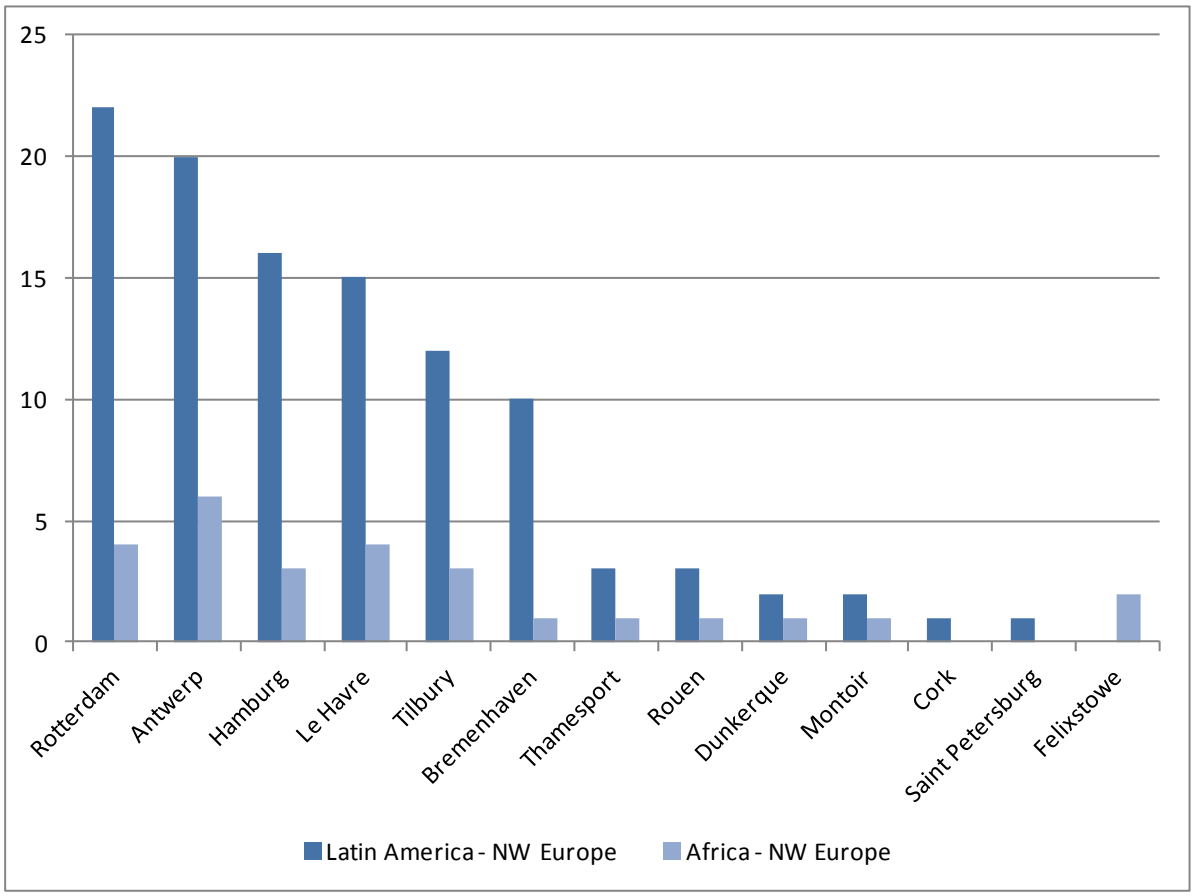
The strong container hub functions of Rotterdam are confirmed by its very frequent inclusion in the intercontinental routes of the largest global container carriers. It is most frequently included in Europe-Asia routes (with only Hamburg being able to follow to some extent) and on a par with Antwerp and Bremerhaven on inclusion in Europe-North America routes (Figure 11). This can be concluded from an analysis of the routes and service loops of ten of the eleven largest global shipping companies in March 2012, undertaken for this report. For this analysis the number of times that ports in North West Europe were included in routes with Asia, North America, Latin America and Africa were counted. Intercontinental service loops between Europe and Latin America or Africa are more limited, but Rotterdam is also having a strong, although not dominant position in these routes: leading with respect to inclusions in routes with Latin-America, but behind Antwerp and on a par with Le Havre with regards to Europe-Africa routes (Figure 12).

Figure 11. Inclusion of NW-European ports in intercontinental maritime routes



Source: Author's own elaboration of data from intercontinental routes from 10 of 11 largest global container carriers.

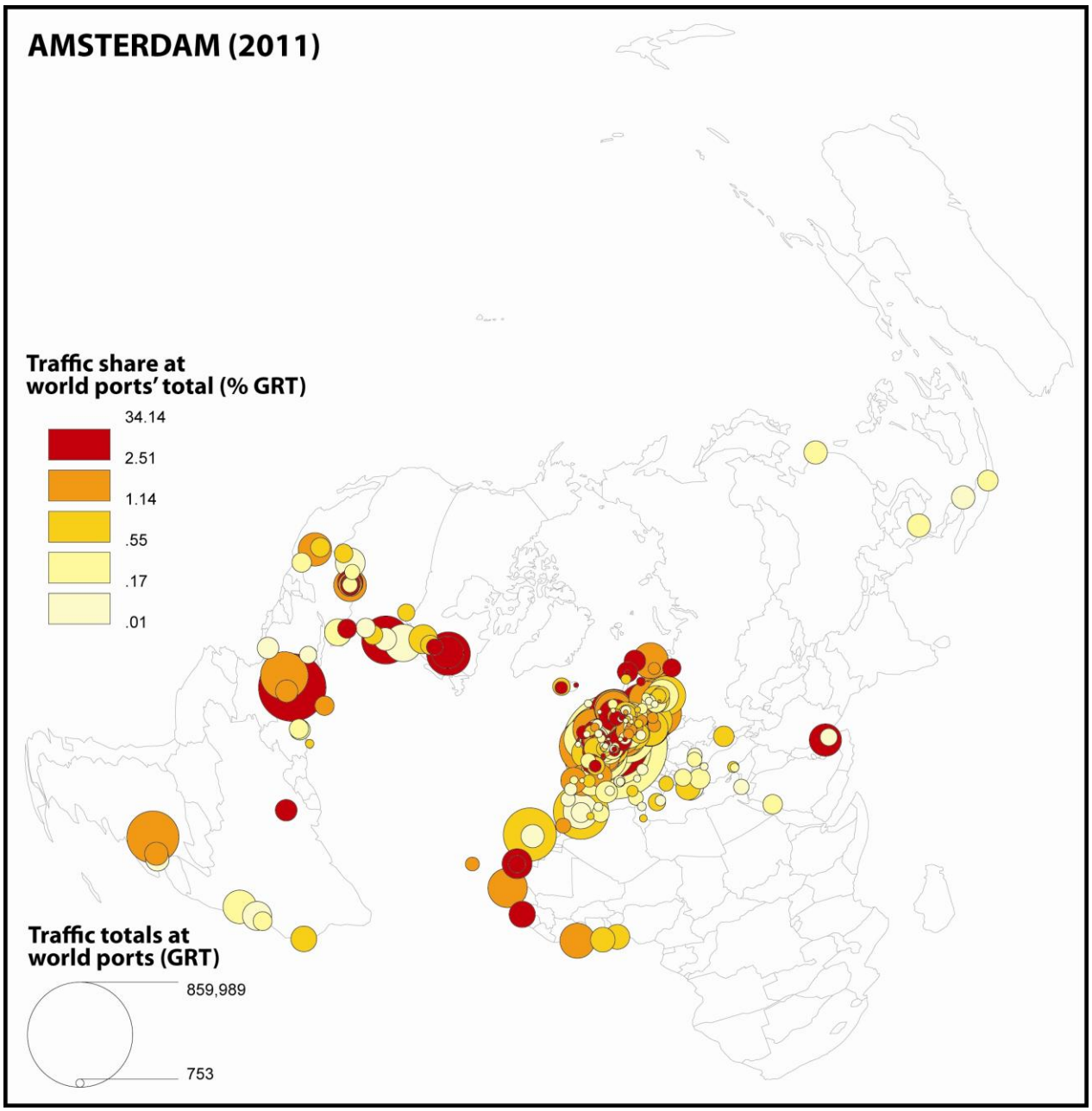
Figure 12. Inclusion of NW-European ports in intercontinental routes with emerging markets



Source: Author's own elaboration of data from intercontinental routes from 10 of 11 largest global container carriers.

The diversity of Amsterdam's maritime connections is relatively limited. Most of its connections are within Europe, with North and Latin America and to a more limited extent with West Africa. Traffic with Asia is very limited. This can be concluded from a mapping of all maritime connections of the port of Amsterdam, making distinctions between absolute volumes and relative share of traffic related to Amsterdam in the port's total throughput (Figure 13).

Figure 13. Maritime forelands of the port of Amsterdam (2011)



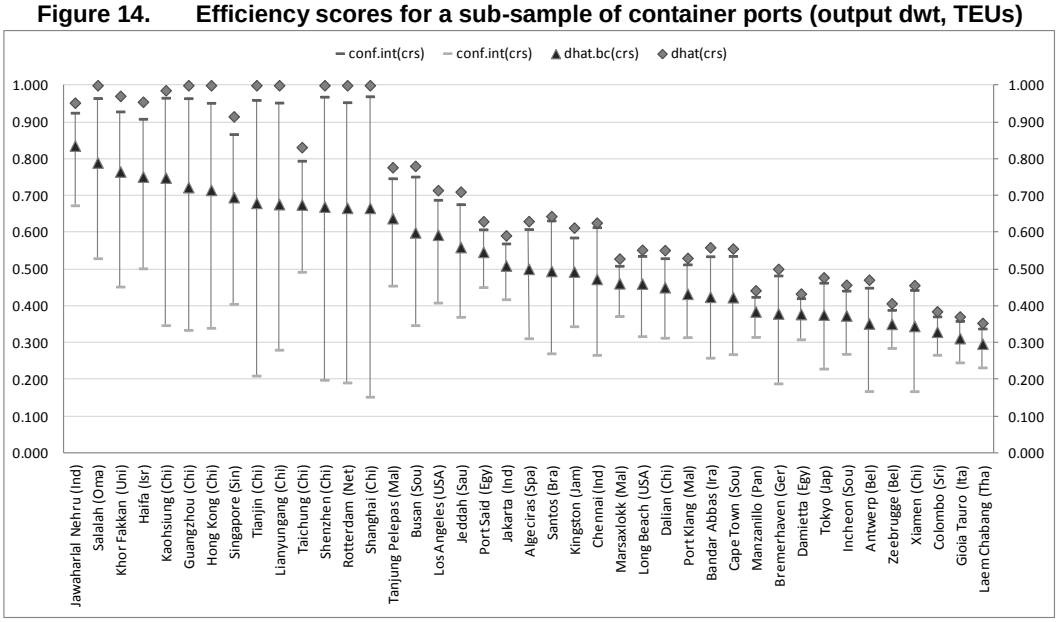
Source: Elaboration César Ducruet based on dataset from Lloyds Marine Intelligence Unit (2011)

Port efficiency

Rotterdam is among the most efficient world ports with respect to containers and crude oil; and the North Sea Canal port of Velsen/IJmuiden with respect to coal. This can be concluded from an analysis that we carried out on port efficiency with regards to containers and bulk goods, using DEA methodology and a unique database set up for this purpose (both dataset and methodology are described in Annex 1), in order to fill the current gap on port efficiency studies on anything else than container ports and terminals. Our findings indicate that the most efficient crude oil ports are very large specialised oil ports in the Middle

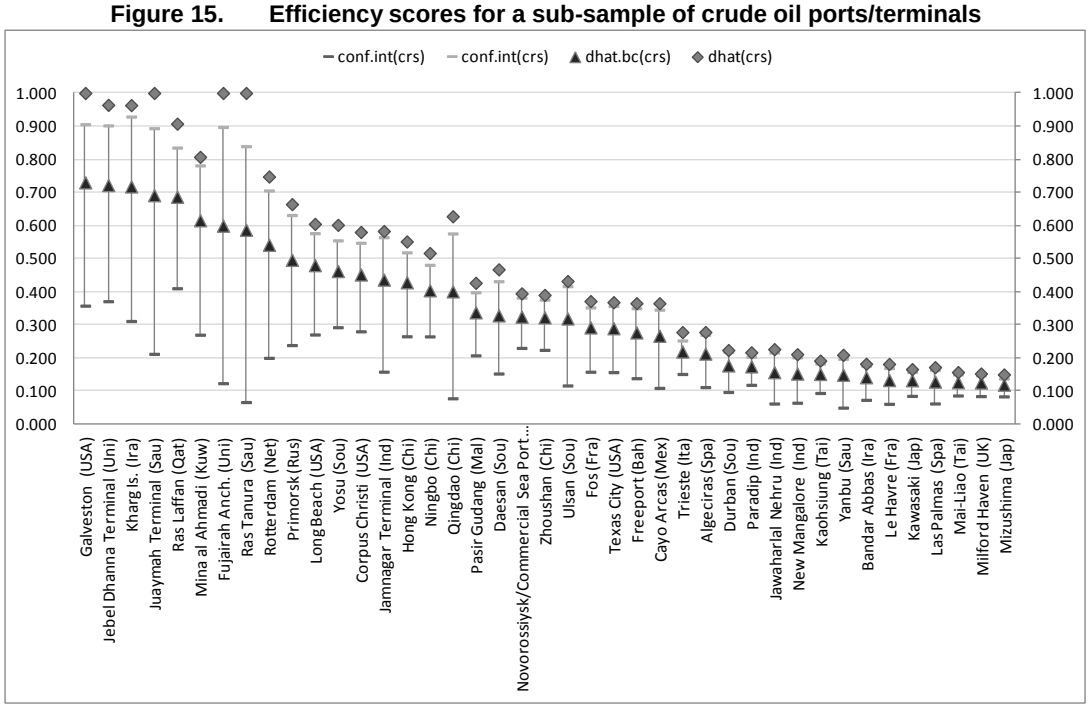
East, but also include Rotterdam and some of the Chinese ports. As such, Rotterdam scores higher than the other European oil ports (Figure 15). Rotterdam also ranked among the world's efficient ports with respect to containers (Figure 14), although not with respect to grains (Figure 17). The North Sea Canal port of Velsen/IJmuiden had a very high efficiency score on the handling of coal bulk (Figure 16).

Figure 14. Efficiency scores for a sub-sample of container ports (output dwt, TEUs)



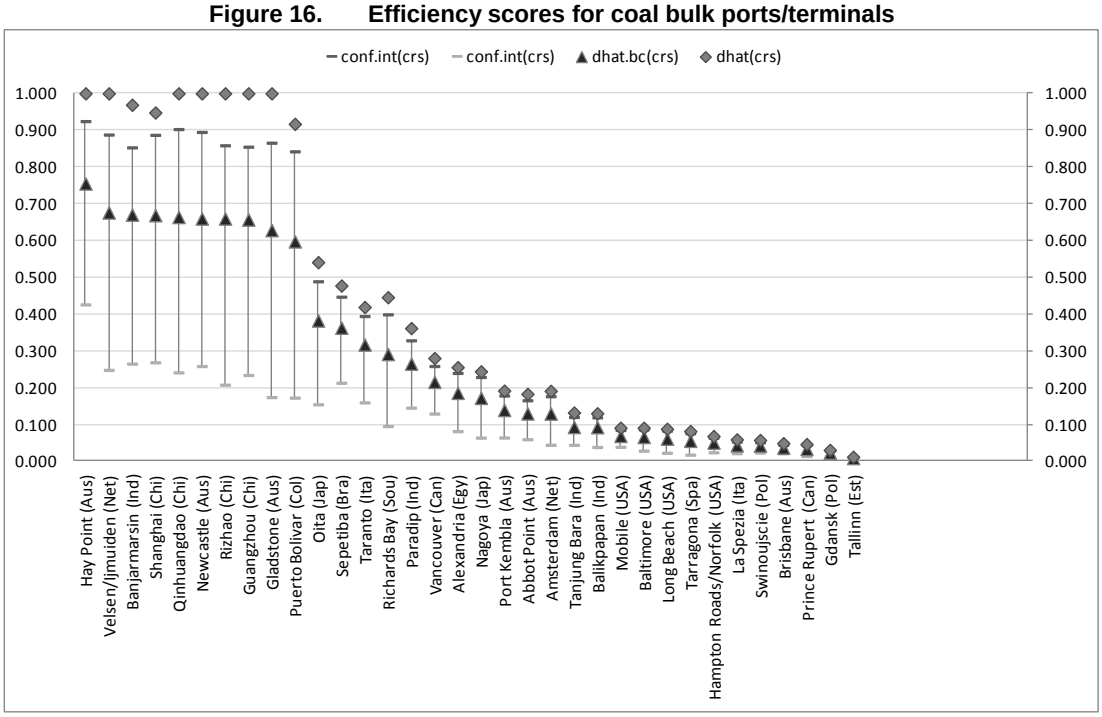
Source: Authors' own calculations.

Figure 15. Efficiency scores for a sub-sample of crude oil ports/terminals



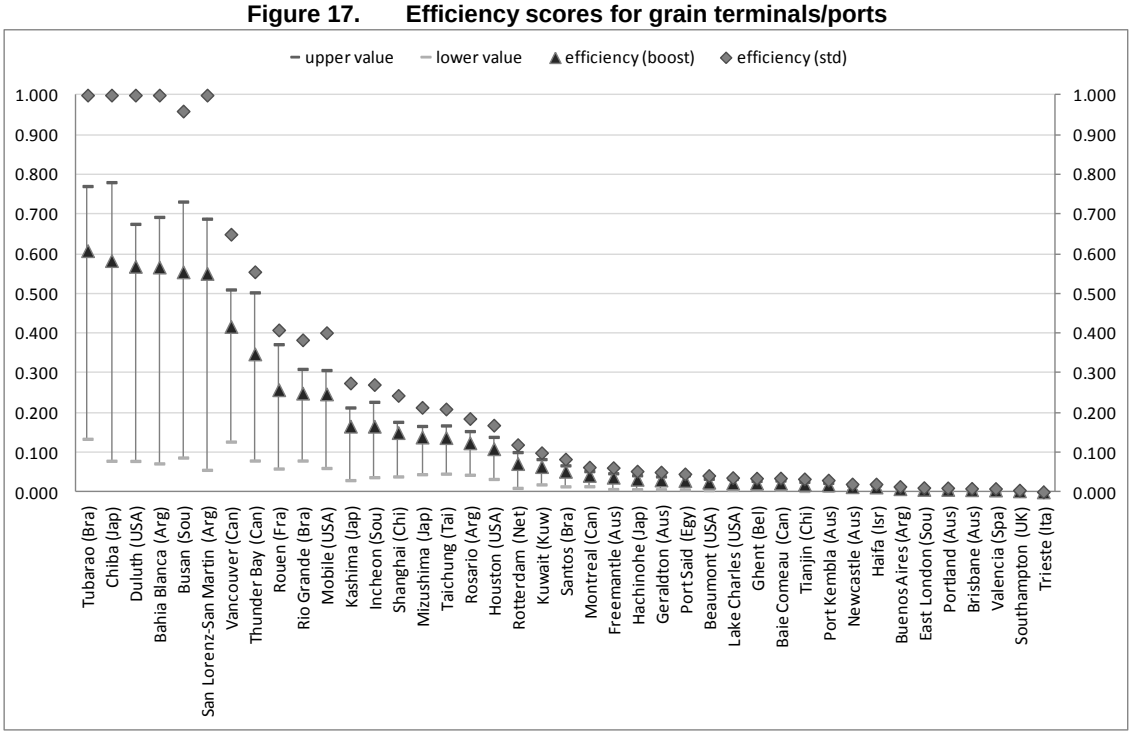
Source: Authors' own calculations. Note: (dhat) refers to efficiency scores derived using the standard DEA methodology; (dhat.bc) indicates scores derived using the bootstrapping method and (conf.int) indicates the upper/lower bound values of the interval of confidence; (crs) is the abbreviation of constant returns to scale, assumptions used in both methodologies.

Figure 16. Efficiency scores for coal bulk ports/terminals



Source: Author's own calculations. Note: (dhat) refers to efficiency scores derived using the standard DEA methodology; (dhat.bc) indicates scores derived using the bootstrapping method and (conf.int) indicates the upper/lower bound values of the interval of confidence; (crs) is the abbreviation of constant returns to scale, assumption used in both methodologies.

Figure 17. Efficiency scores for grain terminals/ports



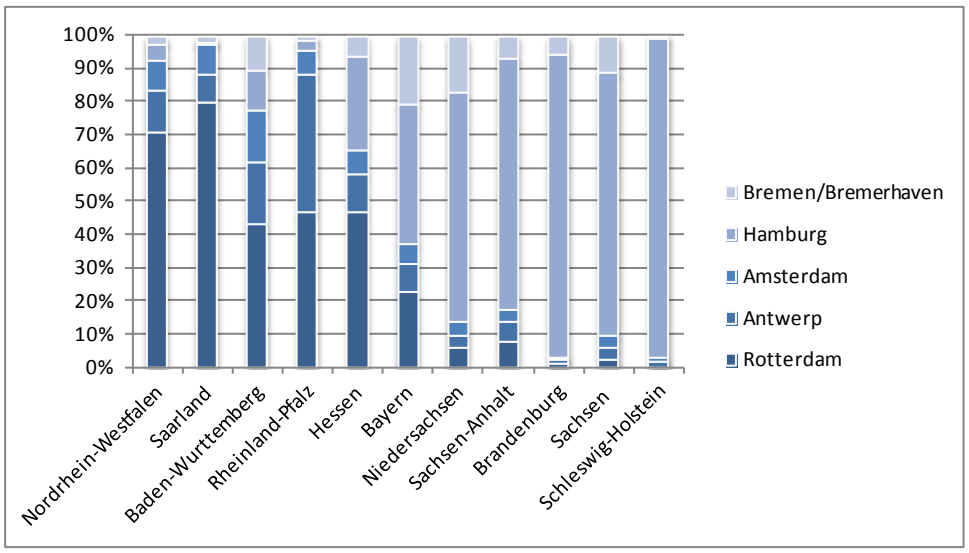
Source: Authors' own calculations. Note: (dhat) refers to efficiency scores derived using the standard DEA methodology; (dhat.bc) indicates scores derived using the bootstrapping method and (conf.int) indicates the upper/lower bound values of the interval of confidence; (crs) is the abbreviation of constant returns to scale, assumption used in both methodologies

Hinterland connectivity

Local or immediate hinterlands remain the backbone of ports' cargo bases. This is very apparent when looking at the inland distribution patterns of dry and liquid bulk products in the ports of Rotterdam and Amsterdam. A large part of the volumes is relatively captive to the discharging ports since the customers are typically located in the port or in the vicinity of the port (steel plants, power plants, oil refineries, chemical companies, etc.). The gateway function for major dry and liquid bulks of Rotterdam and Amsterdam involves a dominant traffic direction (mostly incoming seaborne cargo), a limited number of market players and a few nodes, i.e. the port and a limited number of destinations in the hinterland (mainly the Netherlands and western Germany).

However, the hinterlands of the port of Rotterdam and Amsterdam extend far beyond the Netherlands. In large and important states of western Germany (such as Nordrhein-Westfalen and Rheinland-Pfalz), but also Baden-Wurttemberg in southern Germany, Rotterdam and Antwerp are the main ports competing with each other for hinterland; the port of Amsterdam is in these states the third most important port. The dominance of these three ports in the German states in the North and East of Germany is much less important: in these states Hamburg and Bremerhaven compete, but the presence of Rotterdam and Antwerp is relatively marginal (Figure 18). Germany is the most important foreign hinterland for Rotterdam and Amsterdam, but their reach on foreign hinterland goes beyond that. Rotterdam is the largest port for Switzerland, the second largest in Austria, and of the important ports for central European countries, such as Slovak Republic, Hungary and the Czech Republic (Figure 19). As the decline of the market share of Rotterdam in Austria shows, these hinterlands are highly contested by ports from inside and outside the Hamburg-Le Havre range (Figure 20).

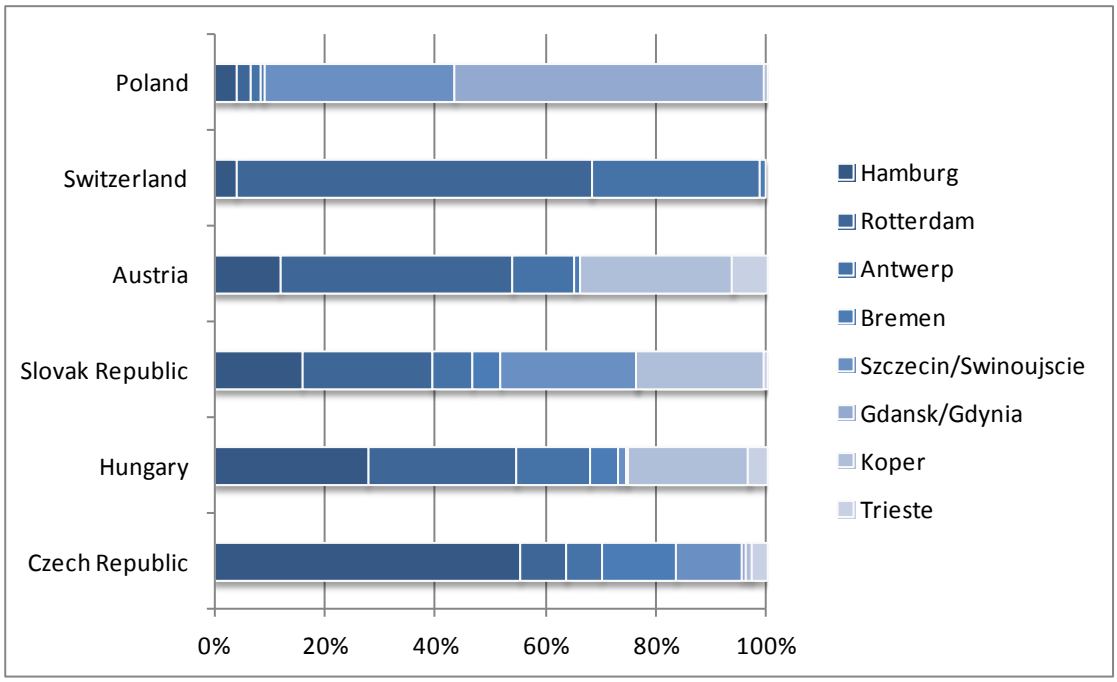
Figure 18. Port hinterlands in German states



Note: shares refer to situation in 2006. For reasons of comparability only hinterland traffic by rail and barge are included in this figure.

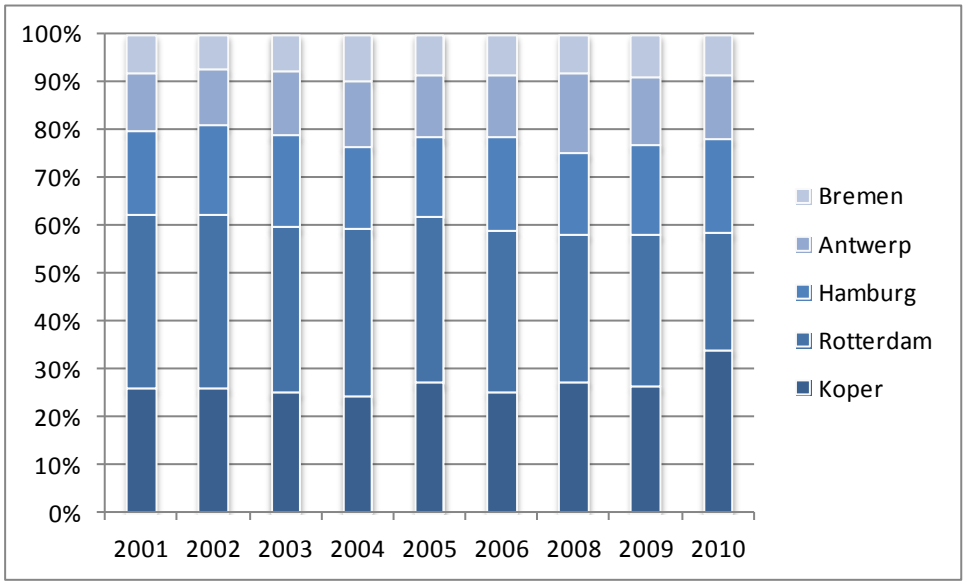
Source: Own calculations based on data in Bundes Amt für Güterverkehr 2007.

Figure 19. Market share of main import ports for central Europe, 2006-2007



Source: Author's own compilation of data from different port authorities, Eurostat and Bündesamt für Güterverkehr (2007)

Figure 20. Main five ports for Austrian imports and exports, 2001-10



Source: Author's own elaboration based on data from Österreichische Seehafenbilanz (2010, 2011).
Note: These are market shares of the main five ports for Austria. Other ports that are used for Austrian foreign trade have much lower goods flows with Austria (Rijeka, Constantza). Data on Trieste, the sixth largest port for Austria, are incomplete, which makes comparison of market shares over time difficult.

Competition with Med ports?

Gateway ports in the west Med have gained a much better connectivity in the global shipping networks than before, which gives these ports the opportunity to benefit from a higher critical mass and economies linked to larger vessels. But so far, they seem to have difficulties in substantially extending their hinterland reach north through rail services (Gouvernal et al, 2005). In practice, only Spanish Med ports have been successful in large part due to the strong economic growth in Catalonia and Madrid, while Italian and French Med ports lag behind in growth (see Notteboom, 2010 for a more detailed discussion). While Spanish ports face a major technical problem in setting up rail shuttles to France (i.e. difference in rail gauge), the north-south paradox for North-Italian cargo is mainly linked to a weaker intermodal organisational performance for intra-Italian rail products, and existing (but converging) differences in port efficiency between Northern ports and North Italian ports.

One of the main obstacles to Med ports is that the hinterland volumes are a lot smaller than in the Rhine-Scheldt Delta, which implies that frequent intermodal services are hard to maintain and sometimes disappear soon after introduction. In 2008, the container ports in the Rhine-Scheldt Delta (mainly Rotterdam, Antwerp and Zeebrugge) jointly generated an inland cargo flow – so excluding sea-sea transshipment flows - of some 16.8 million TEU, much more than any other port region in Europe. This concentration of flows largely explains why the range and diversity of the intermodal service offer of large load centers in the north such as Rotterdam is still far bigger and more established than in their Mediterranean counterparts.

1.3. Synergies

Synergies can take place if through cooperation the total outcome has more net benefits than the net benefits of the different port operations in isolation. Of course this is a simplification, as ports can be in competition and still co-operate, but generally co-operation tends to take place more often when there are fewer areas where the ports compete with each other. This section focuses on synergies between the ports of Rotterdam and Amsterdam, then focuses on synergies between Rotterdam and Antwerp, and finally brings these synergies into a broader perspective of mega-gateway regions, in which also airport functions are included.

Synergy between the ports of Rotterdam and Amsterdam

The potential for synergies between the ports of Rotterdam and Amsterdam is thus to some extent determined by the extent to which the ports in the area are different from each other. How different are the ports of Rotterdam and Amsterdam? Differences between these ports can relate to the following areas (see also Notteboom, 2009b): a) scale; b) diversification; c) room for growth; d) location and nautical access; e) foreland orientation; f) hinterland orientation and exchanges over land.

Scale: Rotterdam and Amsterdam are both large ports (no. 1 and no. 4 in Europe in terms of total cargo volumes). However, Rotterdam is an 'all-round' hub port with strong to very strong positions in almost all market segments (liquid bulk, dry bulk, conventional general cargo, roro business such as new cars and ferries and containers), a very strong international maritime connectivity and a strong hinterland orientation with intra-European connections over land and via feeder/shortsea. Amsterdam is an important player in some specific markets - such as coal, cocoa and petrol – but a small player in other markets such as containerised cargo. Around a quarter of the container traffic to Rotterdam is transshipment of goods. All global container shipping lines call directly at the port of Rotterdam, while Amsterdam only receives calls from smaller operators active in the feeder or shortsea business.

Diversification: As already discussed earlier in the traffic analyses, Rotterdam and Amsterdam have a strong position in bulk cargo. However, Amsterdam is much more specialised in bulk compared to Rotterdam: nearly 93% of Amsterdam throughput relates to bulk, mainly petrol and coal. Amsterdam's cargo volumes in agribulk and coal are comparable in size to Rotterdam's volumes. In liquid bulk, the focus of both ports is somewhat different as discussed in the traffic analysis section: a comparatively much stronger focus on crude oil in Rotterdam and on mineral oil products (particularly petrol) in Amsterdam. The positions of the two ports are very different when it comes to roro and containers. The roro business is very small in Amsterdam while Rotterdam has a sizeable roro throughput, mainly linked to ferries to the United Kingdom and the handling of new cars. Rotterdam is Europe's largest container port. Containerised cargo represents more than a quarter of total throughput. Amsterdam's containerised flows are very small and largely linked to cocoa trade and its extended gate function. As a result of the different specialisations, the vessel types calling at the ports are different.

Table 1. Cargo distribution in Rotterdam and Amsterdam in 2010

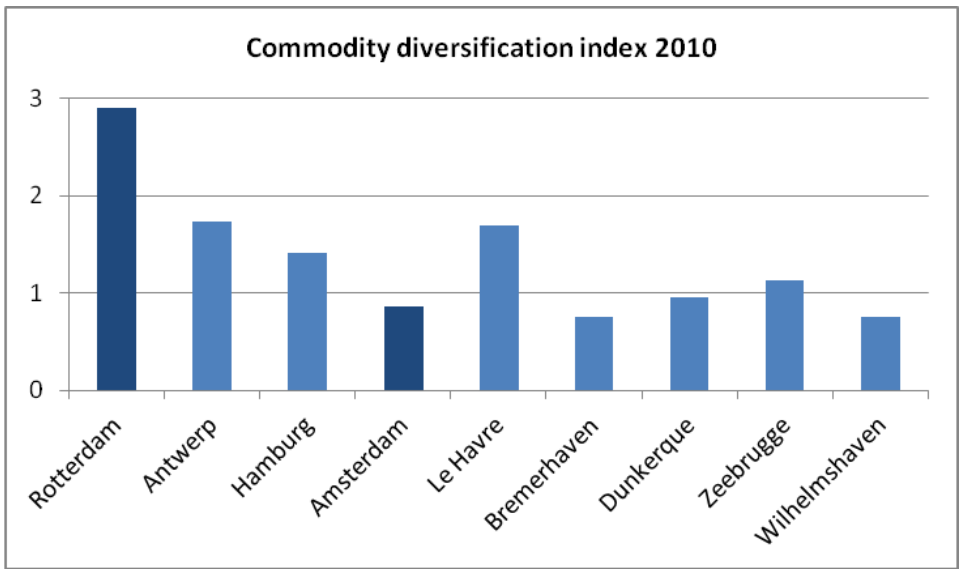
in 1000 tons	**Rotterdam**	**%**	**Amsterdam (*)**	**%**	**Ratio R'dam vs. A'dam**
Agribulk	8368	1.9%	8950	9.9%	0.9
Iron ore and scrap	39822	9.3%	9655	10.7%	4.1
Coal	24080	5.6%	18767	20.7%	1.3
Crude oil	100300	23.3%	173	0.2%	580
Mineral oil products	77580	18.0%	34654	38.2%	2.2
Other bulk	43797	10.2%	11951	13.2%	3.7
Total bulk	**293947**	**68.4%**	**84150**	**92.8%**	3.5
Containers	**112293**	**26.1%**	**830**	**0.9%**	135
RoRo	**16748**	**3.9%**	**862**	**1.0%**	19.4
Other general cargo	**6938**	**1.6%**	**4803**	**5.3%**	1.4
Total	**429926**	**100.0%**	**90645**	**100.0%**	**4.7**

(*) North Sea Canal Area

Source: based on statistics of respective port authorities.

The port of Rotterdam is the most diversified in North West Europe, whereas Amsterdam is far less diversified. Its score on a commodity diversity index (CDI), based on 14 different commodities, in 2010 was almost 3. The port of Amsterdam is less diversified and has CDI-scores similar to Dunkirk, Wilhelmshaven as well as smaller ports such as Rouen, Ghent and Flushing.

Figure 21. Commodity diversification index for North-West European seaports (2010)



Source: Elaboration by the OECD secretariat on the basis of Eurostat data.
Note: This commodity diversity index is comparable with the relative diversity index proposed by Duranton and Puga (2000) and has for the first time been applied to seaports by Ducruet el al. (2010). It allows for correcting and comparing differences in commodity shares at the European level. For each port the absolute differences between the share of a commodity j in port i and the share of the corresponding commodity j at European level are summed.

Room for growth: The Rotterdam port area covers 10,500 ha, of which half can be used for businesses. In 2009 about 5,272 ha was leased by the port authority to private operators. In the existing port area only 175 ha are still available for lease. This only involves small plots of land. With the Maasvlakte 2 extension a total of 1,000 ha of leasable land is created. In this sense the port of Rotterdam overshadows Amsterdam in terms of room for future port development. The first terminal should be open for business by 2013-14. Future expansion in the port of Amsterdam is more focused on the existing port area. The port area of Amsterdam amounts to some 2,600 ha, of which 1,600 hectares are business sites and the remaining 1,000 ha involves harbours and other infrastructure. The supply of vacant business sites has decreased sharply from 426 hectares in 2003 to 270 in 2009 (Gemeente Amsterdam, 2003; 2009). The port's strategy to 2020 underlines that the existing port area should be able to cope with future growth of the traffic through an increase in land productivity, redevelopment of existing port areas and changes in the land lease policy. Amsterdam still has spare capacity available for accommodating container business. While the expansion and pressure of the city and environmental pressures are felt in Rotterdam and Amsterdam, it is expected that these factors will have a larger effect on the development potential of the latter port. A more elaborate discussion on the spatial development of city and port will be provided later in this report.

Location and nautical access: Rotterdam is a coastal port with the best nautical accessibility profile in north Europe. Terminals at the Maasvlakte offer a draft of 16.7 up to 22m. This implies that the terminals on Rotterdam's Maasvlakte can accommodate the largest vessels at any time. Amsterdam is a canal port. The port area in Ijmuiden in front of the locks offers access to Capesise vessels. The Canal area is only accessible to vessels with a draft up to 13.7m which is particularly troublesome to large bulk carriers and container vessels. A new sea lock is planned.

Traffic volumes – foreland orientation: Table 2 provides an overview of the top ten places of origin and destination of maritime traffic in both ports. For bulk commodities, important regions of origin are South America, Russia, North America and South Africa. For conventional general cargo the geographical foreland distribution is much wider. The roro business is mainly in relation with the United Kingdom,

Scandinavia/Baltic and the Iberian Peninsula. While both Rotterdam and Amsterdam have maritime connections which a large number of overseas destinations, the foreland distribution of Amsterdam is more concentrated than Rotterdam (e.g. in Amsterdam nearly 75% of the incoming cargo originates from the top ten countries compared to 62% for Rotterdam). The ports do not have the same relations with other ports. These relations with other ports can be measured through vessel movements arriving in and departing from these ports. The correlation between the port links of Rotterdam and Amsterdam is fairly small, which indicates that they form part of different port networks with relatively limited overlaps (figure 22). These data should however be treated with caution, as these are container vessel movements, and container traffic to Amsterdam is relatively limited. As illustrated earlier, Rotterdam is very central and well connected in the global container liner service network, while Amsterdam is of little significance in this market. Rotterdam and Hamburg remain the dominant European players in the fast-growing intra-European and Far East markets. One of the success factors of Rotterdam in attracting Far East trade relates to its excellent nautical access for the very large vessels that are deployed on this trade (i.e. at present unit capacities of up to 15,000 TEU with Triple E-class vessels of Maersk Line with a capacity of 18 000 TEU entering the market in 2014).

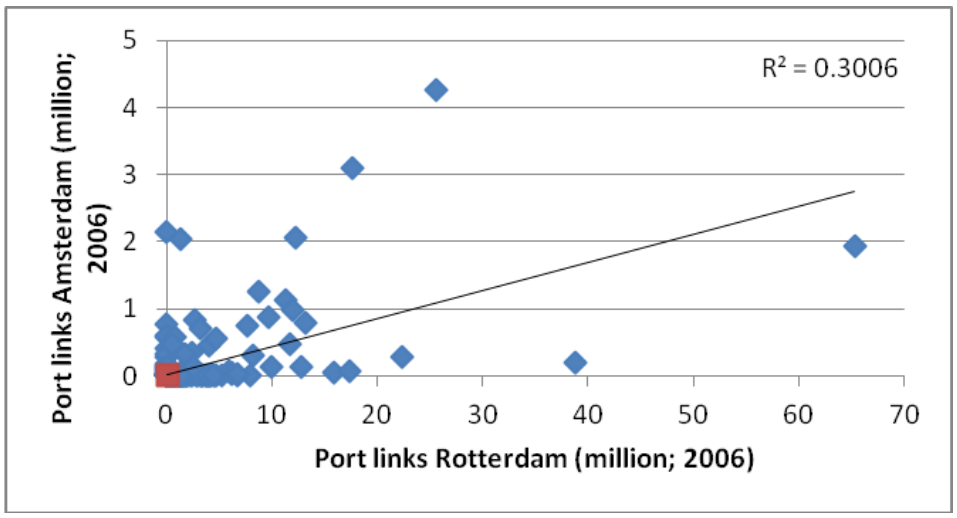
Table 2. Top ten foreland countries for maritime traffic in Rotterdam and Amsterdam

	AMSTERDAM 2010		AMSTERDAM 2010		ROTTERDAM 2009		ROTTERDAM 2009	
	Top 10 places of origin		Top 10 places of destination		Top 10 places of origin		Top 10 places of destination	
	Country	1000 tons	Country	1000 tons	Country	1000 tons	Country	1000 tons
1	Columbia	6458	Nigeria	5635	Russia	38797	United Kingdom	23867
2	United Kingdom	5908	United Kingdom	2675	United Kingdom	32222	China	10323
3	Russia	4922	Mexico	2240	Norway	20777	United States	9202
4	Brazil	4742	United States	2072	Brazil	17752	Singapore	8551
5	Latvia	3426	France	1093	South Africa	13041	Germany	4679
6	Norway	3342	Germany	783	United States	11885	Spain	4225
7	United States	2788	Spain	732	China	9816	France	4157
8	Netherlands	1917	Brazil	504	Egypt	9071	Sweden	2649
9	France	1686	Norway	499	Columbia	7013	Russia	2387
10	Argentina	1185	Gibraltar	497	Canada	6181	Japan	2269
	Subtotal	**36374**	**Subtotal**	**16730**	**Subtotal**	**166555**	**Subtotal**	**72309**
	Total	**48825**	**Total**	**23872**	**Total**	**270370**	**Total**	**116384**
	% of top 10	*74.5%*	*% of top 10*	*70.1%*	*% of top 10*	*61.6%*	*% of top 10*	*62.1%*

Note: The figures of Amsterdam only relate to the Port of Amsterdam excluding the other ports in the North Sea Canal area.

Source: own compilation based on traffic statistics of respective port authorities.

Figure 22. Correlation between port links of Rotterdam and Amsterdam (2006)



Source: Elaboration by the OECD secretariat on the basis of Eurostat data.

Traffic volumes – capturing foreign hinterlands: As indicated earlier, the local hinterland remains very important for both ports. Germany is the most important transit hinterland for Amsterdam and Rotterdam. About half of the German transit is concentrated in the region Nordrhein-Westfalen (impact of the Ruhr area). Rotterdam shows more extensive European hinterland coverage than Amsterdam with stronger market share in the East and the more distant hinterlands in the Southeast of Europe.

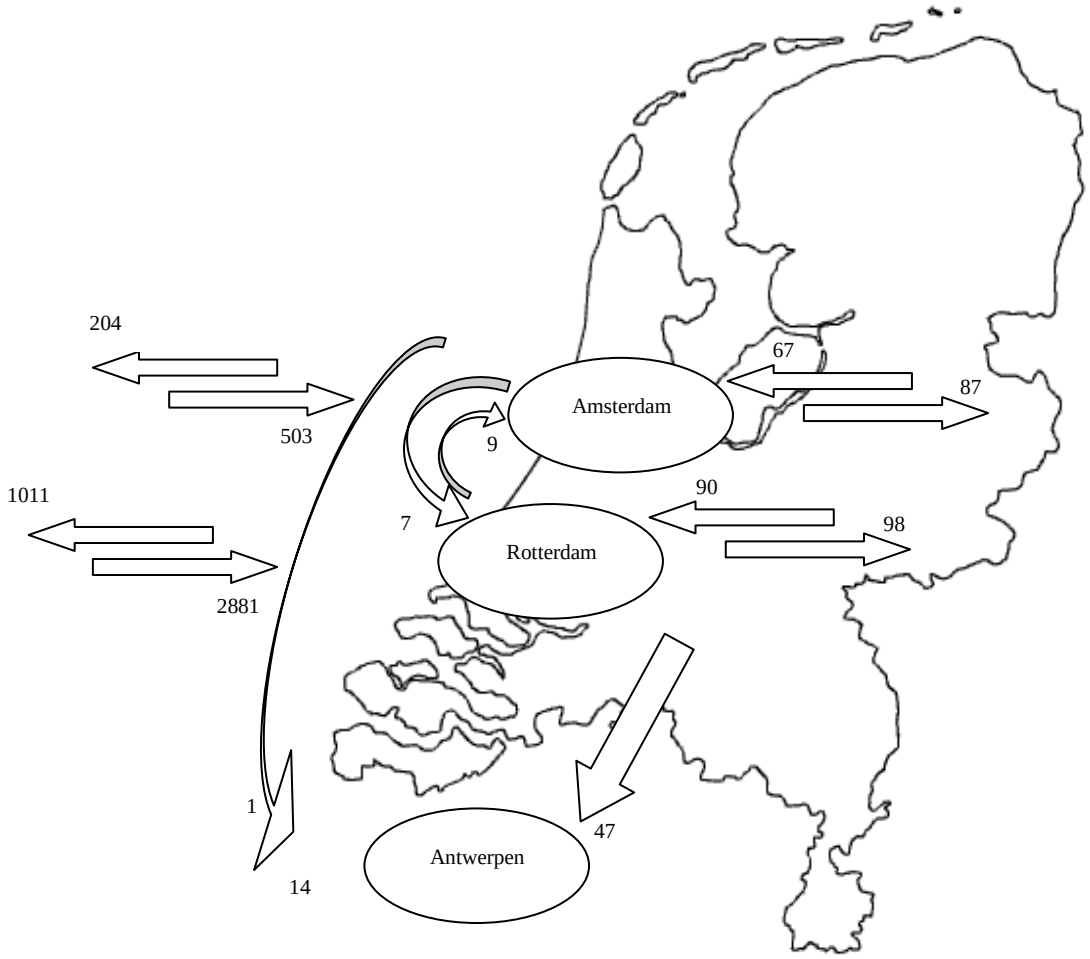
Exchanges over land: Large cargo exchanges over land are particularly found in the container business and in liquid bulk. The Rotterdam-Amsterdam container (mostly barge) connections are estimated to generate less than 50,000 TEU in 2010, mainly linked to the extended gate position of Amsterdam. These flows are small compared to the Antwerp-Rotterdam connection by inland barge over the Scheldt-Rhine canal, by rail and by pipeline (the Rotterdam Antwerp pipeline but also pipelines for other chemicals). The container exchanges between Antwerp and Rotterdam are estimated at nearly 1 million TEU in 2008 compared to 560 000 TEU in 1997 (both directions) of which 30% empty containers. Shuttle trains between Antwerp and Rotterdam transported 285 000 TEU in 2004 compared to 120 000 TEU in 1997. Containerised cargo often receives a bill of lading (B/L) for one port, although the physical handling from deep-sea vessel to land takes place in another port. Shipping lines stimulate cargo to come to the ship by installing port equalisation systems.

In summary, Rotterdam and Amsterdam are large ports which compete mainly in the area of bulk commodities, but show a lot of complementarity in the container business. Rotterdam is an 'all-round' hub port with a strong international maritime connectivity and a comprehensive hinterland orientation. Amsterdam is, despite its scale, more of a niche player with a somewhat smaller hinterland and a more spatially concentrated foreland. The traffic exchanges over land between the two ports are rather weak. With the realisation of Maasvlakte 2, Rotterdam has secured room for future growth. Amsterdam has some strategic land reserves inside the port area. The construction of a new sea lock at IJmuiden should give a new impulse to the canal zone. Both ports experience an increasing tension from city expansion and environmental concerns, but these factors are felt the most in Amsterdam.

Synergies between the port-cities of Rotterdam and Antwerp

There are important good flows between Rotterdam and Antwerp. The maritime container flows between Antwerp and Rotterdam in 2006 were larger than to any other port from Antwerp, and around ten times larger than the flows between Amsterdam and Rotterdam. The link with Antwerp is also one of the largest flows of Rotterdam, which indicates the interrelatedness of these two hub ports. In addition, the good flows by other transportation means between the two port-cities are also considerable. The good flows between Rotterdam and Antwerp represent 14 million tonnes (gross weight); they are roughly twice as large as those between Amsterdam and Rotterdam. Flows from Rotterdam to Antwerp represent one fifth of total flows from the Netherlands to Antwerp. Good flows between Amsterdam and Antwerp are relatively marginal (Figure 25).

Figure 23. Good flows Amsterdam-Rotterdam-Antwerp



Source: TNO
Note: The following geographical definitions are used: Amsterdam is defined as the NUTS 3-areas of Groot-Amsterdam, IJmond, Zaanstreek and agglomeratie Haarlem; Rotterdam as NUTS 3-areas of Groot-Rijnmond and Zuid-Holland-Zuid; Antwerpen as NUTS 3 –area of Antwerpen and Sint-Niklaas. The arrows connected to Amsterdam and Rotterdam on the left-hand side of the figure indicate the imports and exports connected to Amsterdam and Rotterdam. The arrows to the right of Amsterdam and Rotterdam indicate the good flows with the rest of the Netherlands. Short sea shipping flows are excluded from this figure, as are good flows from Antwerp to the Netherlands due to limited data availability.

Around half of these good flows are connected to the petro-chemical industry: 35.5% connected to oil products and 13.1% to chemicals. Most of the other goods are in the category "cars, machines and other goods". In comparison, the good flows between Rotterdam and Amsterdam are even more dominated by oil products, whereas the flows between Rotterdam (as well as Amsterdam) and the rest of the Netherlands have a more varied character with relatively larger shares of goods related to minerals and construction materials, as well as food stuffs and fodder (Tables 3 & 4). River transport is the main transport mode for goods between Rotterdam and Antwerp: representing approximately 6 times the tonnage amount of road transport, and twelve times of rail transportation.[5] By contrast, most of the good flows between Rotterdam and the rest of the Netherlands (approximately 69%) is via road.

Table 3. Main good flows from Rotterdam per commodity

	Antwerp	Rotterdam	Rest of Netherlands
Oil products	36.0%	23.2%	4.9%
Chemical products	4.4%	8.9%	9.3%
Raw materials, intermediate goods and construction materials	4.5%	19.3%	29.5%
Agricultural products	6.3%	4.2%	6.6%
Other food stuffs and fodder	10.2%	12.3%	14.0%
Iron, steel and non-ferro-metals	13.9%	3.6%	2.6%
Cars, machines and other goods	21.4%	26.1%	28.6%
Total	**100%**	**100%**	**100%**

Source: own elaborations based on information provided by the Netherlands Statistical Office (CBS)

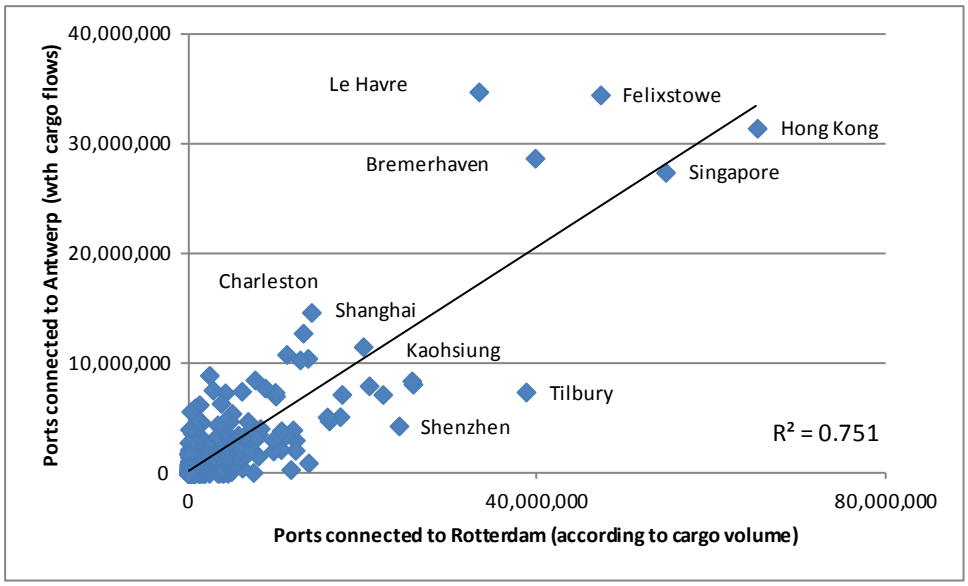
Table 4. Main good flows from Amsterdam per commodity

	Antwerp	Rotterdam	Rest of Netherlands
Oil products	36.0%	23.2%	4.9%
Chemical products	4.4%	8.9%	9.3%
Raw materials, intermediate goods and construction materials	4.5%	19.3%	29.5%
Agricultural products	6.3%	4.2%	6.6%
Other food stuffs and fodder	10.2%	12.3%	14.0%
Iron, steel and non-ferro-metals	13.9%	3.6%	2.6%
Cars, machines and other goods	21.4%	26.1%	28.6%
Total	**100%**	**100%**	**100%**

Source: own elaborations based on information provided by the Netherlands Statistical Office (CBS)

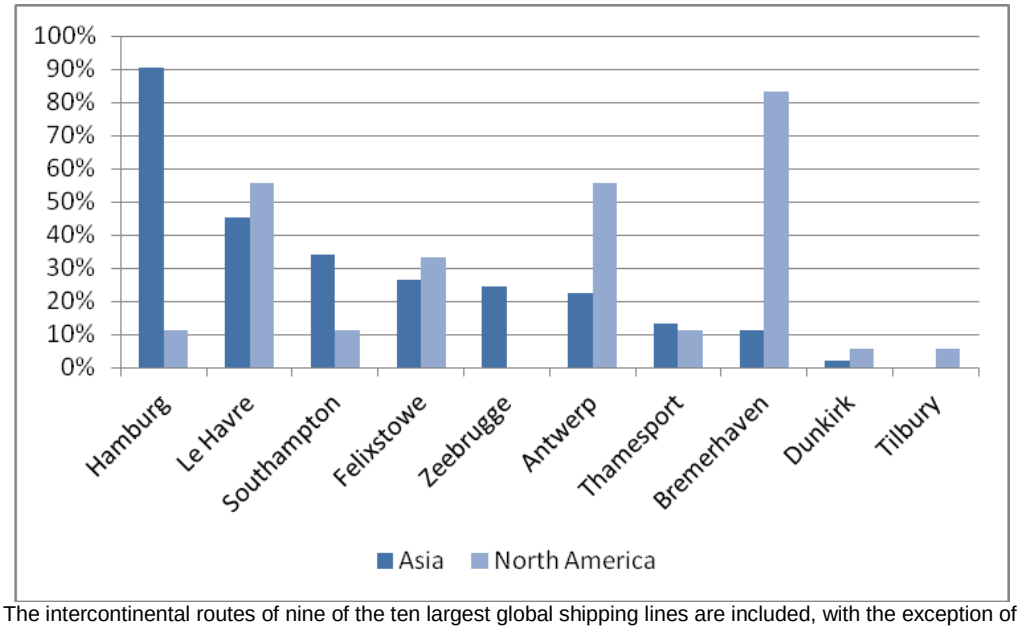
There is a relatively large overlap of maritime connections between Rotterdam and Antwerp. The correlation between their respective maritime foreland connections (weighted according to the cargo volumes handled between each pair of ports) is high (0.75). Important ports for both Rotterdam and Antwerp are Hong Kong, Singapore, Shanghai, Le Havre, Felixstowe and Bremerhaven; so the major hub ports in Asia and Europe. Ports that are more important to Rotterdam than Antwerp are Tilbury, Shenzhen and Shanghai, whereas ports such as Charleston are more important to Antwerp (Figure 24). Despite this overlap of maritime connections, Rotterdam and Antwerp are to some extent each other's substitutes with respect to intercontinental deep sea container lining schedules. This is especially the case for traffic between the Far East and Europe: the largest container shipping lines have only in 23% of the cases direct calls to both Rotterdam and Antwerp (Figure 25). There is more overlap on the Europe-North America schedules, but also for this leg the overlaps with the main German and UK ports and Le Havre are larger. This indicates that for the large shipping lines, Rotterdam and Antwerp can be considered functionally integrated: in order to reach the hinterland of Antwerp, it is not necessary to have a direct call to Antwerp (and the same for Rotterdam).

Figure 24. Overlap of maritime connections of Rotterdam and Antwerp



Source: Own calculations based on data Marine Intelligence Unit Lloyd's List.

Figure 25. Overlap of Rotterdam with other ports in intercontinental routes of global shipping lines



Note: The intercontinental routes of nine of the ten largest global shipping lines are included, with the exception of MSC.

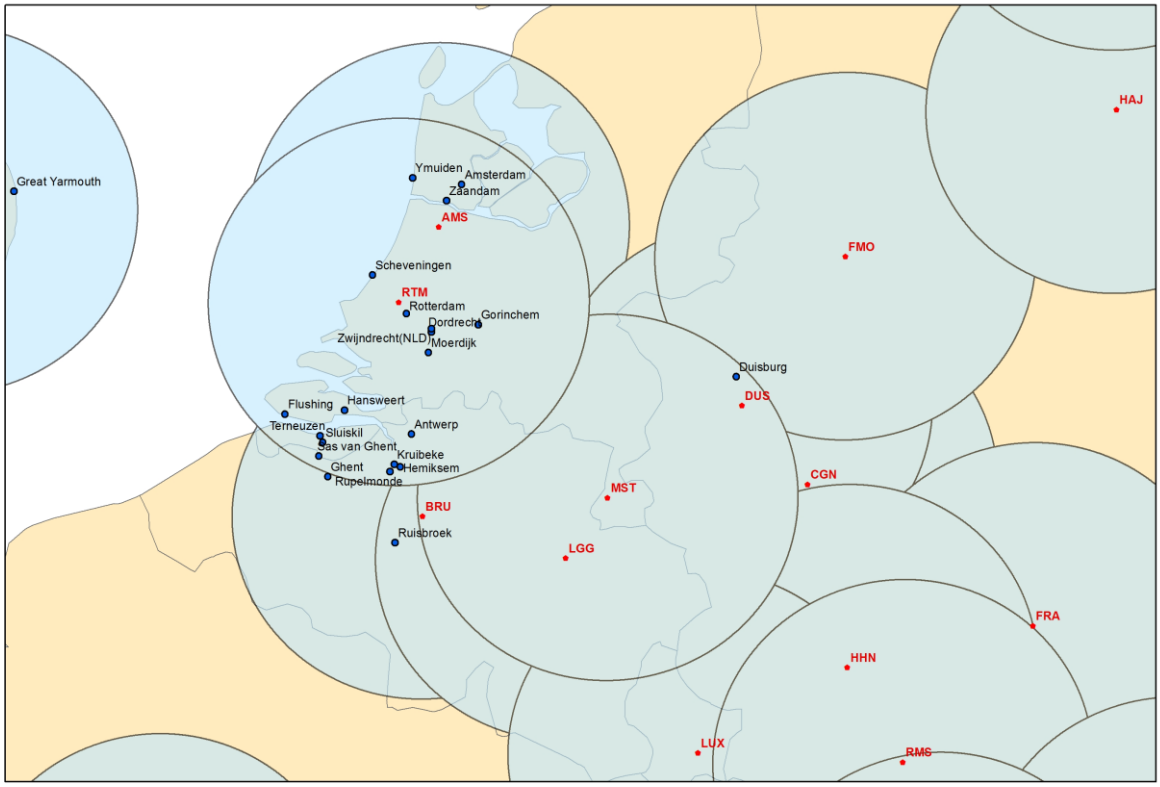
Source: OECD on the basis of data from major global shipping lines (March 2011).

Synergies within multi-port gateways

The different overlaps and synergies identified above should be analyzed in a more holistic manner. This can be done by analyzing the largest multi-port gateway regions in the world in which also main cargo airports are integrated. All of these regions have one or more of the top 30 container ports of the world; most of these gateway regions have one or more of the top 30 air cargo airports (but the Bohai Bay,

Helgoland Bay and the Korean Twin Hub are the exceptions). Rotterdam and Amsterdam form part of the Rhine Scheldt-delta, in which also the ports of Antwerp and Zeebrugge are included (Figure 28). The Rhine Scheldt-delta could be considered the 5th largest multi-port region in the world; it contains Amsterdam Schiphol which was the 17th largest cargo airport in the world according to Airports Council International data. The combination of seaports and airport within a circle of 100 km is relatively rare in Europe (Annex 2).

Figure 26. Seaports and airports in the Rhine Scheldt Delta



Source: Own elaborations based on data Marine Intelligence Unit Lloyd's List and database École Nationale de l'Aviation Civile (ENAC).

Table 5. Regional gateways (multi-port and airports)

Region	Main ports	Sea cargo volume (1000 TEUs, 2009)	Main cargo airports	Air cargo volume (1000 metric tonnes, 2010)
Pearl River Delta	Hong Kong Shenzhen Guangzhou	50423	Hong Kong Guangzhou Baiyun Shenzhen Bao'an	6122
Malacca Straits	Singapore Port Klang Tanjung Pelepas	39175	Singapore Changi Kuala Lumpur	2538
Yangtze River Delta	Shanghai	35504	Shanghai Pudong	3228

Region	Main ports	Sea cargo volume (1000 TEUs, 2009)	Main cargo airports	Air cargo volume (1000 metric tonnes, 2010)
	Ningbo			
Bohai Bay	Qingdao Tianjin Dalian	23512	Qingdao Tianjin Dalian	
Rhine-Scheldt Delta	Rotterdam Antwerp Zeebrugge Amsterdam	19583	Amsterdam	1538
Korean Twin Hub	Busan Gwangyang	13764	Busan	
San Pedro Bay	Los Angeles Long Beach	11815	Los Angeles	1810
Helgoland Bay	Hamburg Bremerhaven Wilhelmshaven	11585	Hamburg	
Tokyo Bay	Tokyo Yokohama Shimizu	6365	Narita Tokyo	2972

Source: Own calculations based on data Marine Intelligence Unit Lloyd's List, AAPA ranking top 125 world ports 2009, and ACI ranking top 30 cargo airports 2010.

Within these gateway regions, there is arguably room for synergies if overlaps between seaports are relatively limited and overlaps between airport and seaport are relatively large. In this analysis, the overlap of global networks of the main ports and airports will be considered (weighted for the volume of cargo). If overlaps between main seaports are limited, they can complement each other and thus together provide a larger set of services. The contrary is the case for seaports and airports; they can only complement each other if they have some degree of overlap; the attractiveness for a gateway region could be to offer the possibility to switch modality (from air to sea or the other way around); this possibility is more limited if the respective global networks do not overlap.

The Rhine Scheldt delta shows one of the more moderate overlaps between its main ports (Rotterdam-Antwerp), but relatively limited overlap between main seaport and airport (Table 6). Other port pairs, such as Singapore-Port Klang, Shanghai-Ningbo and Los Angeles-Long Beach, show much larger overlaps; which means these ports could be to a large extent considered each other's substitutes. An interesting exception is Hamburg-Bremerhaven with the lowest overlap, indicating large complementarities. Analysis of overlaps between the main seaport and cargo airport in gateway regions indicate that there are considerable differences ranging from no overlap (Bohai Bay) to considerable overlap (Singapore, Hong Kong and Busan-Gwangyang), with the Rhine Scheldt delta in between these.

These findings fit in a more detailed analysis of overlaps between the Schiphol airport and the seaports in Rotterdam and Amsterdam, provided in Annex 2, the main findings of which can be summarized as follows: there are some seaport-airport connections in relation to cruise traffic, particularly in Amsterdam, but there is not a lot of overlap between the goods transported via Schiphol airport and the port of Rotterdam. This does not necessarily mean that there are no synergies to be reaped. The global connections of Schiphol airport and the port of Rotterdam overlap to some extent and the strong position of Rotterdam in advanced maritime services and maritime headquarters might be related to the passenger hub function of Schiphol airport.

Table 6. Port-port and port-airport overlaps (R^2) in main gateway regions

Region	Overlap main seaports	Overlap seaport-airport
Pearl River Delta	0.60	0.20

Malacca Straits	0.89	0.34
Yangtze River Delta	0.93	0.16
Bohai Bay	0.83	0
Rhine-Scheldt Delta	0.75	0.09
Korean Twin Hub	0.79	0.19
San Pedro Bay	0.84	0.16
Helgoland Bay	0.40	0.02
Tokyo Bay	0.74	0.18
Dubai		0.08
New York		0.02

Source: Own calculations based on data Marine Intelligence Unit Lloyd's List and database École Nationale de l'Aviation Civile (ENAC).

2. IMPACT OF THE PORTS OF ROTTERDAM AND AMSTERDAM

The ports of Rotterdam and Amsterdam have shown impressive performance, but how has this translated into development opportunities for the Randstad region? What has been their impact on the trajectories of the cities of Rotterdam and Amsterdam and the wider metropolitan region? This chapter looks into the port impacts in Rotterdam and Amsterdam. It identifies main benefits and negative impacts; benefits mostly in terms of economic impacts; negative impacts, such as environmental impacts, congestion and land use. The challenge of such an assessment is the confrontation of these benefits and impacts, which will be undertaken in the final part of this chapter.

2.1 Economic impacts

There is a variety of economic impacts of ports that can be distinguished. Port economic impact studies traditionally look at value added and employment and such studies are available for Rotterdam and Amsterdam. These data, as well as our collected data on value added and employment in other port-cities, make it possible to compare labour productivity in various port-cities. For the purpose of this study we assessed the indirect effects of the port cluster in Rotterdam, which will be compared to our findings from other OECD Port-Cities case study cities, such as Hamburg and Le Havre. For the purpose of this study we compared economic specialisations of European port-regions and the position of the Rotterdam/Amsterdam port-region in this respect. We collected data on the location of global maritime services and headquarter functions in port-related industries in order to identify the ranking of Rotterdam and Amsterdam in this respect. We assessed the role of both ports for importing and exporting sectors and assessed the position of Rotterdam and Amsterdam on innovation indicators. Finally, the position of Rotterdam and Amsterdam on wider social-economic indicators was assessed.

This section that the port clusters of Rotterdam and Amsterdam generate large value added, but relatively modest value added growth and stagnant port-related employment growth. It has moderate indirect effects with relatively large spillovers to other regions. Although home to a diverse maritime cluster, the Randstad has not developed into one of the world leading international maritime centres, and headquarter functions seem to be only moderately associated with the port functions. The Randstad has an economic profile that is line with most European port-functions, but has a strongly developed position in port-related research and development.

Modest port-related value added growth

The port clusters of Rotterdam and Amsterdam generate substantial economic value added, ranging from € 11.9 to € 17.6 billion in 2010, depending on definitions. Within this calculation, the value added of the port of Rotterdam represented € 10.3 billion and the port of Amsterdam € 1.6 billion in 2010 (Table 7). Amsterdam can be considered the main port in a cluster of ports along the North Sea Canal which include Velsen/IJmuiden, Zaanstad and Beverwijk. Rotterdam is the main port in the port cluster along the Rhine and Meuse delta, which includes a variety of ports including Moerdijk, Dordrecht, Schiedam and Vlaardingen. These ports are strongly related to the ports of Amsterdam and Rotterdam respectively, so it makes sense to take these into account when considering the value added of the Amsterdam and Rotterdam port clusters. The numbers on value added are based on annual studies published by the National Port Council of the Netherlands.

Table 7. Value added of Rhine Meuse Delta and North Sea Canal Delta in 2010

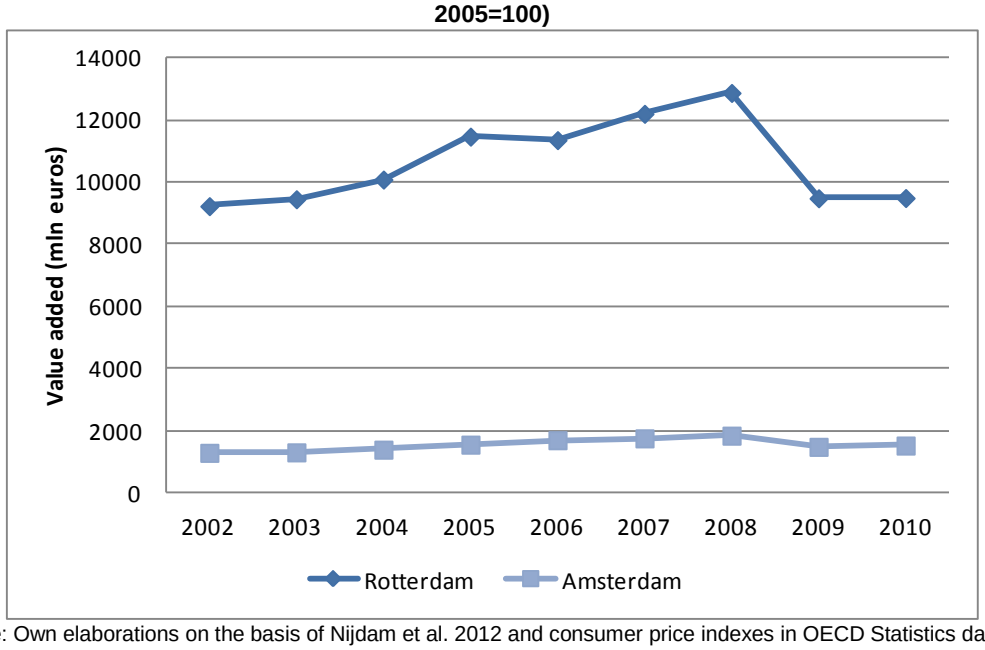
Port clusters	Value added 2010 (million euros)
Rhine and Meuse Delta	**13843**
- of which Rotterdam	10257
North Sea Canal Delta	**3735**
- of which Amsterdam	1645

Source: Nijdam et al. 2011

This economic value added represents a considerable share of regional GDP, ranging from 1.8% (Amsterdam) to 10.5% (Rotterdam) in 2008. This is the weight in the total provincial economy. As the port and port-related activities are localized in a relatively restricted area of these provinces, the dominance of port-related activities in local areas is larger: the Rotterdam port cluster represented 13.2% of the metropolitan economy of Rotterdam-The Hague. If the wider regional port clusters would be taken into account, these shares would still be larger: the North Sea Canal Delta port cluster represents 3.8% of the economy of the province of North-Holland (in which Amsterdam is located), whereas the Rhine-Meuse port cluster represents 12.6% of the economy of the province of South Holland and 15.9% of the economy of the Rotterdam-The Hague metropolitan area.[6]

The growth of port value added was relatively limited over 2002-2010: on average 0.4% per year in Rotterdam and 2.3% in Amsterdam (Figure 27), well below the growth rates of port volumes: which were 4.1% and 5.6% respectively over the same period. This can be concluded from the port-related value added, as provided in the annual Port Monitor (Nijdam et al. 2012). The value added indicated in these reports is in current prices, which would suggest port-related value added growth of on 2.1% average annual growth in Rotterdam and 4.3% in Amsterdam. However, if one puts this in constant prices (with 2005 as the base year), growth of port-related value added is fairly limited, as indicated above.

Figure 27. Value added of port-related value added in Rotterdam and Amsterdam (constant prices, 2005=100)



Source: Own elaborations on the basis of Nijdam et al. 2012 and consumer price indexes in OECD Statistics database

Stagnant port-related employment growth

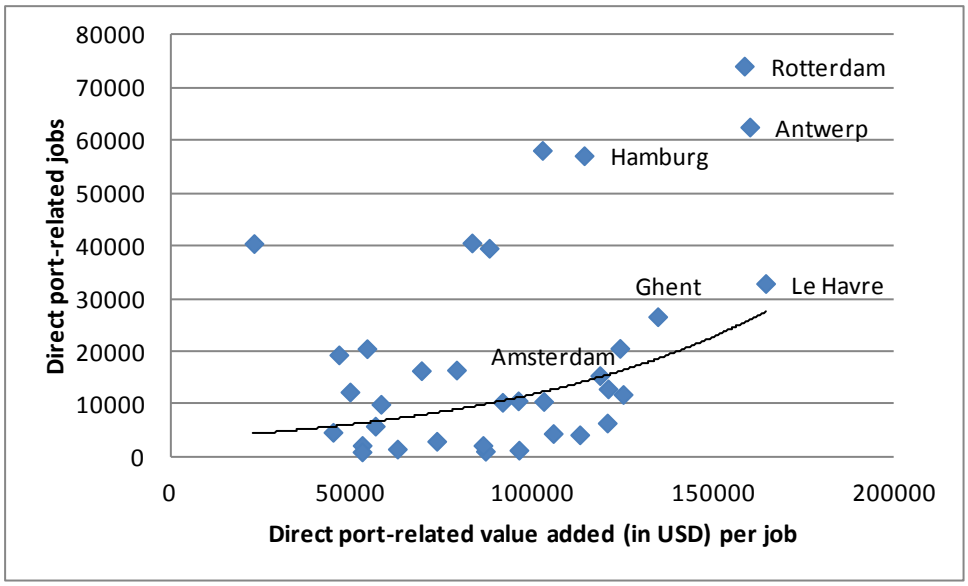
Our analysis of European port-regions found that port throughput is positively correlated to employment in port regions. This study indicates that an increase of one million tonnes of port throughput is associated with an increase in employment in the port region of 0.0003% (Ferrari et al. 2012). This means that in a region with one million employees, employment would increase by 300 units; in the long run this increase would be 7500 units. This impact is slightly larger on industry than on service employment. These conclusions are based an evaluation of the impact of port activity on regional employment in a sample of 560 regions in 10 European countries, 100 of which home to one or more port, from 2000-06. If liquid bulk is not included in port throughput numbers, the employment impact in the region doubles: an increase of one million tonnes port throughput is then associated with a regional employment increase of 600 units. This finding confirms the fact that only a few jobs are needed to handle liquid bulk, due to loading and unloading of a large part of this bulk by pipelines.

The situation in Rotterdam and Amsterdam seems to be at odds with these findings: port-related employment growth in their regions has basically remained flat over the last decade, despite considerable port growth (on average 4.1% per year for Rotterdam and 5.6% for Amsterdam over 2002-2010). Port-related employment in 2010 represented 106.100 jobs in the Rhine and Meuse Delta, of which 73.529 jobs in Rotterdam, according to the annual Port Monitor (Nijdam et al. 2010). It amounted to 32.823 jobs in the North Sea Canal area, of which 4.930 jobs in Amsterdam. Most of this employment is in the manufacturing taking place on the port sites, and logistics activity related to the ports. As indicated, the employment growth in these sectors was zero over the last decade.

High port-related labour productivity

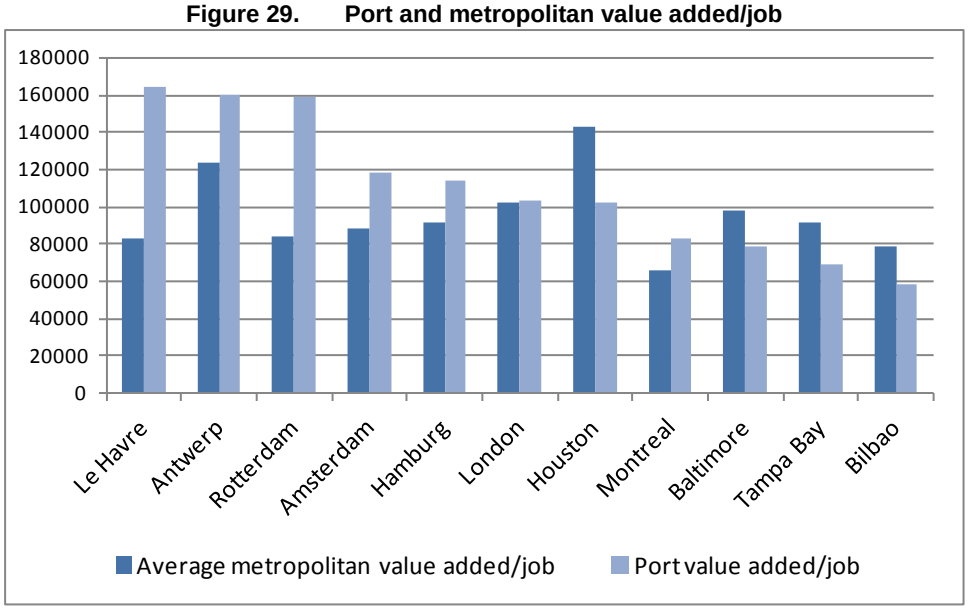
The value added per worker (labour productivity) in the ports of Rotterdam and Amsterdam is considerably higher than the average for both city-regions. Both ports generate high value added per job in the port cluster: USD 160,000 per job for the port of Rotterdam and USD 120,000 for the port of Amsterdam (based on data for 2009). As such, Rotterdam is among the port clusters with the highest labour productivity, with Amsterdam scoring well as well on this indicator (Figure 28). As there is a moderate tendency of ports with more direct employment to be more labour productive, this might indicate economies of scale in port clusters. The value added per worker in the port cluster in Rotterdam is almost twice as high as (90% higher than) the average for the city-region of Rotterdam; the value added per worker in the port cluster of Amsterdam is 35% than the metropolitan average (Figure 29). A similar large positive difference is found in Le Havre, but quite uncommon in other port-cities. The value added per job in the port area is also larger than the metropolitan average in Antwerp and Hamburg, but the difference is less pronounced. In several other port-cities, such as Houston, Baltimore and Bilbao, metropolitan value added per job is higher than the port value added per job, or similar to it (in London). In these metropoles, port-related employment could crowd out more productive uses of this labour force.

Figure 28. Port value added/job in selected worldwide ports



Source: own compilation of data based on port economic impact studies
Note: the dots refer to ports from Europe, North America and Australia for which economic impact studies are available.

Figure 29. Port and metropolitan value added/job

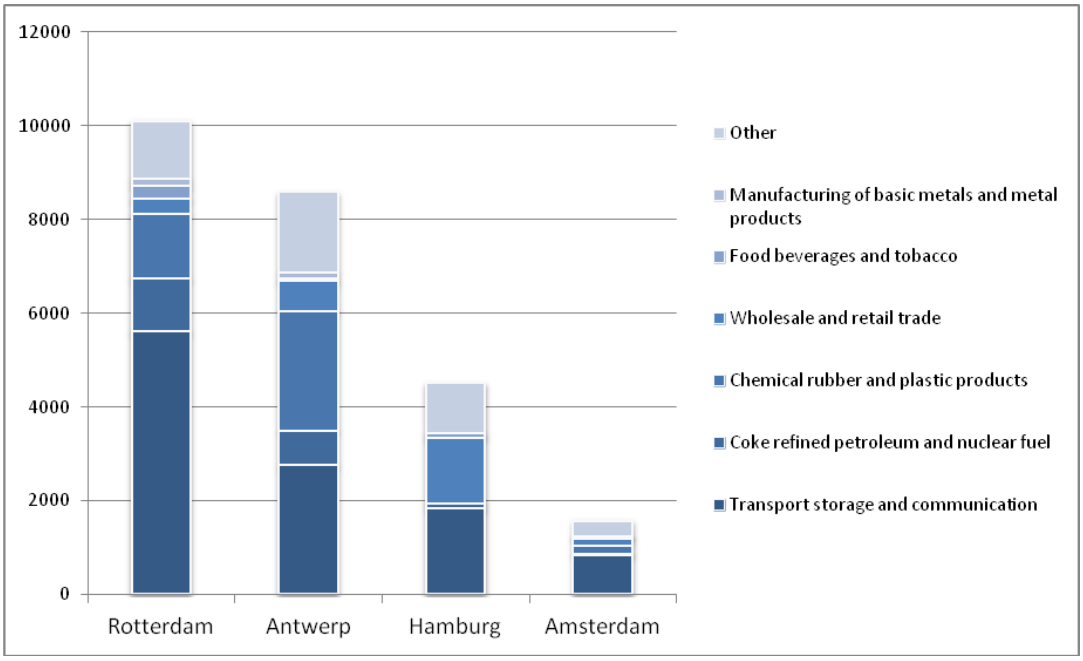


Source: own compilation of data based on port economic impact studies, OECD Metropolitan Database and Eurostat Urban Audit.
Note: the value added per job is expressed in USD. The OECD definition of metropolitan areas as used in the OECD Metropolitan Database is applied, with the exception of Antwerp, Le Havre and Bilbao that are not included in the OECD Metropolitan Database and for which the definition of larger urban zones (LUZ) from the Eurostat Urban Audit is applied.

An important part of this value added is not generated by the transport sector, but by other sectors such as the petro-chemical sector. Just over half of the value added (56% in the port of Rotterdam and 54% in the port of Amsterdam) is in the sector transport, storage and communication. In both ports the petro-chemical and chemical sectors represent a considerable part of the value added: 25% in Rotterdam and 13% in Amsterdam (Figure 30). In comparison with the other large ports in North-West Europe, the value added of the port cluster of Antwerp is even more oriented towards the petro-chemical and chemical

sectors (39% of value added in 2009), whereas in Hamburg wholesale and retail trade is much more dominant (31% of value added in 2010). Other sectors present in these port clusters are the food industry and the transport equipment industry, although the methodologies of the three studies on which this is comparison is based are not harmonised so some caution is required. The combination of these various sectors, as well as the relative dominance of the port cluster in the regional economy, raises the question of inter-relatedness of the port and port-related activities with the wider regional economy. This can be assessed through an analysis of indirect effects (backward linkages) of the port economy.

Figure 30. Main economic sectors in port value added of main NW-European ports (2009)



Source: data for Rotterdam and Amsterdam are from Nijdam et al. 2011; data for Antwerp from Mathys 2011; and data for Hamburg from Planco 2011.
Note: data for Hamburg are for 2010.

Moderate indirect economic effects with relatively large spillovers

The port cluster of Rotterdam is strongly linked to the (petro-) chemical and transport sector in the Netherlands. This can be concluded from an analysis of the backward linkages (indirect effects) of the economy of the port cluster with other economic sectors. Such an analysis is possible by integrating a port cluster economy in national Input/Output-tables and assessing the inputs and outputs from the port cluster economy. A multiplier for the whole economy is found of 1.13. This means than one euro additional demand in the port of Rotterdam leads to 0.13 euro of additional supply in the sectors that provide input in the port. The strongest links are between the port cluster and sectors that are also well represented in the port, such as the petro-chemical sector, the chemical sector and transport, storage and communication, in addition to the electricity sector. In these sectors the multipliers are larger, ranging from 1.17 (electricity) to 1.34 (chemical industries).

Table 8. Multipliers for main economic sectors in the port of Rotterdam

	Multiplier
Total	**1.13**

Chemical, rubber and plastic products	1.34
Transport, storage and communications	1.25
Coke, refined petroleum and nuclear fuel	1.24
Electricity gas and water supply	1.17
Manufacturing n.e.c.	1.09
Food, beverages and tobacco	1.07
Manufacturing of basic metals and metal products	1.06
Transport equipment	1.04
Wholesale and retail trade, auto repair	1.03

Source: own calculations on the basis of Eurostat data

The multiplier of the port cluster of Rotterdam is relatively modest, in comparison to the other large ports clusters in North-West Europe. The ones for Hamburg (1.71) and Le Havre-Rouen (2.47) are considerably higher, whereas the multiplier for Antwerp (1.18) is more in line with the one for Rotterdam. A similar picture emerges at the level of the different economic sectors: Rotterdam and Antwerp have multipliers for different sectors that are more or less similar, but Le Havre-Rouen and Hamburg have much higher multipliers for some sectors, especially for transport equipment, food and the petro-chemical sectors. These differences could partly be explained by the more global character of the ports of Rotterdam and Antwerp: as multiplier effects are only measured within the national boundaries, the backward linkages to sectors in other countries are not taken into account. One could conclude from this that the indirect effects of port activities in Rotterdam and Antwerp are to a larger extent leaking away to other countries than is the case for Hamburg and Le Havre-Rouen. This might also be derived from the multiplier than was found for a similarly global port, the port of Singapore, and that was in the same range, namely 1.27 (Toh et al. 1995).

Table 9. Multipliers for main economic sectors in NW-European ports

	Rotterdam	Antwerp	Hamburg	Le Havre-Rouen
Total	**1.13**	**1.18**	**1.71**	**2.47**
Chemical, rubber and plastics products	1.34	1.36		
Transport, storage and communication	1.25	1.39	1.79	2.02
Coke, refined petroleum, nuclear fuel, chemicals	1.24	1.20	2.15	2.76
Electricity, gas and water supply	1.17	1.13		
Food, beverages and tobacco	1.07	1.05	2.22	1.00
Manufacturing of basic metals and metal products	1.06	1.07		
Transport equipment	1.04	1.18	2.47	3.28
Wholesale and trade	1.03	1.09	1.31	2.02

Source: own calculations on the basis of Eurostat data

The indirect effects of the port of Rotterdam take mostly place in Flanders (Belgium), the province of South Holland (in which Rotterdam is located) and to a lesser extent in the rest of the Netherlands. This becomes clear if the I/O-tables are broken down for several selected regions in the Netherlands and Flanders. The interconnectedness of the Rotterdam port cluster is largest for the petro-chemical and the chemical sector, whereas the effects on the transport and food sector are largest within the Netherlands. For most sectors the multiplier effects on the own region (port and province of Zuid-Holland) are larger than

the ones for the rest of the country. This is an interesting finding, as it distinguishes the port of Rotterdam from both the port of Hamburg and Le Havre, for which similar analyses show that all the multiplier effects have a larger impact in other regions (Bavaria and Baden-Württemberg, and Ile de France respectively) than the port region itself (Merk et al. 2011, and Merk and Hesse, 2012).

The port of Rotterdam is closely related to certain economic sectors in Antwerp, especially the chemical industry, petro-chemical industry and the transport industry. The indirect economic effects of the petro-chemical industry industry in the port of Rotterdam that spill over to Antwerp (0.08) are larger than the spillovers for the whole of the Netherlands (0.07). In other sectors, there are also considerable links with economic sectors in Antwerp and Flanders, but the indirect effects with the province of Zuid-Holland and the rest of the Netherlands are generally stronger.

Table 10. Indirect effects of Port of Rotterdam on Antwerp and Flanders

	Port cluster Rotterdam	Port of Antwerp	Antwerp province	Rest Flanders	South-Holland	Rest Netherlands	Total
Total	1.03	0.02	0.02	0.02	0.03	0.02	**1.13**
Chemical, rubber and plastic products	1.08	0.04	0.04	0.04	0.08	0.07	**1.34**
Transport, storage and communications	1.07	0.01	0.01	0.01	0.07	0.06	**1.25**
Coke, refined petroleum and nuclear fuel	1.05	0.04	0.04	0.04	0.05	0.02	**1.24**
Electricity gas and water supply	1.04	0.01	0.01	0.01	0.04	0.04	**1.17**
Manufacturing n.e.c.	1.02	0.01	0.01	0.01	0.02	0.02	**1.09**
Food, beverages and tobacco	1.04	0.01	0.01	0.01	0.04	0.04	**1.07**

Source: own calculations based on structural business statistics Eurostat.

Table 11. Indirect effects of Port of Antwerp on Rotterdam and South-Holland province

	Port cluster Antwerp	Port of Rotterdam	South Holland	Rest Netherlands	Antwerp province	Rest of Flanders	Total
Total	1.05	0.01	0.01	0.01	0.05	0.05	**1.18**
Transport, storage and communications	1.13	0	0	0	0.13	0.13	**1.39**
Chemical, rubber and plastic products	1.10	0.02	0.02	0.02	0.10	0.10	**1.36**
Coke, refined petroleum and nuclear fuel	1.05	0.02	0.02	0.01	0.05	0.05	**1.20**
Transport equipment	1.05	0.01	0.01	0.01	0.05	0.05	**1.18**
Electricity gas and water supply	1.04	0	0	0	0.04	0.04	**1.13**
Wholesale and retail trade	1.03	0	0	0	0.03	0.03	**1.09**
Construction	1.02	0	0	0	0.02	0.02	**1.08**

Source: own calculations based on structural business statistics Eurostat.

Another distinction is that considerable shares of the multiplier effect occur within the port area, which could indicate relatively large interconnectedness (clustering effect) of the firms within the port area of Rotterdam, as well as Antwerp (Table 12). Similar inter-sectoral linkages were found in earlier research on the Amsterdam port cluster (Manshanden et al. 2002). In conclusion, there are important indirect effects of the port of Rotterdam and its main port-related sectors. These effects are relatively modest, due to the global character of Rotterdam's port, but at the same time the regional impact of the port cluster is larger than in ports such as Hamburg and Le Havre-Rouen. There are important connections between the port of Rotterdam and the Flanders region in Belgium.

Table 12. Main backward linkages Port of Rotterdam per sector and region

	Port cluster Rotterdam	Zuid-Holland	Rest Netherlands	Flanders	Total

Total	**1.03**	**0.03**	**0.02**	**0.06**	**1.13**
Chemical, rubber and plastic products	1.08	0.08	0.07	0.12	**1.34**
Transport, storage and communications	1.07	0.07	0.06	0.03	**1.25**
Coke, refined petroleum and nuclear fuel	1.05	0.05	0.02	0.12	**1.24**
Electricity gas and water supply	1.04	0.04	0.04	0.03	**1.17**
Manufacturing n.e.c.	1.02	0.02	0.02	0.03	**1.09**
Food, beverages and tobacco	1.04	0.04	0.04	0.06	**1.07**
Manufacture basic metals/products	1.02	0.02	0.01	0	**1.06**
Transport equipment	1.01	0.01	0.01	0	**1.04**
Wholesale and retail trade, auto repair	1.01	0.01	0.01	0	**1.03**

Source: own calculations based on structural business statistics Eurostat

Table 13. Main backward linkages Port of Rotterdam per sector and region

	Rotterdam		Antwerp		Hamburg		Le Havre	
	port	**region**	**port**	**region**	**port**	**region**	**port**	**region**
Total	**1.03**	**0.03**	**1.05**	**0.05**	**1.01**	**0.02**		
Chemical, rubber and plastic products	1.08	0.08	1.10	0.10				
Transport, storage and communications	1.07	0.07	1.13	0.13	1.00	0.02	1.00	0.03
Coke, refined petroleum and nuclear fuel	1.05	0.05	1.05	0.05	1.00	0.03	1.00	0.06
Electricity gas and water supply	1.04	0.04	1.04	0.04				
Manufacturing n.e.c.	1.02	0.02	1.02	0.02			1.00	0.04
Food, beverages and tobacco	1.04	0.04	1.02	0.02	1.00	0.03		
Manufacture basic metals/metal products	1.02	0.02	1.02	0.02				
Transport equipment	1.01	0.01	1.05	0.05	1.00	0.03	1.00	0.08
Wholesale and retail trade, auto repair	1.01	0.01	1.03	0.03	1.01	0.01	1.00	0.03

Source: own calculations based on structural business statistics Eurostat

An economic profile in line with European port-regions

The Randstad region is highly specialised in water transportation and the petrochemical sector, and has an economic profile that is in line with those of other European port-regions. This can be concluded from an economic specialisation analysis using a methodology that allows for comparison between port-regions and non-port regions in European countries.[7] Other specialisations, mostly in different wholesale and retail sectors, are less outspoken, whereas it is only slightly (more than average) specialised in construction, which constitutes a large economic sector in many port regions (Table 14). There is a range of sectors in which European port regions are specialised, but not the Randstad region: these underrepresented sectors include wood manufacturing, recycling, maintenance of motor vehicles, manufacture of food products and retail estate. Note that these specialisation indexes are derived from specialisation in European perspective; it is possible that some of these sectors can specialisations of the region from a national perspective, but not when compared to regions in Europe. The Randstad is relatively unique among port-regions with respect to its specialisation in air transport, wholesale of agricultural raw materials and publishing and printing. The Randstad is also unique in that it is specialised in a sector in which non-port-regions in Europe are specialised, which is land transport and transport via pipelines.

Table 14. Port-related economic specialisations Rotterdam-Amsterdam

	Frequent specialisation European port-regions		Less frequent specialisation port-regions	
	Sector	LQ	Sector	LQ
Very high	Water transport	5.07	Wholesale of agricultural raw materials and live animals	4.21

specialisation Rotterdam-Amsterdam	Manufacture of coke, refined petroleum products and nuclear fuel	2.43	Air transport	3.79
			Retail sale of second-hand goods in stores	2.13
			Other wholesale	2.06
Specialisation Rotterdam-Amsterdam	Wholesale of food, beverages and tobacco	1.38	Publishing, printing and reproduction of recorded media	1.40
	Retail sale not in stores	1.33		
	Retail sale of food, beverages and tobacco in specialized stores	1.31		
	Repair of personal and household goods	1.25		
	Other retail sale of new goods in specialized stores	1.20		
	Retail sale in non-specialized stores	1.16		
	Supporting and auxiliary transport activities; travel agencies	1.14		
	Construction	1.04		
	Wholesale of non-agricultural intermediate products, waste	1.01		
No specialisation Rotterdam-Amsterdam	Hotels and restaurants	0.92	Wholesale on a fee or contract basis	0.80
	Manufacture of other transport equipment	0.90	Mining and quarrying	0.57
	Renting of machinery and equipment without operator	0.84	Manufacture of furniture; manufacturing n.e.c.	0.47
	Retail sale of automotive fuel	0.77	Manufacture of other non-metallic mineral products	0.30
	Real estate activities	0.75	Manufacture of wearing apparel; dressing; dyeing of fur	0.16
	Sale, maintenance and repair of motorcycles and related parts	0.74	Manufacture of leather and leather products	0.03
	Manufacture of food products, beverages and tobacco	0.71		
	Collection, purification and distribution of water	0.50		
	Maintenance and repair of motor vehicles	0.42		
	Recycling	0.42		
	Manufacture of wood and wood products	0.37		

Source: own calculation and elaboration on the basis of structural business statistics of Eurostat
Note: LQ indicates: location quotient, with a location quotient higher than one indicating specialisation, and a location quotient lower than one represent sectors in which the European port regions are less specialised than the average European region.

Not a world leading maritime centre

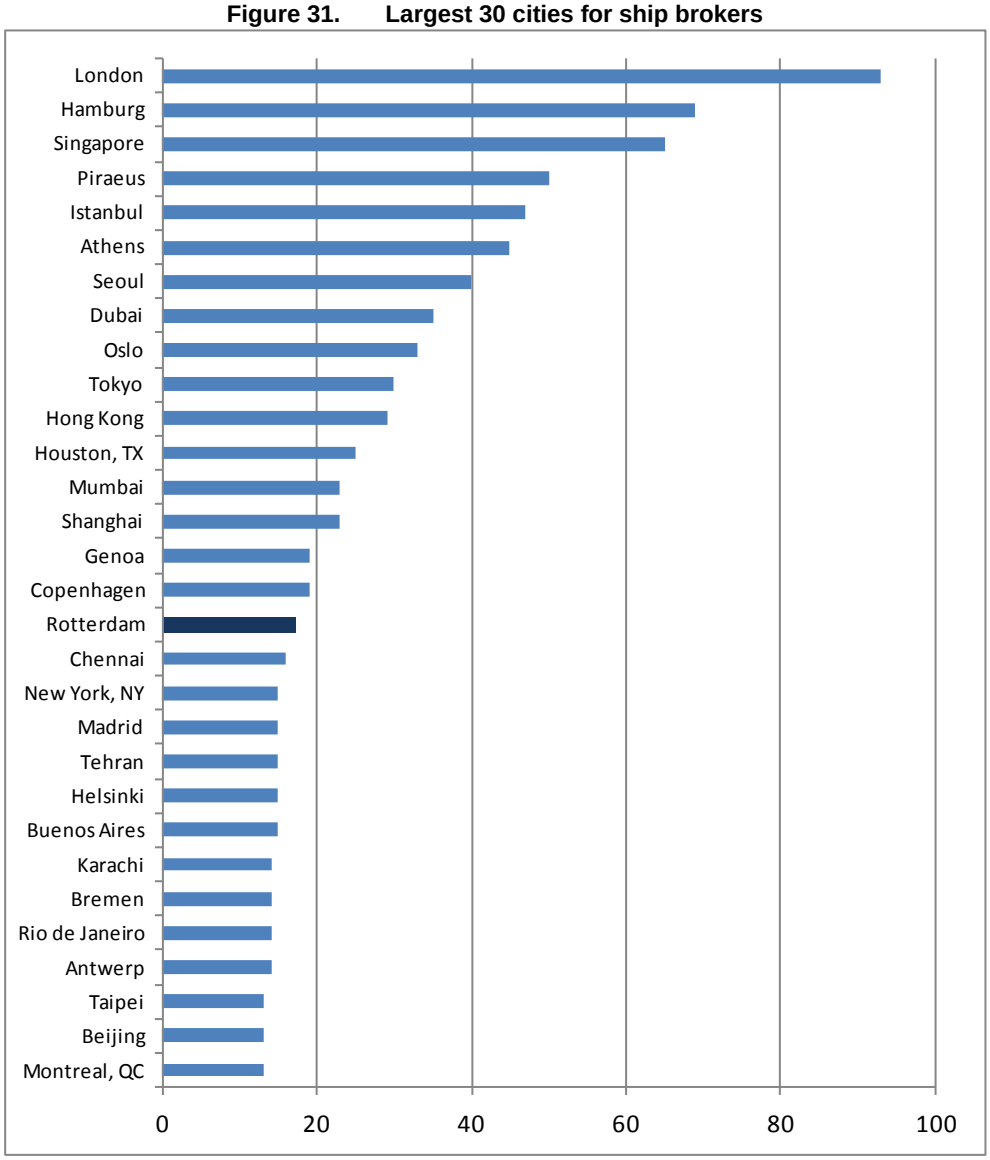
Ports can be drivers of advanced maritime services industries in port-cities, such as maritime headquarters, finance, insurance, engineering law and consultancy These activities have all some connection with the port, but the port does not necessarily have to be large for a leading maritime cluster to emerge, as can be illustrated by the cases of London, Oslo and Copenhagen that all have strong maritime clusters but relatively modestly sized ports.

Existing studies do not consider Rotterdam to be one of these 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 (Jacobs et al. 2011). In this study Rotterdam is ranked as sixth maritime services centre in the world in terms of multi-office firms for maritime insurance, law and consultancy, behind London, Singapore, New York, Hong Kong and Piraeus, but also indicates that Rotterdam is not in the top 10 of global maritime command centres. Another study identifies main cities from which container shipping companies are run, analysing the global office structures of 35 of the largest container shipping companies 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. The two first level world maritime cities identified were Hong

Kong and Hamburg; Rotterdam only figures as third level city in this respect (as is Antwerp), below cities like Singapore, Shanghai, Tokyo, New York, Bangkok and London. Yet another study on lead maritime cities looked at 12 cities, included Rotterdam, but did not rank it among the five leading maritime cities, nor in any of the main categories that it distinguished: ship owners and ship operations, maritime finance, maritime law and insurance; and maritime technology and competence (Menon, 2012). The world leading maritime cities in this report was considered to be Singapore, Oslo, London, Hamburg and Hong Kong. Finally, another comparative study on world maritime centres indicates that the Rotterdam maritime cluster is less comprehensive than for example the cluster in London and Singapore, with lacunae with respect to marine insurance, financial services, ship registries, ship classification societies, ship brokers and legal services (Lam and Zhang, 2012). All in all, the overall impression of Rotterdam is that it certainly provides a wide set of maritime services, but that it cannot be considered to be on the world leading maritime services centres.

This relatively modest perception of Rotterdam is confirmed by datasets on port-related maritime services collected for this report. Surely enough, Rotterdam counts a wide diversity of firms and actors related to the port, several of which are among the most important in the world. Rotterdam is one of the world's leading cities for cargo handling, it has world-leading firms in dredging, salvage and terminal operation (Annex 3). At the same time, there are many maritime services in which Rotterdam, nor Amsterdam for that matter, is not world leading. Most of the shipbuilding activity is now taking place in South Korea and China and relatively small in Europe; and even though the Netherlands is one of the more important shipbuilding countries in Europe, activities are relatively scattered and Rotterdam is not one of the main areas for this activity (Annex 3). With regards to ship ownership, the Netherlands is not one of the major countries: it ranked 20th in the world in terms of gross tonnage as of 1st January 2011, far behind countries such as Greece, Norway and Denmark. Nor is the Netherlands one of the major ship operating countries, ranking 16th in terms of vessel capacity of container carriers. In addition, Netherlands is not an important country in the global ship scrapping market, now dominated by India, Bangladesh and China with a 76.5% market share in 2010; and unlike Denmark and Belgium it does not figure among the top 10 scrapping nations. Also in shipping support services, Rotterdam is not among the leading cities in the world. It is not a major city for ship brokers, unlike London, Hamburg and Singapore and many other cities (Figure 31). None of the 20 ship classification societies in 2010 is originating from or headquartered in the Netherlands; there is no Dutch member of the International Group of P&I Clubs; and the Netherlands is not in the top 20 of biggest suppliers of ratings or officers, whereas countries such as Norway, UK, Canada and Greece are. Additionally, other cities such as London host international organisations specialised in maritime transport (IMO), whereas the international organisations in the Rotterdam/The Hague city-region are mostly specialised in international criminal law.

Figure 31. Largest 30 cities for ship brokers



Source: own elaboration on the basis of World Shipping Register Database.
Note: This database includes the locations of more than 2,000 ship brokers

Rotterdam is increasingly becoming an important city for ship finance, but the sector could be further developed. Dutch banks were not among the largest global players in the sector in 2009 (Annex 3). The Fortis Bank was the only bank based in the Netherlands (and Belgium) with a large shipping portfolio, but has since been split in different parts. The ABN Amro Bank, one of the parts resulting from that split and nationalised by the Dutch government, has recently been active in increasing its shipping portfolio, as has the ING bank. Both banks are headquartered in Amsterdam, but have their ship finance division located in Rotterdam. After the global financial crisis of 2008 and the subsequent wave of bank nationalisations, many banks with large shipping portfolios, such as RBS and major German and French banks, have re-directed strategic objectives and portfolios towards value added for their national economies, implying less focus on global ship financial deals. This provides opportunities for expanding the Dutch presence in global ship finance, aligning well with the open and trade-oriented nature of the Dutch economy. Further development might also be considered by attracting public listings of port- and shipping-related companies to the Amsterdam Stock Exchange, similar to those in New York, Hong Kong, but also Oslo, Athens and

Copenhagen. The large pension funds in the Netherlands could also provide opportunities to develop a separate financial stream to port- and shipping-related projects.

This maritime cluster is not confined to the city of Rotterdam but stretches out to the wider city-region. Several of the maritime-related sectors and firms indicated above, such as shipbuilding and repair, service industries and other maritime activities, are located in the municipalities surrounding Rotterdam. Another example is the maritime related engineering services sector: there are relatively few maritime-related engineers based in city of Rotterdam, but there is a considerable presence in the wider metropolitan area (Table 15). Although there are maritime-related services industries located in the city-region of Amsterdam (Jacobs 2009), these are of a relatively small nature in comparison to those of Rotterdam and other major maritime clusters.

Table 15. Main locations of maritime related engineering services (2011)

City with large port	Country	Score	Other cities	Country	Score
Tampa	US	35	Aberdeen	UK	22
London	UK	17	Workington	UK	20
Hamburg	Germany	15	Birmingham	UK	15
Shanghai	China	14	Limassol	Cyprus	11
Singapore	Singapore	14	Bhavnagar	India	11
Piraeus	Greece	12	Dordrecht	Netherlands	10
Dubai	UAE	12	Sheffield	UK	10
Houston	US	12			
Melbourne	Australia	11			
Southampton	UK	11			
Bremen	Germany	9			
Abu Dhabi	UAE	9			
Rotterdam	Netherlands	6			

Source: own elaborations on the basis of the Lloyd's List Marine Equipment Buyers' Guide 2011

Overall, despite hosting an important maritime cluster, Rotterdam has not developed into a comprehensive world-leading international maritime centre such as Singapore and London. In these cities, a great diversity of maritime firms and actors co-exist that in many instance rank among the largest in their respective sub-sectors. This diversity of maritime-related expertise has arguably created substantial value added, without causing the environmental externalities and space consumption associated with port business. The port of Rotterdam is strongly developed, has probably facilitated the emergence of a maritime cluster, and provides unique assets that might be further exploited in order to build up a comprehensive international maritime centre.

Moderately associated with wider headquarter functions

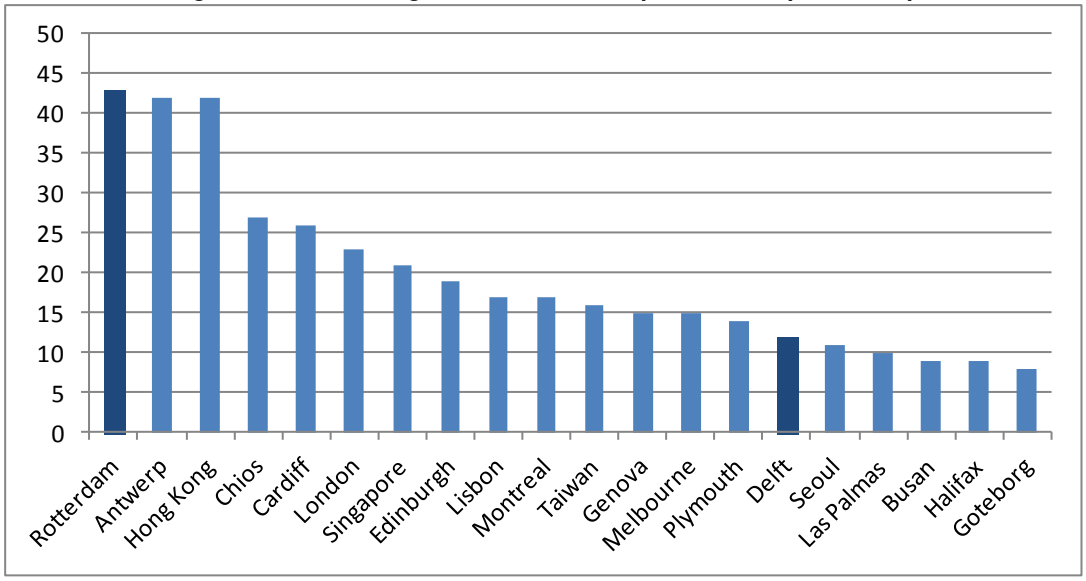
The metropolitan region of Rotterdam is one of the leading headquarter locations in the global petro-chemical industry, which might be related to its port. The city-region of Rotterdam is home to three oil-related headquarters in the Forbes 2000 ranking over 2010, representing sales revenues of approximately USD 400 billion. One of these is due to the Shell headquarter, located in The Hague. The relation between seaports and headquarter locations in the oil business is not clear-cut: several cities with important headquarters are no port-cities, but some of these certainly are, including Houston, Rotterdam and London. A similar conclusion could be drawn on headquarter functions in logistics: some important port-cities, such as Tokyo, Singapore and Hong Kong are strong in logistics headquarters, but so are some cities without ports but large airports such as Atlanta and Paris. The position of both Rotterdam and Amsterdam is

relatively limited in this respect, both home to one logistics Forbes 2000 company (Annex 3). The question is not trivial, as headquarter functions are generally considered to be important as they are associated with high value added business services as well as an extensive personal services industry.

Assets for research and development

Rotterdam is a leading city in port-related research. This can be concluded from a count of the city affiliations of the authors and co-authors of 576 port-related articles published in leading peer-reviewed academic journals between 1997 and 2011 (Figure 32). Rotterdam is the city that ranks highest on this count, closely followed by Antwerp and Hong Kong. The city of Delft, which could be considered to form part of the wider city-region of Rotterdam, also figures highly in this ranking (15th position), underlining the strong position of the region as a whole. Amsterdam is only to a limited extent represented in this ranking with a score of 4 articles over this period (ranking 41st). As becomes clear from this ranking, the location where port-related research is conducted is strongly related to the presence of ports: almost all the highly ranked cities in this list are port-cities and this selection of places does in no way resemble the worldwide university rankings, in which leading US and UK universities, such as Harvard, Oxford and Cambridge, tend to figure. Unlike other port-cities, such as Copenhagen, Rotterdam or Amsterdam do not have maritime business education programmes, such as maritime MBAs, although Rotterdam and Antwerp do have strong post graduate courses in shipping and ports.

Figure 32. Leading cities in academic port studies (1997-2011)



Source: own data compilation based on list of articles mentioned in Pallis et al. 2010 and www.porteconomics.eu

In addition, the Rotterdam region (Zuid-Holland) is one of the leading regions with respect to shipping and port-related patents, and Amsterdam (Noord-Holland) in petroleum. Approximately 1.9% of all world-wide patent applications over 2005-2007 came from Zuid-Holland. This is half the amount of patents coming from the first ranked shipping patent region, the metropolitan region of Houston, but close to the other regions that are ranked above Zuid-Holland. These are the regions of Los Angeles-Long Beach, Tokyo and San Jose-San Francisco-Oakland. All these regions are home to one or more large global ports. Of the other regions in the top 10 for shipping patents, only the Zürich region does not have a port. The regions of Stockholm and Rogaland have ports (Stockholm and Stavanger respectively), but they are not among the top 125 world ports. The Rotterdam and Amsterdam regions are also strong with respect to patents in port-related in a wider sense. These include patents in technologies that are used in the port

sector (constructions, hoisting-lifting-hauling), or important commodities handled in port areas, such as petroleum and food stuffs.

Table 16. Top 10 world regions for shipping patents (2005-2007)

Region	% of shipping patents	Top 125 ports
1. Houston-Baytown-Huntsville (US)	3.9%	Houston
2. Los Angeles-Long Beach-Riverside (US)	2.1%	Los Angeles & Long Beach
3. Tokyo (JP)	2.1%	Tokyo & Yokohama & Chiba
4. San Jose-San Francisco-Oakland (US)	2.0%	Oakland
5. Zuid-Holland (NL)	**1.9%**	**Rotterdam**
6. Västra Götalands län (SE)	1.5%	Gothenburg
7. Zurich (CH)	1.4%	
8. Stockholm (SE)	1.4%	
9. New York-Newark-Bridgeport (US)	1.3%	New York/New Jersey
10. Rogaland (NO)	1.2%	

Source: OECD Patent Database

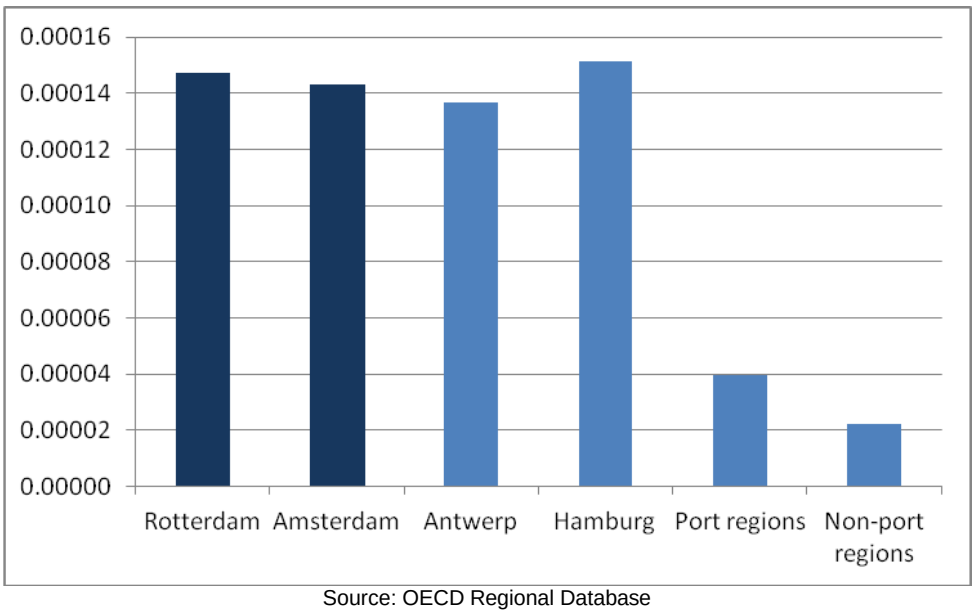
Table 17. Top 10 regions for port-related patents (2005-2007)

Constructions		Hoisting-lifting-hauling		Petroleum		Food and food stuffs	
Seoul (KR)	1.9	Tokyo (JP)	20.1	Houston (US)	6.9	New York (US)	4.2
Regensburg (DE)	1.8	Hartford (US)	5.9	New York (US)	5.0	Kanagawa (JP)	3.9
New York (US)	1.8	Uusima (FI)	5.9	Kanagawa (JP)	5.0	Tokyo (JP)	3.4
Gyeonggi-do (KR)	1.7	Aichi (JP)	1.5	Tokyo (JP)	3.7	Osaka (JP)	2.9
Tokyo (JP)	1.6	Luzern (CH)	1.4	San Jose (US)	3.6	**Zuid-Holland (NL)**	2.9
München (DE)	1.6	Stuttgart (DE)	1.1	Tshiba (JP)	3.0	Chicago (US)	1.8
Wien (AT)	1.4	Nordschwarzwald (DE)	1.1	**Noord-Holland (NL)**	2.3	Minneapolis-St.Paul (US)	1.7
Zuid-Holland (NL)	1.4	**Zuid-Holland (NL)**	1.0	Philadelphia (US)	2.3	Gelderland (NL)	1.4
Minneapolis (US)	1.3	Stockholm (SE)	0.9	Chicago (US)	2.1	Vaud (CH)	1.3
Sydney (AU)	1.2	Gyeonggi-do (KR)	0.9	Cleveland (US)	2.1	Atlanta-(US)	1.3

Source: OECD Patent Database

This fits into a wider picture of strong performance with respect to patent applications in Rotterdam and Amsterdam. Their number of patent applications per capita over 2007 is above Antwerp's and slightly below Hamburg's, but exceeds largely the average for both port- and non-port regions in Europe. Evidently, patent applications are just one of the possible indicators and some authors have argued that innovation might be difficult to measure at all. However, patent applications are one of the few indicators for which comparable data sources at the regional level are available.

Figure 33. Patent applications per capita in port regions (2007)



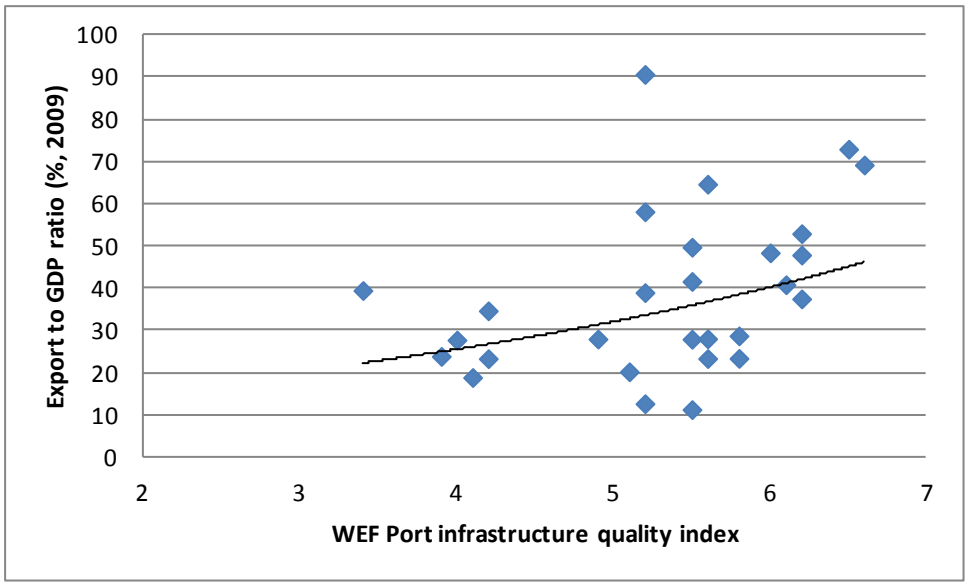
Source: OECD Regional Database
Note: Rotterdam and Amsterdam are here defined as the province of Zuid-Holland and Noord-Holland respectively

The strong interlinkage between the Rotterdam and Antwerp region that was indicated earlier in terms of traffic flows and indirect economic effects, can also be found in the domain of innovation (co-patent links). Co-patent applications are patent applications submitted by more than one agent, who can be located in more than one region. Because these co-patent applications are registered, they give valuable information about co-operation of the relevant actors (including inventors and firms) across regions. These co-patent linkages can be considered to be inter-regional linkages in innovation. Over 2005-07, the province of Zuid-Holland was the second most important foreign region for the province of Antwerp in terms of co-patents; the first one being North Brabant that increasingly plays the role as liaison between Rotterdam and Antwerp.[8] The co-patent links with other regions also indicate functional integration of the Rotterdam/Antwerp region (the Rhine Scheldt delta) with its most important hinterland and hinterland corridors. The strongest co-patent links with foreign regions of North Brabant (South Netherlands) are with Flanders/Belgium and Nordrhein-Westfalen/Germany. These links are equally important for the other regions involved: the two main regions for foreign co-patents of Flanders are Nordrhein-Westfalen and North Brabant; and Flanders and Nordrhein-Westfalen are the 5th and 6th most important co-patent region for West Netherlands.

Facilitators of cheap exports and imports

Ports are important assets for countries with high export and import ratios such as the Netherlands. Several studies have illustrated that port infrastructure is a significant determinant for maritime transport costs (Clark et al. 2004, OECD 2010, Kurinek 2011). These costs form a substantial part of the value of exported or imported goods, generally in the range of 5% to 10% of the value of the imported or exported good, but these shares can be considerably higher for some goods: e.g. 25% for edible fruits, 25% for salt and sulphur and 14% for fertilizers. Port costs, consisting of charges for port facilities and services, form a non-marginal share of maritime transport cost, approximately 10% according to industry observers (Stopford, 2009). As such, efficient ports provide benefits for firms with high import and export ratio's as well as consumers of imported goods; and OECD countries with better equipped ports tend to have relatively higher export ratios (Figure 34). These effects can be substantial: if the Dutch ports of Rotterdam and Amsterdam would have the level of efficiency and development of ports like those in Brazil, maritime transport costs for Dutch goods would be 15% higher than current levels.

Figure 34. Link between exports and port infrastructure in OECD countries



Source: OECD Trade Statistics and World Economic Forum Global Competitiveness Report 2011-2012
Note: Land-locked countries (who do not have seaports) are excluded from this figure

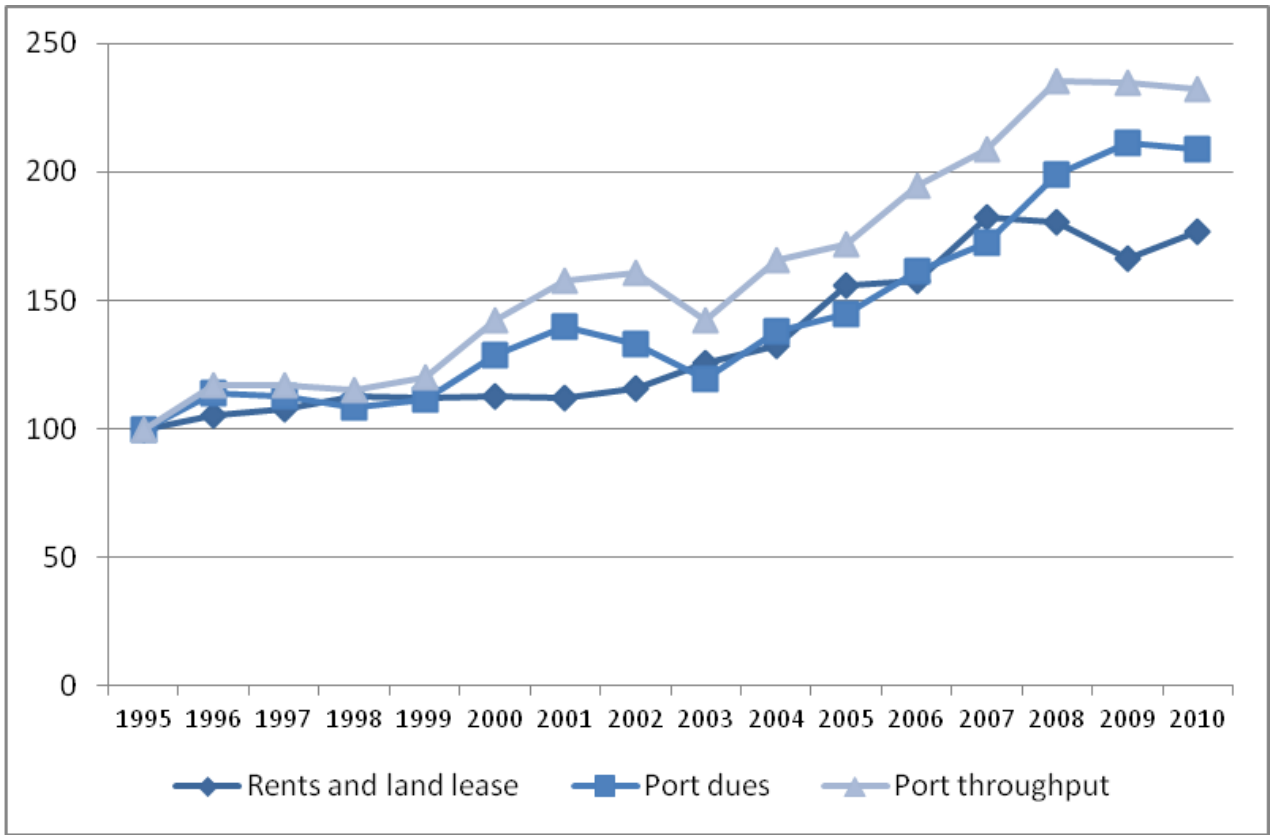
Port costs represent around € 300 million of production costs of firms in the Netherlands. The efficiency of ports of Rotterdam and Amsterdam thus has a substantial impact on production costs of firms in the Netherlands. Total logistics costs in EU27-countries represented between 4%-12% of total inputs in the economic production process in 2000: 4.3% for the primary sector, 4.2% for the secondary sector and 11.7% for the tertiary sector. These percentages are even higher for selected economic sectors, such as wholesale trade, where the transport input was 21%. The largest part of these logistics costs are generally in transport support service and in land transportation. The share of water transport is relatively modest: it represents approximately 0.2% of total production costs in the primary and secondary sector and 0.4% in the tertiary sector in 2000 in EU27-countries. Despite these small percentages, they still represent large absolute numbers: water transport making up € 27 billion of total production costs in EU 27-countries in 2000 (SEALS, 2008). This would suggest that around € 2.7 billion of production costs in EU27-countries are port costs, using the assumption indicated above that port costs represent approximately 10% of maritime transport costs.

German firms benefit from the efficiency of Dutch ports: if port costs in Rotterdam would increase with 10% this would cost approximately € 80 million per year to German industries. A similar raise in Amsterdam would mean another € 10 million of additional costs for firms in Germany. However, the impacts differ per sector and region. The economic sectors in Germany in which water transport costs make up the largest share in production costs are wholesale trade (0.9%), manufacturing of basic metals and metal products (0.5%), manufacturing of chemical products (0.3%) and manufacturing of motor vehicles (0.2%) (SEALS, 2008). The port of Rotterdam is the main seaport for important parts of Germany, in particular western (Nordrhein-Westfalen) and southern states (such as Baden-Württemberg). Nordrhein-Westfalen locates the main concentration of the metal industry in Germany, and the southern states the car industry. Better performance of the port of Rotterdam (leading to lower maritime transport costs) will have a particularly strong impact on these economic sectors: e.g. a 10% increase of port costs of Rotterdam would mean € 2 million of additional production costs only for the wholesale industry in Baden-Wurttemberg.

Revenue sources for cities

The ports of Rotterdam and Amsterdam are also considerable public revenue sources of public revenue (€ 106 million in 2010). The net revenues of the port of Rotterdam amounted to € 154 million over 2010; the dividend in 2010 was € 45.2 million for the city of Rotterdam and € 18.6 million for the central government. The net revenue of the port of Amsterdam to the city was € 42.2 million in 2010. The total cumulative operating results of the port of Amsterdam since 1995 add up to around € 300 million. These port revenues were highly dependent on the throughput volumes of the port. The two main revenue sources of the port authority of Amsterdam, port dues and rents and land leases, are both closely related to port throughput (Figure 35).

Figure 35. Main revenue sources port of Amsterdam and port volumes (1995-2010)



Source: Own calculations based on annual reports of the port of Amsterdam
Note: In 1995 index is 100. Revenues are deflated with CPI-index and reflect price-level 1995

Favourable social-economic performance

The regions of Rotterdam and Amsterdam have better socio-economic performance than the average European port-region. They have higher GDP per capita and higher GDP growth (over 2001-2008). Although port regions in Europe had lower GDP per capita than non-port regions, they showed higher growth rates over 2001-2008. In addition, an assessment of main social indicators does not indicate that Rotterdam and Amsterdam (nor port regions in general) suffer from adverse social conditions that are sometimes associated with port-cities. Rather the contrary: performance on indicators ranging from

unemployment, ageing, mortality rates and murder rates all suggest a favourable position in comparison with the benchmark-regions Antwerp and Hamburg, also in comparison to the average port- and non-port region. Finally, Rotterdam and Amsterdam score highest with respect to intra-urban social equity among a selection of European urban areas for which these data are available (see figures in Annex 4). This indicates that there might be relatively limited social lock-in in the port-cities of Rotterdam and Amsterdam.

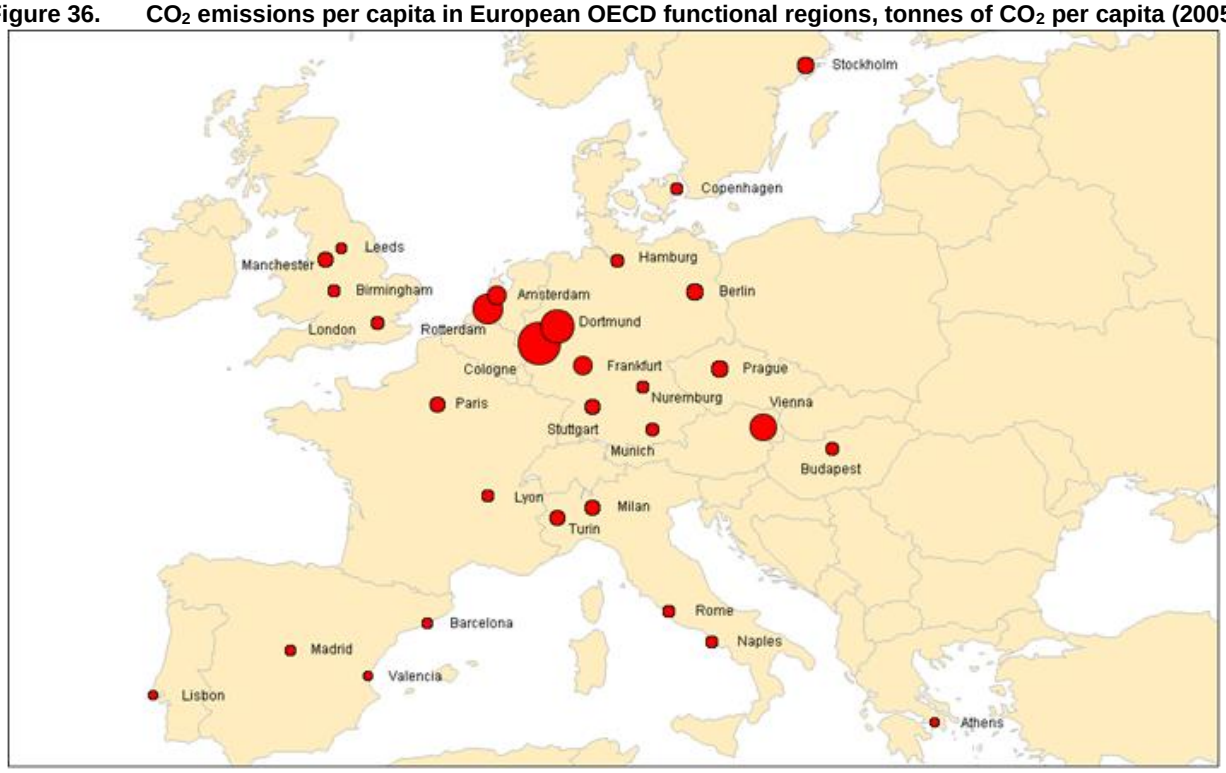
2.2 Environmental impact

Ports have a range of potential negative impacts, including on the quality of air, water, soil, biodiversity, as well as dust, noise, congestion and land use. The aim of this chapter is not to give a comprehensive overview of environmental impacts of the ports of Rotterdam and Amsterdam. These impacts are relatively well document and monitored, including by the port authorities themselves in their annual reports and other publicly available documents. Instead, this chapter will focus on three different negative impacts that are prominent in many port-cities throughout the world and that can be put in a comparative perspective; these impacts are air pollution, land use and the impacts of hinterland transport.

Air pollution

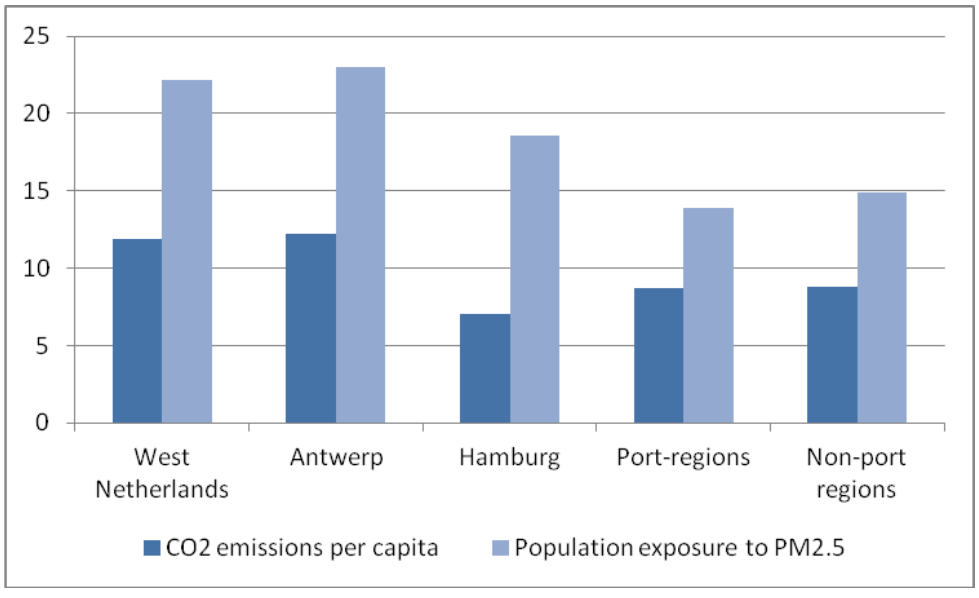
The Randstad region – Rotterdam in particular - scores relatively negatively when it comes to air pollution. CO_2-emissions per capita and the share of population exposed to particulate matter ($PM_{2.5}$) are approximately 50% higher than the average for European port regions. This position is shared with Antwerp that has similar scores, whereas Hamburg scores better on both indicators. More disaggregated data indicate that particularly Rotterdam has relatively high CO2-emissions, one of the highest among European cities, alongside cities in the industrial heart of Germany, the Rhine-Ruhr-area (Figure 36). This high score for Rotterdam has been explained by the presence of a large industrial port by some authors (Hoornweg, 2011). Although no studies exist that have managed to collect air quality data in all world port-cities, it is possible to estimate shipping-related emissions in ports, based on vessel movements. Based on such an approach (elaborated in Merk, 2012), it can be shown that the shipping-related emissions in the ports of Rotterdam and Amsterdam represent 10% of the shipping emissions in all European ports.

Figure 36. CO_2 emissions per capita in European OECD functional regions, tonnes of CO_2 per capita (2005)



Note: Data not available for some OECD member countries. This map is for illustrative purposes and is without prejudice to the status of or sovereignty over any territory covered by this map.
Source: OECD calculation using the Emissions Database for Global Atmospheric Research (EDGAR), version 4.1. See OECD (2011d) and OECD (2011e).

Figure 37. Environmental indicators in port regions

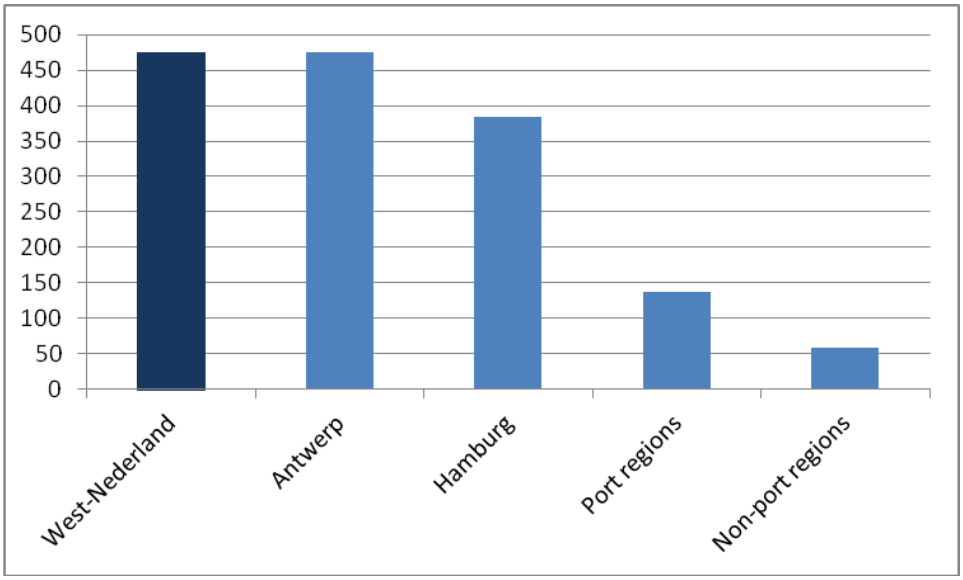


Source: OECD Regional Database

At the same time, port regions such as the Randstad region, are leading with respect carbon absorption via biomass production. The average absorption in Randstad region (West Netherlands) is more than 3

times larger than the average port region, and around nine times larger than the average non-port region in Europe. Antwerp (Flanders region) is at similar level as the Randstad, but the level in Hamburg is smaller.

Figure 38. Average carbon absorption via biomass production (2006)

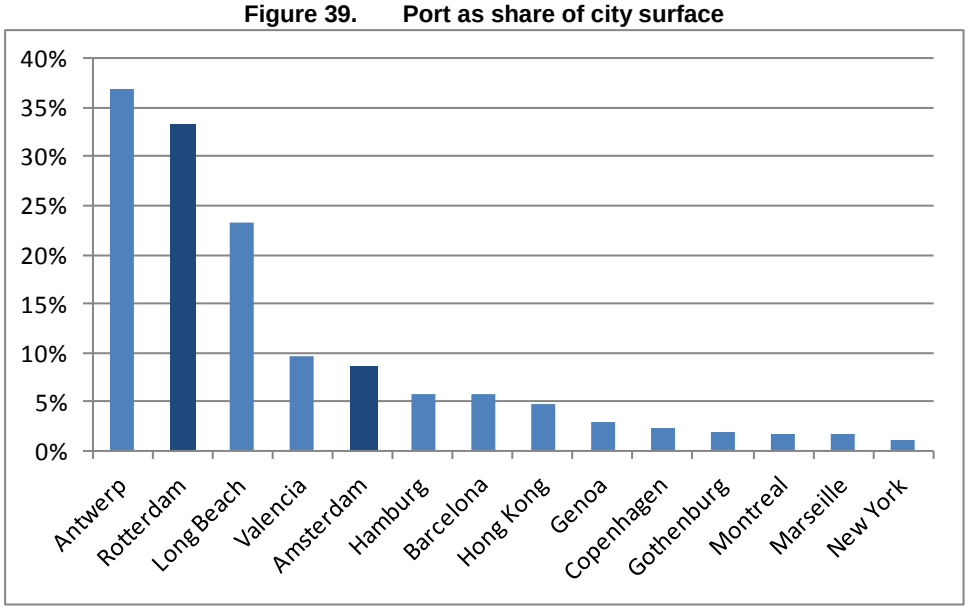


Source: OECD Regional Database

Land consumption

Ports are land intensive, particularly in Rotterdam where they take up around a third of available land surface in the city (8% in Amsterdam). Among selected port-cities only Antwerp had a larger share of urban land used for port activities (Figure 39). Other large ports tend to use a share of the city surface that is lower than 5%. Even a port like Hamburg, located in the very core of the city, uses only slightly more than 5% of the land surface of the city. Evidently, one needs to be cautious with these comparisons as the administrative boundaries of cities vary a lot, but have a large impact on the outcome of these calculations. Still, these comparisons are not meaningless. Apart from the environmental dimension connected to port land use, there is also an economic dimension, because there could be opportunity cost of port land use. Agglomeration effects and high job density are generally considered to be factors of urban economic growth, and these agglomeration effects might be constrained by the presence of large port areas, that are generally not easily accessible to the public, so not expected to generate the agglomeration effects associated with urban areas (knowledge spillovers), although there could be positive clustering effects in port areas that might be dependent on size.

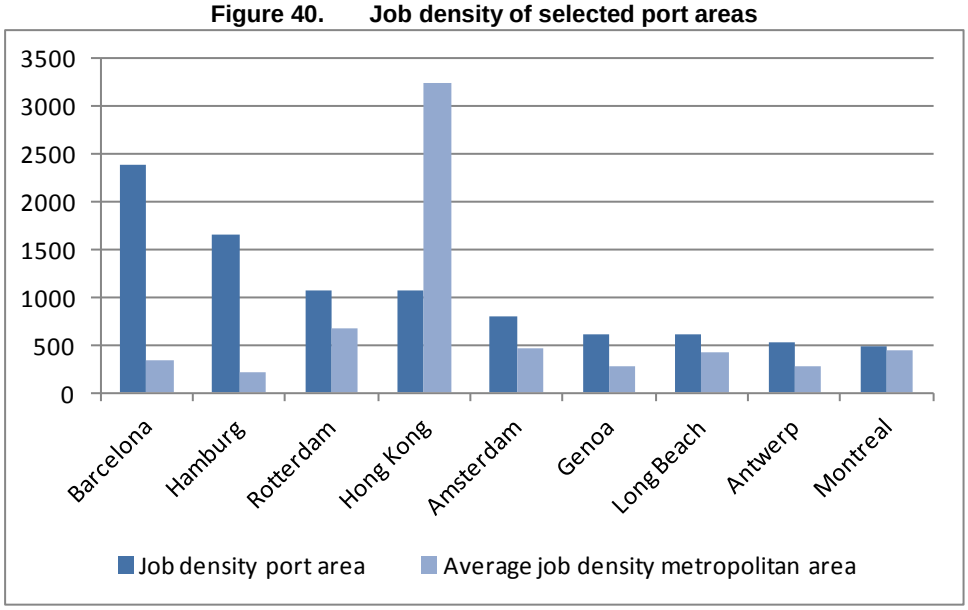
Figure 39. Port as share of city surface



Source: own data compilation based on OECD Metropolitan Database, Eurostat Urban Audit and port websites

Still, job density in the ports of Rotterdam and Amsterdam is relatively high (1050 and 800 jobs per square kilometres) in comparison to many other port-cities (Figure 40). In addition to that, job density in port areas is higher than the average job density in the metropolitan area in all of the selected port-cities, with the exception of Hong Kong.[9] Port job densities in Rotterdam and Amsterdam are roughly 40% higher than the average job density in the metropolitan area. Even though the port takes up large part of the urban land it still locates more jobs than the metropolitan area as a whole. This relative job density is higher in Barcelona and Hamburg, but they have small metropolitan job densities, so a job-intensive port area might in some ways be needed to compensate for that. In Hong Kong, one could wonder if the land used for the port area is not crowding out other more labour-intensive activities.

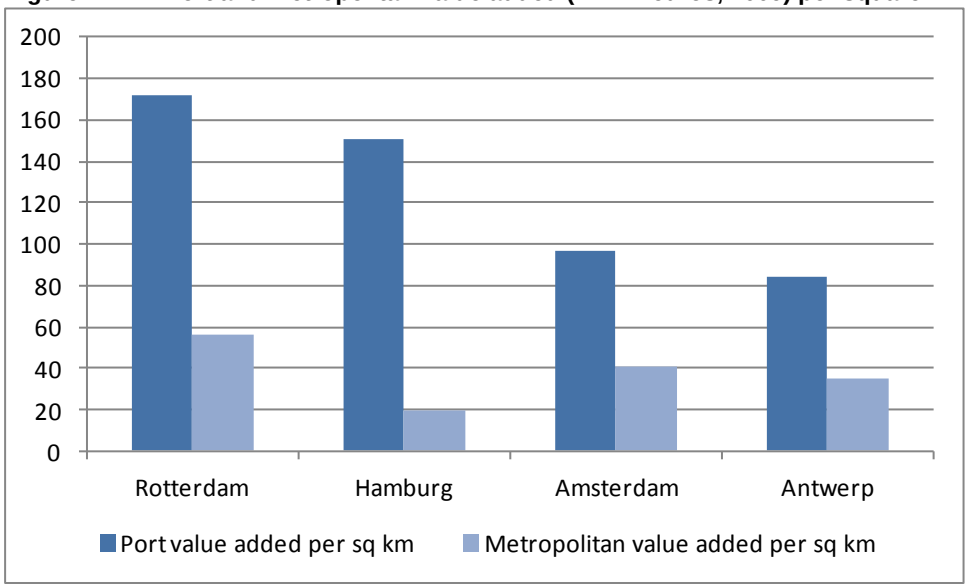
Figure 40. Job density of selected port areas



Source: own data compilation based on OECD Metropolitan Database, Eurostat Urban Audit, collected port impact studies and port websites

The GDP density of the port area is higher than of the metropolitan area as a whole. This is particularly the case for Rotterdam where the average GDP per square kilometre was € 170 million in the port area in 2009 and € 55 million for the metropolitan area. The other large North-West European port-cities show a similar pattern, with the GDP density of the port area more in line with the metropolitan GDP density in Amsterdam and Antwerp, but still more than twice as high (Figure 41). Although the activities in the different port areas take up a considerable amount of space, they generate more value added than the average of the metropolitan area. Of course, one has to be cautious in interpreting these findings, as the average land use of metropolitan areas also includes nature areas and undeveloped land. Ideally, one would like to compare the land productivity of port land with other industrial or commercial areas, but such analyses are difficult to perform on a comparative basis between cities.

Figure 41. Port and metropolitan value added (in mln euros, 2009) per square km



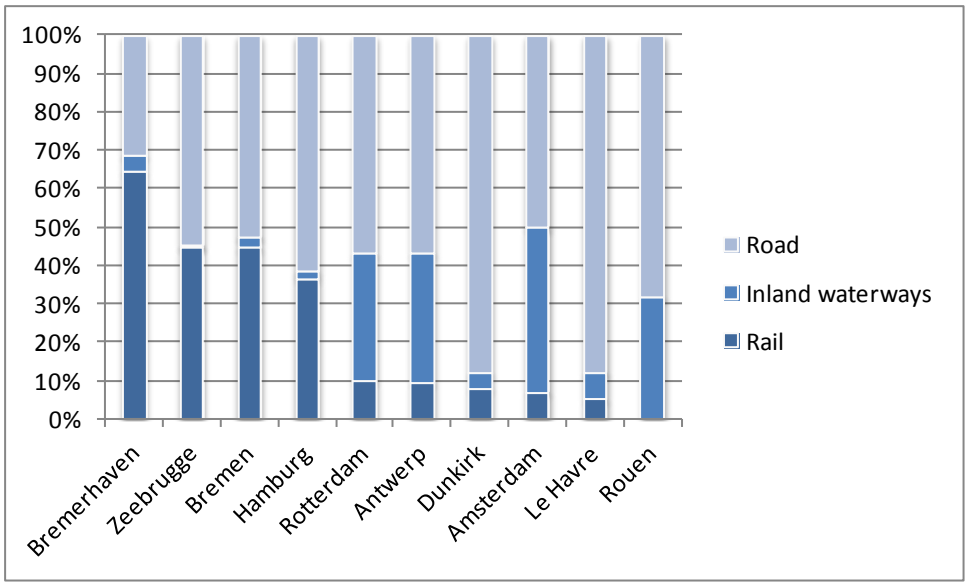
Source: own data compilation based on OECD Metropolitan Database, Eurostat Urban Audit, collected port impact studies and port websites

Impacts from hinterland traffic

With respect to externalities of hinterland traffic, Rotterdam and Amsterdam compares relatively favourably to other ports in North-West Europe, mainly due to a high share of barge traffic. This represented more than 40% of the total hinterland traffic in 2010 for Amsterdam and more than 30% for Rotterdam, which is relatively high compared to other most ports (Figure 42). As a result, the share of road transportation is fairly low. Rotterdam has over the last decade managed to slightly reduce the share of hinterland traffic by road, but the decrease in Hamburg is steeper (Figure 43).

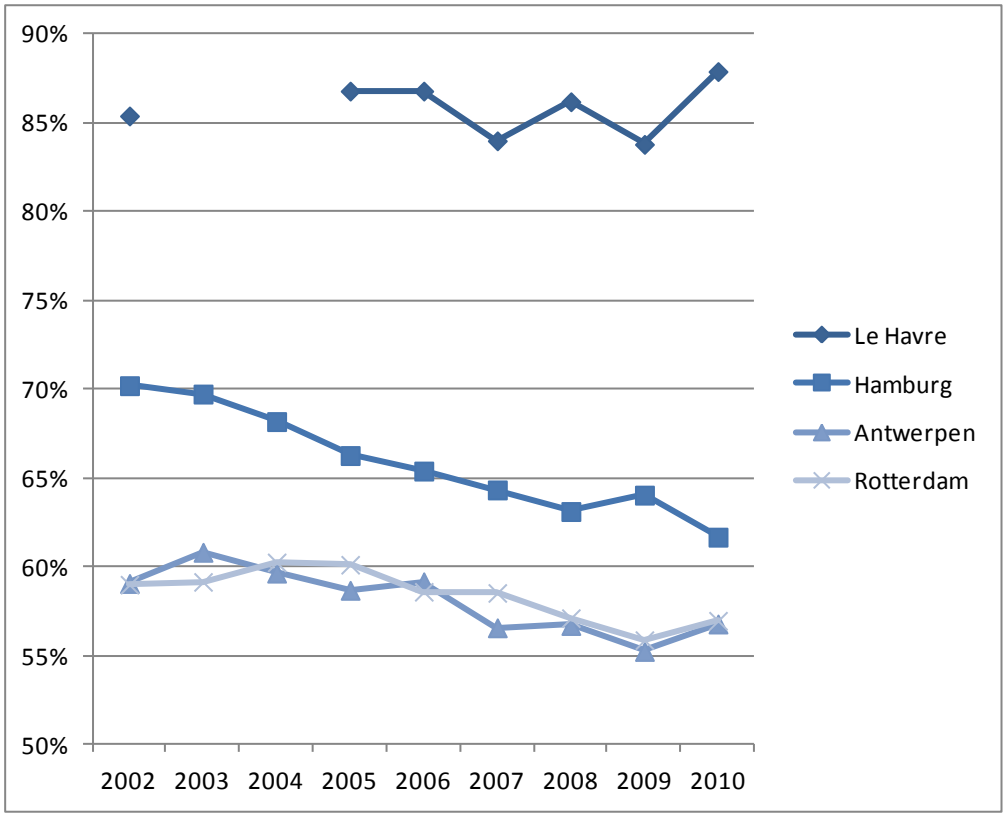
Despite the observed modal shift in Rotterdam, the expected future volumes of trucks to and from the hinterland remain a major concern. The only hinterland route by road consists of the A15 highway, connecting the port of Rotterdam with the hinterland in eastern direction. The capacity expansion of this highway did not keep up with the persistent traffic growth of road transport and this highway is increasingly faced with congestion problems both inside and outside the port area. The fact that the A15 is the only available major road giving access to the port not only endangers future accessibility, but also makes it very vulnerable. Many containers transported by road have a regional origin or destination, but are also transported nation-wide, but even in international traffic the role of road transport is significant. The much needed plan to widen the A15 has been approved[10].

Figure 42. Modal split hinterland traffic of main ports in HLH range (2010)



Source: based on data port authorities and Schiffahrt Hafen Bahn und Technik
Note: these are modal splits for containerized traffic. Data for Bremerhaven cover the Eurogate-terminal exclusively. Data for Bremerhaven, Bremen are from 2009; Rouen from 2008; Amsterdam and Zeebrugge from 2007 and Dunkirk from 2006.

Figure 43. Development truck hinterland traffic (as % of modal split) in main NW-European ports



Source: based on data port authorities and Schiffahrt Hafen Bahn und Technik

The external costs of this hinterland traffic of containers related to the port of Rotterdam could amount to approximately € 425 million in 2010. These external costs include costs related to congestion,

accidents, air pollution, noise and other external costs. At least this could be derived from an update of a study by Haezendonck and Coeck (2006), who calculated these external costs to be around € 240 million in 2000. Even if these calculations are dependent on the data quality and underlying assumptions, there is a growing academic literature underpinning such results (Maibach *et al.*, 2008). The increase over the last decade is evidently due to increased throughput volumes in the ports of Rotterdam and Amsterdam, despite the reduction of truck shares in the modal split in Rotterdam and Amsterdam. With port volumes project to steadily grow over the next decades, the impacts of hinterland traffic will grow in parallel, and will crucially be determined by modal shifts and greening of whole supply chains.

2.3 Balancing costs and benefits

The case of Rotterdam and Amsterdam indicates a certain un-balance with respect to benefits and impacts of port development, in line with the mismatch between costs and benefits of port related investment assumed by various authors (e.g. Musso 1996, Hesse 2006). Costs and negative effects are localised, whereas the benefits would be generated at the supra-regional (national) and even supranational level. The main costs and benefits of port-related development which apply to Rotterdam and Amsterdam are indicated in table 18, summarized below.

There are substantial benefits from the ports of Rotterdam and Amsterdam, but they have considerable leakages to other regions. Benefits identified in this chapter include port-related economic value added, certain port-related economic specialisations, knowledge spillovers, lower logistics costs and ports as revenue sources. The spillovers to other regions include the reduction of logistics costs, especially since the hinterlands of the ports of Rotterdam and Amsterdam extend well beyond their own regions – and own country. There are also some economic specialisations that spill over to other regions; this can be illustrated by the case of maritime-related engineering services that are to a limited extend located in Rotterdam, but to a much larger extent in the Rotterdam metropolitan region and the rest of the Netherlands. Port-related employment is increasingly de-concentrating, in many cases away from port regions. The port can be a revenue source for local governments (both Amsterdam and Rotterdam), but also for the national government as minority shareholder of the port of Rotterdam. Ports like Rotterdam and Amsterdam provide very interesting locations for renewable energy production, in particular biomass production considering the large diversity of commodity flows and sophisticated refinery infrastructure. This production capacity will most likely serve a wider area than just the port region.

Most of the negative effects of ports are localized. This chapter found that the main local costs of the ports are connected to their environmental impacts. Most of these effects are localized: the Randstad has worse emission levels than many other regions, and within the Randstad area Rotterdam has much higher CO2-emissions than Amsterdam, probably related to its large industrial port complex. The environmental effects of hinterland traffic are also local, in particular because most of the short range hinterland traffic is by truck (and thus most polluting) whereas most of the longer range hinterland traffic is by modes with less negative externalities (rail and barge). Other local costs that are sometimes assumed, such as social costs, appear to be relatively limited. The scores of the Randstad on social indicators are favourable; and although Amsterdam's performance on most of these is better than Rotterdam's, their differences are relatively small in comparison to their differences with other port-regions and non-port-regions in Europe.

Table 18. Costs and benefits of global ports

Local	National	Supra-national

Costs			
- Economic	Infrastructure investments Opportunity costs land use	Infrastructure investments	
- Social	Population composition		
- Environmental	Negative effects close to port area Hinterland traffic (trucks)	Hinterland traffic (trains and barges)	Hinterland traffic (trains and barges)
Benefits			
- Economic	Port-related value added Agglomeration effects Knowledge spillovers Lower costs of exports and imports	Lower costs of exports and imports	Lower costs of exports and imports
- Social			
- Environmental		Renewable energy production	

This combination of impacts leads to distinct perspectives for Rotterdam and Amsterdam. In spatial terms, port functions and urban functions have become increasingly disintegrated in Rotterdam, with the newest and most active port terminals now at more than 40 km from the city centre, and part of port activities taking place in inland terminals (extended gates such as Moerdijk). In Amsterdam, port functions have retreated to some extent, but a significant part of the port activity is still taking place relatively close to the city centre. As a result, the port-city challenges are different. In Rotterdam, the congestion and environmental impacts related to the port-industrial cluster can be felt, but most of the port jobs are now occupied by workers from outside the city and the connection of urban citizens and businesses to the port complex is becoming loose. In Amsterdam, there is a strong pressure on transforming parts of the port land in order to develop other urban functions, such as housing and office development.

There is however one common denominator: the challenge to link port and urban functions that have a very distinct logic. This is a challenge because successful ports are "club goods" where clustering is needed to share infrastructure among a few large industrial players, but where interaction is avoided because of competitive pressures; whereas successful cities are agglomerations that maximise the opportunities for interaction between a very large number of people mostly employed in service industries. Or, to put it differently, port systems and urban systems obey different organisational and sometimes opposing rationales: the attractiveness of metropolitan areas is based on "openness", whereas the attractiveness of port-industrial complexes is based on "closedness" (Box 1). This is a delicate balancing act for port-cities.

Box 1. The diverging priorities of port and urban systems

Spatial clusters could be classified into three different groups, with different characteristics of relations between firms and knowledge spill-overs (based on work by McCann and Sheppard, 2003; Iammarino and McCann, 2006):

- Pure agglomeration: metropolitan areas can be considered engines of growth thanks to economies of agglomeration: the assumption is that people and firms tend to cluster in metropolises because of the positive knowledge spill-overs that result from interaction between individuals. Firms in such a constellation typically have no market power, and will continuously modulate their interactions with other firms and customers in response to market arbitrage opportunities, leading to intense local competition. Loyalty between firms, and long-term relationships, are difficult to establish in these circumstances. The cost of the membership in this cluster is the local real estate market rent. There are no free riders, access to the cluster is open and the price that local real estate can command is a benchmark for the cluster's performance.

- The industrial complex is characterised primarily by long-term stable and predictable relations between the firms in the cluster, involving frequent transactions. In order to become part of a cluster, firms within it each undertake significant long-term investments, particularly in terms of physical capital and local real estate.

Access is restricted by high entry and exit costs: the rationale for clustering is that proximity is required to minimise inter-firm transport transaction costs. In this constellation, a few large firms dominate the market; these firms often perceive that knowledge outflows to industry rivals can be extremely costly in terms of lost competitive advantage. These firms will thus decide to locate in industrial complexes characterised by stable planned and long-term inter-firm relationships.

- The third type of spatial cluster is the social network model. A key element of this model is mutual trust. These mutual trust relations will be manifested by a variety of features including joint lobbying, joint ventures, informal alliances and reciprocal arrangements. Relations of trust are assumed to reduce inter-firm transaction costs, because when they exist, firms do not face the problem of opportunism.

Although these models are theoretical ideal types, not intended to represent any particular location, it is tempting to apply this classification to ports and port cities, as they could clarify the challenges facing them. Large ports, especially those connected to heavy industries and specialised in containers and oil products, like Le Havre, mostly correspond to the industrial complex-model: an oligopolistic firm structure, high entry and exit costs and a relatively closed character, in order to avoid leakage of strategic knowledge. The metropolitan area of Paris would correspond predominantly to the pure agglomeration model: its attractiveness is determined by its potential for interaction and positive knowledge spill-overs. The city of Le Havre, like many port cities, is faced with a dilemma: between the closed culture typical of a large port-industrial complex and the openness required to create an attractive city. Whereas very large port-cities, such as New York, Singapore and Hong Kong, can combine these two imperatives, the situation is more complicated in smaller port cities such as Le Havre, and also to a certain extent in Rotterdam. Rotterdam has used economic diversification strategies, but still struggles with relatively negative perceptions of its urban attractiveness. The challenge for cities like Le Havre could be to compensate its relative “closedness” due to the port cluster by building regional networks, with Paris among other places, in order to develop a larger mass of “pure agglomeration” effects.

Not all cities with successful ports have good economic performance. This is well illustrated by the case of Rotterdam: despite its impressive port performance, the city of Rotterdam has a mixed economic profile, with lower GDP per capita, growth rates and employment rates than the national average. Its limited urban attractiveness – in comparison with other world port-cities – has made it difficult to attract high value added firms, headquarters and talent: despite it being a central node for physical flows, Rotterdam has not developed into a world leading services centre, not even for maritime services. The case of Amsterdam illustrates that cities with a more diversified economic profile naturally focus on stimulating a wide set of economic sectors, even if – or maybe because - the port functions well. The challenge for many port-cities, including Rotterdam and Amsterdam, is thus to find a way to use the port cluster as an asset for a wider urban economic development and a more high value added services economy, such as ship finance, maritime law, engineering, consulting, commodities trading, headquarter functions and energy.

3. GOVERNANCE AND POLICIES

The port-city relationship in Rotterdam and Amsterdam is complex and multi-faceted: its ports have shown good growth rates but this has not automatically translated in more value added; most of its benefits spill over to other regions but most of the negative impacts are localized. How to deal with these dynamics is the major challenge for port-city policies and the actors involved in its governance. This chapter will stress the need of a sustainable and selective port growth strategy, the creation of an international maritime services centre to reap local benefits from port presence, regional cooperation to increase synergies, and smart funding mechanisms that take into account the externalities of port development.

3.1 Towards a sustainable and selective port growth strategy

The Port of Amsterdam has the clear mission to rank among the most sustainable ports in Europe. In 2008, the Port of Amsterdam developed an ambitious environmental policy plan for the period between 2008 and 2012. This plan on 'Sustainability: Boldness, Action and Resolve' further developed the sustainability theme of the Port Vision 2008-20 with concrete measures linked to set objectives. In developing the plan, the Port of Amsterdam has extensively consulted all stakeholders, including environmental groups, industry organisations, city departments, city-district governments, regional players and central government. Concrete actions and ambitions in the plan include: become a carbon-neutral organisation by 2015, use of innovative techniques and technology for sustainable energy production and reduction of noise and dust nuisance, increase the number of shore-power outlets for river barges and river-cruise vessels; reduce the contribution made by road transport (from 53% to 45% by 2020) and to strengthen the roles played by river barging (to 49%) and rail transport (to 6%);

The ambition of the port of Rotterdam is to be the global leader in 2030 in terms of efficiency and sustainability. The port of Rotterdam aims for a further strengthening of its status as Global Hub for goods within Europe and between Europe and other continents and Europe's Industrial Cluster in 2030. The latter objective demands competitiveness of the industry at a global level which calls for efficiency increases and strong links between companies in Rotterdam and Antwerp. The Port Compass thus explicitly refers to a transition towards one integrated industrial complex in the region. The port of Rotterdam is also at the forefront of the fight against climate change, it designs and implements a set of policies organised in cooperation with local authorities. The city of Rotterdam has established a program called the Rotterdam Climate Initiative, whose aim is to achieve a 50% reduction of CO_2 emissions in 2025 compared to 1990. The Rotterdam Climate Initiative is organised along five axes: sustainable city, energy city, sustainable transport, innovation laboratory and sustainable energy port. The port of Rotterdam adheres to this general policy and acts on two of these five axes: sustainable transport and sustainable energy port. Main elements in the aim of the port of Rotterdam to develop sustainable transport are focused on the emissions of vehicles[11] and ships used by the port authority, by implementing a "green fleet"-program. In 2008, the port has signed a convention to limit the sulphur emissions of its ships. Land-based vehicles will in the future use engines that are less polluting. Moreover, the port of Rotterdam supports the program to develop service stations in the city that provide bio-fuels (biodiesel, bio-ethanol, bio-gas).

The Rotterdam port area is already one of the world leading sites for port-related production and innovation in sustainable energy. This has taken the form of development of energy efficiency, production of renewable energies and the capture and storage of CO_2. The ambition of more energy efficiency is taking shape in the development of networks that do not emit GHG: in particular a system of exchanging heat by pipeline of the different firms in the port area. With respect to renewable energies, the objective is to replace fossil fuels by energy sources with no CO_2 emissions. Within this perspective, the port has signed in 2009 a convention for the extension of windmill parks: between 2009 and 2020 the energy

produced by this energy source will be doubled from 151 MW to 300MW. Off shore windmills further away from the coastline are in particular being considered. The development of solar energy is also being studies, in partnership with Deltalinqs; and the use of on shore electricity for inland barges has been experimented since 2007. The port of Rotterdam also has an ambitious program for capturing and storage of CO_2 under the North Sea, including water transport of CO2 and application for oil extraction. The port works at this moment with a consortium of private enterprises to develop the technologies and know how that would be necessary for this project. EU funds up to 180 million euro would allow the first stages of the program to be financed, in particular a pipeline for the transport of CO_2.

All these initiatives suggest the emergence of sustainable port growth, which should be expanded and be complemented selective growth strategies. Selective growth strategies focus port growth on areas with highest positive regional impacts. Such a strategy could build and expand on existing concepts, such as "smart port" and "smart growth", but could also include a stronger focus on high value added services. For example, the port of Rotterdam could in addition to its ambition to be a world cargo hub and leading energy hub aim to be a world port city. Port land use might be intensified even further and development of green businesses and green port-related technology could become a core port activity, along the lines of clean tech development in Los Angeles and Long Beach. The position as sustainable ports needs to be retained and expanded through policies that aim at stimulating the bio-based economy, carbon capture and storage, the use of LNG as fuel for seaborne and inland shipping and shore power. In order to attract green businesses and develop green port-related technologies that could be commercialised, a series of programmes have been developed in the ports of Los Angeles and Long Beach (Box 2).

Box 2. Green business incubation and commercialisation in LA/Long Beach

The ports of Southern California have several programmes at their disposal to attract and create green high value added activities, both trough a green business incubator (PortTech LA) and a Green Tech Commercialisation Programme called Technology Advancement Programme.

PortTech LA is a public benefit, non-profit technology center and business incubator founded by the San Pedro and Wilmington Chambers of Commerce in collaboration with both the City and Port of Los Angeles. Its mission is to attract technology companies to the Los Angeles port area that will create new well-paid "Green Collar" jobs by developing, testing, commercializing, manufacturing and marketing products and solutions for local and international port-related environmental, security and logistics challenges. Services provided by PortTech are the provision of physical space for technology companies near the ports, business and IPR mentoring, financial seminars and access to angel investors and venture capital opportunities.

The Technology Advancement Program aims at accelerating the verification or commercial availability of new, clean technologies, through evaluation and demonstration, to move towards an emissions free port. The Technology Advancement Program is focused on new and emerging technologies, with the objectives of streamlining the process for reaching consensus on the emission reductions achieved by various technologies and facilitating development of new technologies and their adoption throughout the port industry.

Examples of successful outcomes of both programmes are the Automated Photosynthetic Algae Reactor (APAR) and the Advanced Maritime Emissions Control System (ACTI). The APAR consumes CO2 and NOx and produces three grades of biofuels (biodiesel, JP8 jet fuel and agri-diesel); the "waste"product is used as fertilizer and pharmaceutical additive. The ACTI removes NOx, Sox and Particulate Matter (PM) from auxiliary engine exhaust gases while ships are hotelling, with effectiveness rates of 95-99% in demonstrations in the port of Long Beach.

Source: www.advancedalgae.com ; www.advancedcleanup.com

Sustained port growth is dependent on local support. Rotterdam and Amsterdam understand that they cannot take broad public support for development plans for granted. This aspect of port competitiveness

will undoubtedly become more important in the near future as resources such as land are becoming scarcer and as broader social and environmental functions are challenging the economic function of seaports. The more international the maritime and port industry becomes, the more energy will have to be put in embedding the port in the local community. In line with the 'soft values' approach introduced by Van Hooydonk (2006, 2007), ports are challenged to improve the public image of seaports. The port authorities of Rotterdam and Amsterdam do this by combining several approaches: (a) external communications policies and public events and festivities in and around port areas – such as Port Days and Futureland, an information center about Maasvlakte 2; (b) convince the general public of the importance of ports by presenting figures on employment effects and added value; (c) adopt a green port management strategy; (d) stakeholder relations management, i.e. the development of good relations with all parties concerned, particularly with respect to port expansion plans or redevelopment/regeneration plans focusing on older port areas (i.e. waterfront redevelopment). Rotterdam has been among the first cities to adopt growth-oriented entrepreneurial approaches to governance, as witnessed through their hosting of major events, their efforts at branding and marketing, and, more recently, their support of flagship regeneration projects such as "Kop van Zuid". Efforts are also made to increase the awareness among youngsters about future career possibilities in the ports.

3.2 Develop into a leading international maritime centre

To the credit of the Dutch, the ports are well integrated in multi-annual spatial and transport planning frameworks and crucial policy conditions for port and port hinterland development, such as road bottlenecks, have been taken care of. Subsequent governments have since decades stressed the importance of port development in Rotterdam, either as a "mainport", as a key node in metropolitan development, a "peak in the Delta" or a "top sector" (Box 3). As a result, new port and hinterland infrastructure was consistently planned and developed in line with national spatial plans. Despite this strong focus on port development and port hinterlands, the Dutch government has been less active in stimulating the maritime cluster as a whole. The potential for the Rotterdam/Amsterdam, in combination with Antwerp, to grow into one of the leading international maritime centres could be more coherently addressed in current policies.

Box 3. The integration of port development in main government strategies

In the 1980s the government started to develop a mainport strategy. This implied that the two mainports – the port of Rotterdam and the airport of Schiphol – were considered as gateways to Europe and important strongholds and facilitators for the Dutch economy. The basic idea behind the mainport strategy was that good flows are concentrated in a limited number of nodes or hubs. This led to a spatial concentration of investments and justified very large infrastructure projects such as the Betuweroute and the high-speed rail connection between Amsterdam/Schiphol to Brussels/Paris. The mainport strategy was supported by strong commercial initiatives to attract logistics and distribution activities to the Netherlands as well as European head offices. The overarching government policy entitled 'The Netherlands, distribution country' (Nederland Distributieland) aimed to attract flows of goods transported between other countries to The Netherlands and channel them through Dutch airports and seaports. This led to a surge in re-exporting activities through the Netherlands and the establishment of a large number of European Distribution Centers (EDC) in the Netherlands (Kolk and Van der Veen, 2002: Erasmus University Rotterdam – RHV, 2010).

The mainport policy has enabled the rapid growth of Rotterdam and Schiphol throughout the late 1980 and the 1990s. However, controversies increased likewise, particularly in view of the limited space available in a densely populated country such as The Netherlands, and the negative environmental and social effects felt by its inhabitants. In the late 1990s, the argument that the mainport strategy is justified given the important role of the mainports for the Dutch economy was more and more contested. Eding et al. (1999), Oosterhaven et al. (1999) and Pols (1997) argued that the mainports have limited positive effects for national economic development, and that weak linkages exists between air and maritime transport and other sectors outside the mainport regions. In spite of such criticism, however, the expansion of the mainports was not halted. The end result of each debate has always been the further growth in the size of the mainports.

In recent years, the focus on nodes only has somewhat been softened and the attention shifted to the metropolitan region of the Randstad Holland as a competitive unit, at least in terms of policy discourse. Combination of

scale, diversity and level of internal and external interaction are important in this respect. By combining a better internal interaction between the city regions, the Randstad Holland would be able to fully benefit from the potential agglomeration effects, diversity and external accessibility. This would make the Randstad stronger in dealing with competition from foreign metropolitan regions (Van Gils et al., 2009). The role of the mainports in this setting is different: the value of Schiphol to the Randstad primarily lies in the frequent and direct linkages to the global network which is of importance to the development of economic functions in the region. In such a Randstad approach the choice is on a hierarchical structure of the urban network with a limited number of internationally oriented nodes and a bipolar structure based on the two mainports. Such an approach demands investments in the mainports and the main business locations and in the infrastructure connections between these nodes and between the nodes and the hinterland and foreland. Such regional perspective on infrastructure development urges for governance models that enhance cooperation between government agencies at different geographical levels and stakeholders.

This shift from a mainport strategy focusing on the nodes (i.e. the mainports Rotterdam and Schiphol) to a strategy aimed at strengthening the competitiveness of the metropolitan region Randstad Holland also implied that the need for a high accessibility and connectivity is complemented by the need for a high quality of life. The latter is particularly essential in attracting investments in headquarter activity and logistics and in creating a strong local skilled labour pool. Amsterdam has been more successful in this respect than Rotterdam. The new policy thus implies that the large mainports are not considered as the engines of the Dutch economy, but Randstad Holland takes up this role. The mainports are now acting as facilitators for the competitive development of Randstad Holland. A study by Erasmus University Rotterdam – RHV (2010) refers in this respect to the term 'wereldstadhavens' (world city ports) whereby the mainports act as the ports for potential world city Randstad Holland. This new strategic direction is also echoed in several central government documents including the National Seaports Policy 2005-10 (Ministry of Transport, Public Works and Waterway Management, 2004), the economic vision on the long-term development of Mainport Rotterdam (Ministry of Economy, 2009), but also the Peaks in the Delta programme (2004-2010), the Randstad 2040 vision and the Randstad Urgency Programme (2008).

The spatial-economic structure of mainports Schiphol and Rotterdam are more or less fixed: realising new runways in Schiphol or a third or fourth Maasvlakte is not part of the agenda. Growth would have to realised within existing spatial structures, by developing a network strategy with regional nodes and also by also actively striving for (cross-border) cooperation (Erasmus University Rotterdam, 2010). While the port vision document of Rotterdam (see later in this report for more details) refers to strong traffic growth in the coming decades, the Port Authority of Rotterdam reasons along the same lines: there is no foreseeable need for a Maasvlakte 3 and the growth should be accommodated by also benefiting from a stronger network orientation with inland ports and other seaports.

Current policies recognize the importance of the ports for important sectors in the Netherlands, such as agro-food, petro-chemicals and logistics. The logistics sector was considered as one of the nine "top sectors" by the Rutte 1 government, a policy confirmed by the Rutte 2 government. This focus on strong economic sectors has since 2010 replaced the regional economic programme "Peaks in the Delta" in which both the city-region of Rotterdam and Amsterdam were supported (and called South Wing and North Wing of the Randstad). The maritime cluster is part of the top sector "Water" but entails only niche ship building and port development. The logistics sector that is covered in the top sector policy has a broad definition; the ambition is to increase the number of supply chain command centres in the Netherlands. The logistics sector, including the seaports sector, is considered to be instrumental to several of the other top sectors, including energy, chemicals and agro-food. There are also other top sectors that could be considered to have interlinkages to the seaports of Rotterdam and Amsterdam: headquarters and the creative sector

However, ports are only to a limited extent used as assets for regional economic development, or for the development of an international maritime centre. The Dutch Top Sector policy has a narrow definition of the maritime cluster and although logistics and headquarters are considered to be top sectors, this does not translate in more support for maritime logistics or maritime headquarters. This could be considered a missed opportunity and the position of the Rotterdam and Amsterdam in this respect is under continuous pressure, with certain maritime headquarter or staff functions (Maersk, Smit) going elsewhere, or other cities (Hamburg) being able to attract more new maritime headquarters. Unlike cities like London and Singapore, the Randstad (or Rotterdam/Amsterdam) has not developed into a diverse and world leading centre in maritime services; as illustrated in chapter 2. The port and port-related sector could be used as an

asset and potential location to strengthen the existing maritime cluster, especially now considering the debt crisis in Greece and related policies might lead to an exodus of ship owners from one of the world's maritime services hubs - Piraeus, and considering emerging countries able to generate opportunities for new businesses and regional headquarters. A maritime focus could be applied to the development of the "top sectors", in order to attract global and European headquarters of carriers, large ship-owners and a range of maritime services providers in brokering, finance, consulting and other fields.

A much more holistic strategy on developing and sustaining the maritime cluster would be needed and a much wider set of instruments could be more aggressively used to further a maritime cluster, such as development assistance, export promotion, trade missions and anti-piracy policies. This would first of all need a clear statement on the ambition and the development of a strategy to become a comprehensive international maritime services centre. This would mean to sustain the parts of the cluster that are already world-leading and to develop the parts of the cluster that are currently lacking. It is such a comprehensive ambition that drove the development of Singapore of a cargo hub into a world leading international maritime centre. Main elements in this strategy were the development of a shipping registry, tax incentives and major maritime schooling initiatives (Box 4). Although such a strategy might be difficult to emulate elsewhere due to the particular conditions of Singapore, it also shows the power of the sort of comprehensive ambition that would be needed to propel the maritime cluster in the Netherlands towards world leadership.

Box 4. Singapore's transformation into an international maritime centre

In the past, Singapore had been over-reliant on the conventional port functions of providing cargo handling, ship-related services and storage. However, in light of the need to diversify its business operations and thus maintain its position as a logistics hub, the government of Singapore has embarked on establishing Singapore as a maritime logistics hub. Singapore is now a home to more than 5,000 maritime establishments, with S$ 28 billion gross receipts, employing a workforce accounting for 5 per cent of Singapore's national employment and whose output account for 7 per cent of Singapore's GDP. Singapore has attracted a number of shipping groups to register in its Registry of Ships.

To increase the value-added of the port of Singapore, the Singapore government has undertaken a number of fiscal measures and other incentives to attract advanced logistics companies to locate around the port of Singapore and form a maritime cluster. The strategy is to build a maritime business cluster to enhance position as a logistics hub: a clustering of port and maritime-related activities complementary to the trade in goods and services (linking port operations to international trade) and a one-stop service for customers by providing an integrated maritime logistics services and attaining the economies of scale and scope. Apart from maintaining transparency of regulations, provision of world class infrastructure, provision of adequate supply of skilled logistics professionals and provision of a foreign-friendly environment, fiscal measures and other generous incentives have played a major role towards attaining a maritime logistics hub status. The major tax incentives include the Approved International Shipping Enterprise (AISE) scheme, Approved Shipping Logistics Enterprise (ASLE), tax benefits for Ship Registration and Business Development Support. The AISE offers income tax exemption for 10 years for foreign flag ships provided that the owner or charterer controls a significant amount of ships and have a significant operation in Singapore. In the past only Singapore flag ships were given income tax exemption, and this exemption assisted in the substantial expansion of Singapore fleet in the 1970s and 1980s. However, in many cases there was very little further benefit for Singapore and its economy since a large of that fleet was operated, commercially and technically, outside Singapore. To increase the use of Singapore as a base for the management and control of their shipping operations, Singapore introduced in 1991 a tax incentive under the AIS incentive scheme to exempt shipping lines awarded a AISE status from tax on the income from vessels operated by them, whether registered under Singapore flag or elsewhere. The ASLE provides a concessionary income tax on qualifying incremental income for established ship management, ship agencies, freight forwarders and logistics operators.

To encourage foreign vessels to register with Singapore's Registry of Ships, profits of a shipping enterprise derived from the operation of a Singapore-registered ship are income tax exempt. This applies to income derived from the carriage in international waters of passengers, mails, livestock or goods or from towing or salvage operations carried out in international waters by Singapore ships, and includes charter of Singapore ships. It also exempts shipping companies registered with Singapore from withholding tax on interest payments with respect to offshore loans to finance ships. Under this incentive scheme there is also no tax on gains from vessel sales. The government also

exteds business development support to ship-owners and maritime auxiliary service providers by providing grants and defraying expenses at initial development on reimbursement basis.

To foster innovation within the maritime industry, the government has established since 2003 the Maritime Innovation and Technology Fund (MITF) and to address the shortage of supply of skilled logistics professionals, the government has established since 2002 the Maritime Cluster Fund (MCF). The MITF includes the Maritime Industry Attachment Programme, the Joint Tertiary & Research Institutions and MPA R&D Programme, the Maritime Technology Professorships and the Platform for Test-bedding, Research, Innovation and Development for New-maritime Technologies (TRIDENT). The MCF was established by Singapore's Maritime and Port Authority to support the maritime industry's manpower and business development efforts.

The maritime services sector could be an explicit priority for business attraction (e.g. in trade missions, economic attaches at embassies). In its government programme the Rutte 2-government stresses the importance of economic diplomacy as part of the work of embassies, in order to create opportunities for Dutch business. The maritime cluster could be explicitly part of the sectors to promote in such an approach. Port- and maritime-related activities in developing countries might have important economic spillovers for the Netherlands, not only for the Dutch maritime cluster that might find business opportunities there, but also to strengthen trade relations between these countries and the open economy of the Netherlands. The reputation of the Dutch ports sector could be an asset in promoting the wider maritime cluster and their activities. Part of such a strategy would be to attract ship owners, headquarters or European headquarters of carriers, and a range of maritime services providers in brokering, finance, consulting and other fields. This would require specific and explicit briefing of embassy staff and investment attraction agencies on the maritime sector.

More focused development assistance could be used as a tool to promote the maritime cluster. Development assistance the Netherlands has become more focused, following an advice of the Scientific Council for Government Policy (WRR) to focus on key areas in which the Netherlands has world leading experts (WRR, 2010). This advice has been at the basis of an overhaul of the Dutch development assistance in 2011, including the selection of four main thematic areas including water (Minister of Foreign Affairs, 2011). This strategic reorientation has been confirmed by the Rutte 2 government. Although this new policy defines the challenges related to water mainly in terms of water scarcity and water quality, one of its goals is also to stimulate safe deltas and coastal cities, within the light of climate change and flooding risks. The 2011 policy document suggests that it creates opportunities for the Dutch corporate sector to get involved. The programme of the Rutte 2 government, in power since October 2012, has increased the possibilities of linking development assistance with business activities, by creating the new ministerial post of Minister of Foreign Trade and Development Assistance, with the aim of reinforcing the relations between the two areas, e.g. by facilitating possibilities of SMEs to invest in developing countries. In order to stimulate this, a revolving fund of EUR 750 million for 2014-2016 will be developed with the Dutch business sector. The port and maritime cluster could be promoted by developing proposals for this revolving fund. This cluster could also contribute to achieving the goals of safe deltas and coastal cities, by developing critical infrastructure assessments, climate-proof sea protection, port infrastructure and sustainable waterfront development, all areas in which the Dutch maritime cluster might have something to offer.

More links between the maritime cluster and the Dutch financial sector should be stimulated in order to accommodate emerging practices where project developers that bring finance are preferred. These practices are increasingly be applied in large port construction and dredging projects, where businesses that are backed by state banks or financial institutions have more interesting commercial perspectives. Current developments, including the banking crisis and the Basel III regulations, also provide many opportunities to expand ship and maritime finance; the state could be more instrumental in this since its nationalisation

of the ABN Amro Bank. Connections between the maritime cluster and pension funds should be stimulated to expand their port and shipping portfolio.

Despite commendable cooperation between the port and university of Rotterdam on port and transport development (Box 5), a more comprehensive approach on maritime education and research should be considered. A maritime MBA and port-related executive education should be developed e.g. in cooperation between universities in Rotterdam and Antwerp, similar to cities such as Hamburg, Copenhagen and Marseille. This would signal that Rotterdam-Amsterdam is not only a place for academic port studies, but also the location where international maritime executives go to update and upgrade their business skills. In addition, a world-leading expertise centre for waterfront development could be created, capitalising on the well-developed experience with port-related urban transformation and architecture in the Randstad. Such an expertise could also be at the forefront of climate-proof port-city development in developed and developing coastal metropoles. Finally, the anticipated shortage of skilled port workers and ageing should be addressed. Transport and port-oriented vocational schooling and training, well adapted to ports' qualitative demands, should be stimulated. The mismatch between shortage of skilled port workers and excessive unemployment among poorly skilled young people in the cities should be tackled.

Box 5. University initiatives on behalf of the port of Rotterdam

Although it has its sights firmly fixed on a global role, the Erasmus University Rotterdam has shifted its strategy in recent years and is now clearly committed to local and urban development. The economics department recently created a "Smart Port" Centre, bringing together training, research and consultancy services linked to the port's activities. Erasmus has also joined the "Generation R" Programme and the Rotterdam Climate Initiative-RCIP (with financing for start-ups in the energy and climate sector). The University has been in charge of many impact studies for the Maasvlakte 2 program and the westward move of the harbour. The University's Institute of Urbanism promoted the idea of the floating city, which is now in place in the downtown area. Similarly, the Technical University of Delft (TUD) has cooperated with the port authority in the field of computer modeling. TUD has a common interest with the city and the port in safety and security and transportation analysis. In this sense, the metropolitan area and the port can be considered as a laboratory for research activities.

Rotterdam University (university of applied sciences) has established a new campus for research, design and manufacturing (RDM) in one section of the old port. An incubator managed by TUD known as "Yes! Delft" has been established there. RDM Innovation Dock is part of the campus: its goal is to connect practical research and entrepreneurship, by creating a degree of integration between higher education institutions, services and private industry. All these initiatives take place within an ambitious plan promoted by the city (City of Rotterdam Council) and the Port Authority, the goal of which is to redesign CityPorts Rotterdam and make it a showcase for water management, by exploiting Dutch expertise in flood control and extending this know-how into the area of climate change. Beyond the RDM, the strategy relies on three other aspects: reinventing delta technology in the context of the RCIP, developing floating communities, and sustainable mobility programs (the object being to halve truck traffic) Rotterdam intends to become a knowledge port.

Success in developing a world leading maritime cluster will also depend on more generic policies needed to increase the metropolitan quality of life and to create a more favourable business climate, which would include solving bottlenecks with respect to housing, public transport and labour flexibility, stressed in other OECD publications on the Netherlands. In particular in Rotterdam, a long term and sustained strategy by city leaders to improve urban quality would be needed to convince global maritime industry leaders that it could be an attractive place to locate corporate and headquarter functions. Nationally, Rotterdam is not considered to be an attractive city to live in, e.g. ranking 18th on the urban attractiveness index, whereas Amsterdam is ranked 1st (Marlet et al. 2012). Internationally, Rotterdam is not even included in most urban attractiveness rankings, such those of Mercer and the Economist Intelligence Unit, whereas Amsterdam is considered one of the more attractive European cities for expats. Over the last decades, various urban redevelopment projects in Rotterdam, such as the "Kop van Zuid" and

"Stadshavens" projects (Box 6 and 7) have managed to improve urban quality of life. A new generation of urban development projects might be needed to improve the urban quality.

Box 6. "Kop van Zuid" re-development in Rotterdam

Rotterdam's major flagship project is the "Kop van Zuid", a mixed-use development of housing, offices, leisure, and infrastructure, situated on the south side of the River Nieuwe Maas, directly opposite the city centre. Planning for the project began in the late 1980s, and the development progressed rapidly after the completion of the iconic Erasmus Bridge in 1996, which linked the development (and Rotterdam South) with the city centre on the north side of the river. Social goals have played a major role in the development of the Kop van Zuid. A central vision for the Kop van Zuid was for it to become an economic, social, and physical unifier for the city, which has historically been divided by the river. Attracting high-income residents became an explicit municipal goal as policy makers believed that the city has a shortage of middle-class households. The Kop van Zuid created new housing in Rotterdam of types which were generally lacking: large luxury flats and single-family houses. The task of actually building and selling the houses was given to the private sector. The idea to redevelop "Kop van Zuid" dates back to 1968, but it was only in 1991 that a master plan for the Kop van Zuid was adopted by the municipal council of Rotterdam. The Kop van Zuid project became a 'National Key Project' and received subsidies from the Central Government. Proper accessibility by means of a new bridge, a metro station, tram and a viaduct were considered of vital importance for the redevelopment of the south. The whole plan insisted on high quality of design in all buildings and throughout the public realm while at the same time keeping the maritime character alive. Although only part of the project has been completed, it is estimated that 15,000 people are already living in Kop van Zuid and 18,000 working in the area. Kop van Zuid is not only a successful regeneration scheme in its own right, but it has indeed also helped to change the image of Rotterdam – from an industrial port to 'little Manhattan on the Meuse' – and to attract in the new people who are needed to diversify and modernise the city's economy.

The Rotterdam Development Corporation is responsible for the overall project management, supported by the Department of Urban Planning and Housing (dS+V), the Department of PublicTransport (RET) and the Port of Rotterdam. The Rotterdam Development Corporation is a large body, responsible not only for spatial planning, (and hence the vision and strategy for developing the city), but also for organising the provision of infrastructure, and selling off land to developers and investors.

Box 7. City ports ("Stadshavens") in Rotterdam

The Rotterdam CityPorts Development Corporation (RCDC) Ltd was set-up in 2003 to investigate all remaining port areas within the Rotterdam diamond (the areas surrounded by the main highway) for development opportunities. The shares of RCDC are owned by the Rotterdam Port Authority (50%) and the Rotterdam municipal government (50%). The CityPorts area, consisting of the Vierhaven and Merwehaven on the North bank of the river Maas, and the very large Waalhaven and Eemhaven on the South encompasses around 2,300 acres of port-controlled land. The area alone is home to some 850 port or port-related companies. The CityPorts area is planned to transform from port to urban use in the next 25 to 50 years. The initiative for the RCDC foundation was formally motivated by the plans for the Maasvlakte 2 as the future relocation of stevedoring companies from the CityPorts area to new sites with deeper water became a logical expectation.

In February 2005, the RCDC published the concept of their Development Strategy. In 2006, the Rotterdam Port Authority took the lead in the further development of the Waalhaven area. The RCDC, in contrast, would from now on focus their efforts only on the north shores of the river Maas and a smaller area on the north tip of the south banks of the Meuse. In other words, the joint effort of the port and city of Rotterdam to integrally develop the CityPorts area was adjusted.

Source : Daamen (2007).

3.3 Intensify regional cooperation

Cooperation at the city-region level

Cooperation at the level of the city-region is needed to sustain port growth in both Amsterdam and Rotterdam. In Amsterdam, cooperation is needed to agree on westward expansion of the port area on the territory of other municipalities than the municipality of Amsterdam. This requires long term planning, as the current port areas close to the city centre are active and well functioning port areas, unlike port sites that were transformed in other cities (such as the Hafencity-area in Hamburg and the South and West Harbours in Helsinki) which were often no longer very productive. Transformation of these port areas in housing or mixed development areas needs to be carefully planned, especially the timing and phasing out in order to avoid capital losses (Box 8). What would be needed is the development of a long-term strategic land use plan for the North Sea Canal area to plan the westward expansion of the port area, in cooperation between the municipalities and businesses along the North Sea Canal. Schemes could be implemented in which the port would be compensated for eventual land losses, similar to land swaps for the HafenCity-project in Hamburg.In Rotterdam, ongoing regional cooperation would be needed to sustain the existing port and industrial activity.

Box 8. Port-city co-existence in Amsterdam

Amsterdam case is a prime example of how an expanding city and a growing port try to co-exist. The border area between city and port is subject to active spatial claims. Space is scarce so there are hardly any derelict or run-down zones in the whole port. Given the economic growth of the city of Amsterdam and the attractiveness of the area near the old town center, the pressure to consider the redevelopment of parts of the port near the city is stronger than in Rotterdam. However, many of these parts are still in use for port activities, often by industries focusing on commodities and even manufacturing. The port is thus facing the city expansion policy of the Municipality of Amsterdam (the shareholder of the port). Wiegmans & Louw (2011) capture this tension as follows: "*In spatial terms, this means that the expansion of the port area has stopped, while the urban housing frontier is gradually encroaching on the existing, and now fixed, harbour area.*" The plan 2020 of the port of Amsterdam proposes the development of a 'transition zone' between the port and the city. The activities in the Minervahaven, an area of 7 ha, are planned to change from port activities to city activities (in particular the creative industries). A very elaborate discussion on possible scenarios for redevelopment is provided in the study "Port-City: Three prospects for the western IJ-banks" (Gemeente Amsterdam, 2009b).

The development of new living areas in Amsterdam very close to active industrial port areas is a source of contention in stakeholders' circles. Many of the new proposed housing developments, supported by a legal framework via spatial plans, would be very close to active industrial port activities. This could jeopardise the further developments of these companies given severe restrictions on noise and pollution levels. The Municipality realised this potential source of conflicts and in 2008 they reached an agreement with a number of port-related companies to restrict residential development in some older parts of the port (i.e. the Houthaven and NDSM-wharf area) and for the next 20 years to cease all new residential developments which might harm the companies concerned. After 2028 new developments would be possible (Wiegmans & Louw, 2011).

Cooperation between port clusters

The Dutch government traditionally wants to facilitate and encourage cooperation between ports, but does not want to impose this on ports. Actions towards the creation of a national port company or any other form of cooperation should mainly come from the ports themselves. The government only needs to step in when there is market failure, for example when there is abuse of market power or when external costs are too high or not optimally distributed. The need for more cooperation between ports is also echoed in the Mainport Network concept.

The port authorities of Rotterdam and Amsterdam have adopted a clear strategy of increased cooperation in a network perspective. In those areas where there are clear mutual interests and even commercially sensitive issues, the port authorities of Rotterdam and Amsterdam already work together, e.g. with respect to extended gates (Box 9), the Betuwe line (Box 10) and Portbase. Portbase is the joint Port Community System of the ports of Rotterdam and Amsterdam. Portbase was formed by a merger in October 2008 between Port infolink in Rotterdam and PortNET in Amsterdam. The owners are the Port of Rotterdam Authority (75%) and the Port of Amsterdam (25%). Companies and authorities in both ports can exchange information via the platform. The aim is to become the national platform for all ports and airports within the foreseeable future based on a new system that can communicate openly with other systems. This implies that airport Schiphol is scheduled to join Portbase in the foreseeable future.

Box 9. Circle lines: sustainable freight transport in the Randstad

The Port of Amsterdam Authority is promoting the role of Amsterdam as extended gate through 'Circle Lines' for container barges. Circle lines are daily inland waterway services linking industrial transhipment points along waterways with the Rotterdam container transferium and the port of Amsterdam hub. Larger barges or coasters bring containers from Rotterdam to Amsterdam and smaller barges distribute the containerised cargo further from Amsterdam to destinations in the northern part of Holland through a circle line or loop service. Despite the extra handling, the scale advantages of the barge concept in combination with time costs for trucks due to congestion on the road system make it competitive to use this system instead of direct trucking out of Rotterdam to the northern part of the Netherlands. The aim of Circle Lines is to optimise co-modality and unused capacity. The system links to other major centres such as Duisberg and Antwerp, developed with main shippers using the port of Rotterdam and Amsterdam, taking into account the whole transport chain, and based upon a cooperation agreement between the different actors in this chain, such as road transport, barges and container terminals. IT support has been integrated into the project so that administrative procedures can be done electronically. In the first 2 years of operation the national circles have achieved up to 50% reduction in cost and CO2 per TEU and 98% reliability for customers, according to the port of Amsterdam officials.

Box 10. The Betuweroute

The Betuweroute is a double track dedicated freight rail track towards Germany and into Europe. For the section from Rotterdam to the large shunting yard at Kijfhoek existing tracks were reconstructed, but three quarters of the line is new, from Kijfhoek to Zevenaar near the German border. The rail part in Germany is referred to as the Hollandstrecke. Together they formed project no. 5 of the Trans-European Transport Network program (TEN-T). The first discussions on the dedicated freight track go back to 1985. Work on the Dutch part of the track began in 1998. Before and during its construction the route generated a lot of controversy in political and community circles. In 2000 the Court of Audit stated that promoting river transport should have been considered as a realistic alternative. In 2004 the Centraal Planbureau concluded that the construction would never pay its way. Delayed by two years, the railway was finished mid 2007, at a cost of 4.7 billion euro, more than two times the original budget.

The Betuweroute is managed by Keyrail. The shareholders of Keyrail are Prorail (50% - Prorail is the rail infrastructure manager in the Netherlands), Rotterdam Port Authority (35%) and Amsterdam Port Authority (15%). In 2010, rail traffic on the 120 km stretch between Kijfhoek and Zevenaar increased by almost 80% to 17,600 trains. The market share of the Betuweroute in comparison with the other border crossings for freight transport by rail to and from Germany has increased to more than 70% in 2010 compared to 45% in 2009. The main motor behind this growth has been active tariff policy and the electrification – at the end of 2009 – of the Port Railway Line, the stretch between the Maasvlakte and the Kijfhoek shunting centre. As a result of this, many carriers switched from the 'mixed network' to the Betuweroute. In addition, the Port of Amsterdam got connected to the Betuweroute in March 2011 via a railway connection to the Betuweroute near Meteren/Geldermalsen. As such the Betuweroute is now serving both ports. Keyrail expects the number of trains on the Betuweroute to increase to 500 a week by the end of 2011 or a market share of about 75%. A key problem limiting capacity of the Betuweroute is that the German part - the final stretch Emmerich-Oberhausen - is still not completed. The German crisis package has earmarked money for this project.

Source: news releases of Keyrail, Port of Rotterdam and Port of Amsterdam and various specialised press articles.

A merger of the ports of Rotterdam and Amsterdam was proposed in 2010, in a report by a Dutch advisory body to the government (Raad voor Verkeer en Waterstaat, 2010). Also here, the plea for cooperation was focused on a more optimal use of resources: a merger could prevent resources from being wasted on competition or redundant investments. Closer cooperation or a merger between the two could lead to the creation of a Dutch network of ports ('Gateway Holland'). Amsterdam's Schiphol airport is seen as an example in this respect, since its operating company Schiphol Group[12] is already active in multiple locations in the Netherlands with each of the airports playing a specific role (e.g. Lelystad airport is focused on low cost carriers).

Although a merger might not be foreseeable, cooperation between the ports could indeed be intensified. This could entail a search for synergies between the ports that goes beyond shared information systems, joint marketing efforts, joint lobbying and exchanges on policies; this could take the form of a joint vision on the complementarities of both ports and ways to increase value creation for the Dutch economy. The perspective of corporatisation of the port of Amsterdam should also open the possibility of common investment projects with the port of Rotterdam, e.g. in extended gates and inland ports. In the longer term, cooperation might be stimulated by an exchange of shares, similar to cooperation found in Chinese port clusters, such as the Yangtze River Delta (Box 11).

Various mega-logistics regions in the world consider the presence of a large seaport and a large airport an advantage. O'Connor (2010) has observed that more diversified gateways (i.e. those possessing multiple airports and seaports within a radius of 70 km from the "core") generate bigger traffic and larger logistics sectors than more specialised gateways (i.e. those handling either air or sea freight). Although air and sea cargo sectors are in most continents fairly disintegrated (e.g. Ducruet and Van der Horst, 2009 for Europe), there are several cities, such as Hong Kong, Brisbane and San Pedro that have developed air-sea terminals where goods are shipped directly from one mode to another. A similar facility is available in Dubai Logistics City, aimed at increasing the possibilities for certain goods to be transported by a sea leg, followed by an air leg in order to reduce travel time. In 2009, Dubai's Port of Jebel Ali Free Zone joined forces with the Dubai Aviation City Corporation to form one of the largest multi-modal logistics platforms in the world linking sea, land and air cargo. Singapore has also the ambition to grow into a global integrated logistics hub (Box 12).

Box 11. Regional port governance in the Yangtze River Delta

The Yangtze River Delta includes major ports such Shanghai, Ningbo and Lianyungang. Since 2011, Shanghai is the largest container seaport in the world. The Yangtze River Delta regional port system involves three different jurisdictions, the Shanghai municipality and Zhejiang and Jiangsu provinces. Although regional port governance has for long been fragmented (Comtois and Dong, 2007), with intense competition between the main ports, Shanghai and Ningbo, current developments point towards more regional co-ordination, which takes the form of co-ordinated planning, common institutions, co-ordinated finance and co-ordinated operations.

An impetus for co-ordinated planning has been given by the national government. In the National Strategy for the Yangtze River Delta, approved in May 2010 by the State Council, a section on the regional port system lays out development directions and detailed plans for the ports' development and co-ordination. The plan positions Shanghai as the international shipping centre, Ningbo-Zhoushan as the regional hub, supported by other extension and feeder ports in the Yangtze River Delta. Moreover, development plan outlines have been detailed for individual ports, *e.g.* to accelerate general container port infrastructure in Shanghai port, to provide better port infrastructure in Ningbo port, in particular for iron ore and crude oil transportation. Such development outlines have also been applied to inland ports in the region, *e.g.* to develop several feeder ports and transit hubs in Jiangsu to provide connections between Shanghai and hinterland upper stream in the Yangtze River.

Although similar visions in the past have encountered implementation difficulties (Wang and Slack, 2004), there appear currently to be more institutional mechanisms to follow up on this strategy. All container port operations in the Yangtze River Delta are co-ordinated by a single entity, the Shanghai Port System Management Committee created in 1998. The committee is represented by the deputy minister of Communications, deputy mayor of Shanghai, deputy governors of Zhejiang and Jiangsu provinces, as well as senior government officials in charge of economic development and transportation from Shanghai, Zhejiang and Jiangsu. Moreover, since 2006, a Port Management Committee has co-ordinated administration of two nearby ports (Ningbo port and Zhoushan port) in the Zhejiang province. The two ports have subsequently been merged, as reflected in a new name – Ningbo-Zhoushan port.

This institutional co-ordination has been supported by financial participations of the main ports in the area. The two major ports in the Yangtze River Delta, the Shanghai Port and Ningbo Port, set up a joint ventue in 2010, Shanghai Port and Shipping Investment Co., Ltd., to invest in transport, shipping and ports, energy and related areas. Since each side holds around 50% shares of the joint venture, investment carried out by this joint venture is perceived to benefit both ports.[13] According to news sources, the two ports have started to discuss co-operation in more areas, such as co-ordination of future investments and operations.[14] Prior to that, Shanghai Port Group Corporation has invested since 2005 in several inland container terminals – Wuhan, Jiujiang, Nanjing and Chongqing, all upstream of the Yangtze River. As a result, container volume growth in cities such as Chongqing has been exponential (Notteboom, 2007).

Box 12. Singapore's ambition for integrated logistics

The government of Singapore aims to become an integrated logistics hub with robust maritime, aviation and land transport capabilities supporting the global economy. To ensure coordination among these various transportation modes, a champion agency was recommended to overlook the development of these capabilities. The Champion Agency will have the primary responsibility of promoting and developing Singapore into a leading global integrated logistics hub. It should allow and promote a collaborative and consensus-based policy making system and will spearhead and co-ordinate an integrated multi-organizational effort in collaboration with the private sector to promote and develop Singapore into a leading global integrated logistics hub (International Enterprise Singapore, 2002).

While Schiphol airport and the port of Rotterdam are both tagged as mainports, there is no common view in the Netherlands on the linkages between airport Schiphol and the ports of Rotterdam and Amsterdam. Van den Berg & Van Klink (1997) underlined that the mainport strategy of the 1990s for the first time related the two mainports to each other and underlined their role in attracting distribution and cargo control activities to the Netherlands. Cooperation between the ports and the airport is slowly

unfolding. Portbase, the port community system, is planned to be introduced on Schiphol airport. Within the framework of cooperation in Randstad Holland, further opportunities for cooperation have been considered. Remarkable is that the direct and indirect functional linkages are stronger between airport Schiphol and the port of Rotterdam than between the airport and the port of Amsterdam. This observation might be the result of the specific focus of the port of Amsterdam on mainly bulk commodities, while the port of Rotterdam shows a much stronger activity in EDC-related goods flows.

Cross-border cooperation

Cross-border cooperation could build on the strong inter-relation between the port and logistics clusters of Rotterdam and Antwerp (second port cluster in Europe) in terms of business and traffic relations, which would justify co-operation to sustain a joint petro-chemical cluster in the long term future. The call in the port vision 2030 for more intense cooperation between Rotterdam and Antwerp in view of creating an integrated cross-border chemical cluster, and the intention to get more cooperation with German inland ports are important indications that the Port Authority of Rotterdam seeks cross-border cooperation in Europe to support its ambitions as global hub.

The emergence of cross-border region of Randstad-Flanders-Brabant should be facilitated, in close connection to the Rhine Ruhr area. This region has all the potential to become the prime mega-logistics hub for Europe, one of the largest industrial clusters world-wide, and is already organically growing via business and transport links, but policies could help to resolve recent policy obstacles and signal a profound willingness for constructive cooperation. In that context, a common strategic development plan and vision on integrated and coordinated spatial development as well as joint investments could be concretised and expanded, based on a common understanding of regional synergies in the Randstad-Flanders-Brabant area. This could build on current cooperative initiatives such as the Flemish Dutch Delta (VND) and the investigation into a multi-year framework for infrastructure and space Antwerp-Rotterdam (MIRT-VAR). All relevant national and regional governments could be involved in such a vision and development plan, as well as the European Union, considering the important role that such a cross border region could play for the whole of Europe. In addition, there is a potential to build on the vicinity and differences of three important port-cities (Rotterdam, Amsterdam, Antwerp) as a source of metropolitan, poly-centric quality of life that could attract maritime services and business to the area.

This cross-border cooperation might also try to jointly resolve some common outstanding issues with the German national and regional governments. In early 2011, Rotterdam, Antwerp and Amsterdam were considering a joint shareholding of about 1/3 in the Port of Duisburg when the national German government announced it would in dispose of its shareholding in the Duisburger Hafen AG. However, the German government and the State of North Rhine-Westphalia were not very enthusiastic about allowing foreign capital in Europe's largest inland port and a key turntable for traffic to/from east Europe. While the joint offer of the ports still stands, it is more likely that the other shareholders, the city of Duisburg and the federal state of North Rhine-Westphalia, will extend their interest in case the central government would pull out of Duisburg. Earlier attempts of the Port Authority of Rotterdam to buy into the development of Neuss also failed for political reasons. Therefore the port authority is now moving towards a more cautious approach in dealing with German inland ports, for example by first considering joint ventures in the development of new port-related sites.

With respect to port hinterland coordination, there is on-going cooperation of the port of Rotterdam with inland ports in the Netherlands, such as Moerdijk, Dordrecht and Tilburg, as well as foreign inland ports, such as Duisburg. Since 2011 the municipality of Dordrecht and the port authority of Rotterdam intensified mutual cooperation. The port of Dordrecht now is an integral part of the industrial and port complex and of the international network of Rotterdam. The port authority of Rotterdam makes its expertise available for the development of business sites. Also since 2011, the nautical management in the

ports of Dordrecht, the Merwede ports and the ports of Papendrecht and Zwijndrecht is controlled by the port captain service of Rotterdam. Also contract and account management of the area is now under the responsibility of the Port Authority of Rotterdam.

At a wider geographical scale, port cooperation takes place with emerging market ports in Oman and Brazil. Rotterdam and Amsterdam have sister port agreements with a large number of ports in overseas areas (often with ports in emerging economies such as India, Brazil and China). Particularly Rotterdam is also sharing know-how in the development of new ports. For example, the strategic links with the Port of Sohar in Oman reinforce the chain management of the Port of Rotterdam and the expansion of the international competitiveness. The Port Authority is part of a joint venture with the Sultanate of Oman for the development of an industrial port: the Sohar Industrial Port Corporation. The Port Authority supplies knowledge above all, while the government provides the resources for developing the infrastructure. Besides knowledge transfers and the strengthening of typical 'Dutch' competencies in the areas of port design, port construction and port management, the Sohar-connection also brings in concrete orders for Dutch trade and industry. The port authority also entered into an agreement with the port of Suape (Brazil).

3.4 Expand smart funding models

Stimulate funding models that take into account the positive and negative externalities of port development. Port development is very capital-intensive and investments are almost always needed to facilitate maritime access and hinterland connectivity; a considerable share of these investments is done by the public sector. Not all costs and benefits of port development can be monetized, so an assessment of the return on investments of these public investments is complicated. However, economic logic would require that negative externalities be internalised and that private rents from public infrastructure investments be recovered. Such logic is all the more relevant to the ports of Rotterdam and Amsterdam with their large spillovers across national borders, identified in earlier chapters.

Environmentally differentiated port dues

Rotterdam and Amsterdam have introduced environmentally differentiated port dues, based on the environmental ship index (ESI). Both ports have adhered to the environmental ship index, which expresses the environmental performance of ships (Box 13), and apply a reduced port due for vessels that have good scores on this ESI. For example, the port of Amsterdam, gives a rebate on the port due, ranging from EUR 200 to EUR 1400 in 2012, depending on the size of the vessel. The port of Rotterdam announced in 2011 that it would give a rebate on the port dues to the 25 cleanest ships that would call the ship. The amount of reductions in port dues in Rotterdam related to this were EUR 40,000 in 2011 and EUR 600,000 in 2012, according to the Rotterdam port authority.

Box 13. Environmental Ship Index

The Environmental Ship Index is an instrument to determine the environmental performance of ships with respect to air pollutants and CO_2. The idea of the index is that ports can reward ships that score high on this environmental ship index, by providing them with lower port dues. The ESI measures a ship's emissions based on the amount of nitrogen oxide (NO_x), sulphur oxide (SO_x), particulate matter (PM) and greenhouse gas it releases. It is a voluntary system, open to shipping companies, ship owners and ports. The ESI uses a formula to provide points to ships according to their environmental performance, considering current international legislation, mainly the International Maritime Organization (IMO). There are currently 1439 ships with a valid ESI score and 18 ports participating, including Rotterdam, Hamburg, Antwerp, Le Havre, Los Angeles and New York/New Jersey. The ESI was developed in the framework of the World Port Climate Initiative (WPCI), committing to reduce the greenhouse gas (GHG) emissions due to port activity. The ESI ship database is filled and administrated by the ESI Bureau of the International Association of Ports and Harbors (IAPH).

The effect of these incentives is for the moment fairly small, as the number of vessels that qualify for reduced port dues is limited. Although the reductions in port dues indicated in the previous paragraph are not marginal, the number of vessels that have favourable environmental ship index scores remains fairly limited in comparison to the total number of ports calling the port, so one could wonder about the impact of the programme. As the number of ships integrated in the ESI is steadily rising, the perspectives for effectiveness will rise, but so will the consequences for the budgets of the participating ports, as the rebates have so far not been financed by a simultaneous rise in the dues for the other ships (the non-ESI vessels). In order to improve the impacts of this programme, it should be closely monitored on effectiveness and be fine-tuned, where necessary. The port authorities of both Rotterdam and Amsterdam could also consider – in addition to the current bonus-system – to introduce a malus-system as well, like in Sweden were more polluting ships pay higher port dues (Box 14).

Box 14. Environmentally differentiated port dues in Sweden

Sweden has applied environmentally differentiated port dues since 1996, following an agreement between the Swedish Maritime Administration, Ports of Sweden and the Swedish Ship-owners Association to reduce NO_x and SO_2 emissions from ships. This agreement has led to environmentally differentiated fairway and port dues. The fairway dues are mandatory and consist of two parts, one based on the volume of goods loaded/unloaded and one based on the ship's gross tonnage. The latter part is environmentally differentiated and relates to NO_x and SO_2; the differentiation for No_x is given as a reduction to the first part of the fairway due and divided into several emission levels with the ships fulfilling the strictest requirements exempted from the due. For sulphur there is a surcharge added, divided into three levels, if the sulphur content of the fuel exceeds 0.20%. Contrary to the fairway dues, the environmental differentiation of the port dues was voluntary but all large Swedish ports have introduced these. E.g. the port of Gothenburg has sulphur charges (divided in three classes) and nitric oxide discounts (in three classes). There are different assessments of these environmentally differentiated port dues. According to Swahn (2002), they have imposed strong incentives for reducing emissions, whereas Kageson (1999) states that the dues were not differentiated enough to present an actual incentive for ship operators to reduce emissions.

Road pricing for trucks

The Netherlands has a long history of planning for road pricing and congestion charging, but never managed to implement such a system. As a comprehensive road pricing scheme for all traffic categories has proved to be difficult to introduce in the Dutch constellation, priority was given by previous governments to introduce a scheme for truck traffic on highways and major roads, but also this proposal has never been implemented. The Rutte 2-government has excluded the possibility to introduce road pricing.

The "Eurovignette" could be considered a toll for trucks, albeit an imperfect one. This is a common system of user charges of heavy goods vehicles above 12 tonnes, operational in the Netherlands, Belgium, Luxembourg, Denmark and Sweden. This system allows hauliers after the payment of a specified amount to use motorways of the participating member states for a given period (a day, a week, a month or a year). Its main setback is that it is not related to the actual use of the road, unlike distance-based truck user fees such as the LKW-Maut in Germany. Since the adoption of the directive 2011/76/EU of the European Parliament and the Council of 27 September 2011, it is possible to internalise externalities in the Eurovignette, e.g. by imposing a surcharge in peak hours.

In the short run, the potential of the Eurovignette should be used to internalise some of the negative effects of port hinterland traffic. There are at least two of these externalities to be tackled. Firstly, a surcharge in peak hours could reduce congestion related to port hinterland traffic, provided that their

schedules are flexible. Secondly, by applying this surcharge more heavily on the dirty truck classes, the air emissions externalities could to some extent be tackled. This seems to be suggested by the government programme of the Rutte 2 government. However, as the Eurovignette remains time-based rather than distance-based, not the actual externalities but the presumed externalities are taken into account.

In the medium term, introduction of a distance-based user charge for trucks could be introduced. This would more directly relate costs and external costs to the users of the infrastructure. Neighbouring countries of the Netherlands have either already introduced such a system (Germany, Switzerland), or are considering introducing it (Belgium and Denmark), which would mean the end of the Eurovignette. Therefore, there should be a reflection on how the Netherlands would like to charge heavy vehicles in the medium term, in order to make sure that infrastructure costs but also externalities from freight traffic are being recovered. This could mean a harmonized distance-based user fee for trucks, in line with those developed elsewhere in Europe. Within the ports, the port authorities should have the possibility to introduce to charge for externalities, e.g. by introducing a traffic mitigation fee similar to the one that was introduced in the ports of Los Angeles and Long Beach, a fee that is charged for trucks entering the port during peak hours, giving drivers the option to pay the premium cost of accessing the port during the peak or to shift travel times to avoid the fee.

European transport funding

The involvement of the EU in port and transport infrastructure funding takes place within the framework of Trans-European Networks Policy. A new proposal for the development of the Trans-European Transport Network (TEN-T) was published by the European Commission in October 2011, with the aim to transform the existing patchwork of European roads, railways, airports and canals into a unified transport network (TEN-T). The new policy concentrates on a much smaller and more tightly defined transport network for Europe. The aim is to focus spending on a smaller number of projects where real EU added value can be realized, by implementing a dual-layer approach, consisting of a core network and a comprehensive network. Both layers include all transport modes: road, rail, inland waterways, air and maritime transport, as well as intermodal platforms. The comprehensive network constitutes the basic layer of the TEN-T, consisting of all existing and planned infrastructure of the TEN-T network, planned to be in place by 31 December 2050 at the latest. The core network overlays the comprehensive network and consists of the strategically most important parts of the TEN-T network, constituting the backbone of a multimodal transport network, to be completed by 31 December 2030 at the latest.

The future core network proposed by the EC will comprise of 83 main European ports with rail and road links, 37 key airports with rail connections into major cities, 15,000 km of railway line upgraded to high speed, 35 cross border projects to reduce bottlenecks. Rail, road and inland waterway connections between these nodes will carry traffic flows of the highest strategic importance. Within the core network, 10 corridors have been established, that should be connected with a maritime port. Both Amsterdam and Rotterdam are included in these core networks, along with many other European ports. Amsterdam is included in the "Amsterdam-Berlin-Warsaw"-corridor, and Rotterdam in the "Rotterdam-Genoa" corridor; and both port-cities are included in corridors with Paris and Marseille. The financial facility related to this policy is the Connecting Europe Facility (CEF) with a total budget of EUR 31.7 billion dedicated to the transport sector, including EUR 10 billion from the Cohesion Fund, set aside for transport projects in cohesion countries.

The CEF could be focused on hinterland-related projects with real cross-border spillovers, using a more focused conception of core European ports. As our study illustrates, both the port of Rotterdam and Amsterdam have hinterlands and spillovers beyond the boundaries of the Netherlands, so they serve larger than national interests. This is much less the case for the majority of the 'core ports' that in many cases play a regional role, not even a national one, let alone a supra-national role. The risk of underinvestment in

these ports and their networks could be considered limited, as it is the same regional or national territory that does the investments that will be able to benefit from the investments. Although the TEN-T might in part also be designed in a way to counter-balance the supremacy of North-West European ports, it also risks stimulating freight corridor development that have only limited supra-national interest. Hence, in the concrete decisions on the use of the CEF, care should be taken to prioritise projects with cross-border spillovers, including those with seaports of supra-national interest such as Rotterdam and Amsterdam.

However, the need for supra-national coordination might be larger. A European approach could also be developed for cost recovery of port infrastructure investments, in order to limit private rents from public investment in seaport infrastructure. More transparency and coordination in this respect might also help to avoid that public subsidies are used to lower (and thus distort) port tariffs, leading to unfair competition. The currently on-going EU Ports Policy Review might facilitate this transparency and greater market access. In an area such as North West Europe with several ports with huge ambitions for expansion, there is a risk of overcapacity, and thus a waste of public money. European rules for port funding, but also some form of coordination between the main countries concerned, should help to minimise this risk. The European Union could also have a role in promoting standardisation and funding for on shore power supply and LNG fuelling in major European ports, the costs of which could be recovered on shipping companies using these ports. Such an approach might be particularly effective if linked to the Short Sea Shipping and Motorways of Sea-programmes, as these vessels remain in Europe so could be more easily covered by European standardisation.

ANNEXES

ANNEX 1: EFFICIENCY 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 literature[15] [16](Cheon, *et al.*, 2010; Wu and Goh, 2010; Martinez-Budria, *et al.*, 1999; Wang and Cullinane, 2006; Al-Eraqui, *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 inefficiency[17]. However, use of the Bonilla (2000) and Barros (2007) bootstrapping[18] 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).[19]

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

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, sidelifts, reach stackers, or container lorries used to manoeuvre underneath the crane base and collect the containers) were taken into account.

Table 19. 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

Crude oil

The sample includes 71 major worldwide ports. The regional pattern reflects a noticeable imbalance in the distribution of terminals across the world. About two-thirds of the sample oil ports are concentrated in Asia (with 34% in the East/Southeast and 24% in the western/southern), while the remaining ports are located in Europe and North America (respectively accounting for 24% and 10% of the total sample). Table x shows the input variables specific to the sample oil ports. Capital inputs are proxied by the capacity of terminal reception of oil tankers, such as quay/jetty lengths, maximum vessel capacity, canal draught/depth and tank storage capacity. Labour input is proxied by the loading capacity of equipment as measured by their discharge rates (tonne/hour) and pipeline/loading arm capacity (diameter in mm).

Table 20. Descriptive statistics of input/output variables of the crude oil port sample

Oil terminal sample	Output May 2011	Quay length	Max vessel capacity (dwt)	Max draught/depth	Tank storage capacity	Discharge rate (t/h)	Pipeline/loading arm capacity
Average	**2,665,512**	**1,833**	**250,346**	**19**	**2,300,030**	**32,016**	**9,623**
Max	33,557,799	16,222	750,000	50	7,092,000	112,000	25,245
Min	2,247	100	2,000	5	123,211	382	2,040
Normalised standard deviation	1.98	1.40	0.66	0.44	1.04	1.13	0.85
N (non missing)	71	52	47	66	9	11	12

Source: own data collection

Coal

The coal bulk port sample includes 34 of the largest ports across the world. The regional distribution of the sample is broadly well balanced across Asia, America and Oceania, while Europe tends to be under-represented. Capital inputs used by dry bulk terminals dedicated to handling coal are proxied by specific terminal quay length and their storage capacity. Labour input is approximated by the capacity of terminal handling equipment ranging from 1 to 39 thousand tonnes per hour over the sample.

Table 21. Descriptive statistics of coal bulk terminals/ports sample

Coal bulk terminal sample	Output May 2011	Quay length (m)	Storage capacity (tonnes)	Loading/unloading (total capacity per h)
Average	2,178,910	1,020	2,648,195	10,863
Max	7,787,066	4,215	10,425,000	39,000
Min	41,688	235	350,000	1,000
Normalised standard deviation	1.00	0.94	0.95	0.97
N (non missing)	34	33	28	27

Source: own data collection

Grain

The data sample covers 41 grain ports/terminals worldwide. The sample is equally distributed across the main regions, such as Asia, North and South America, followed by Oceania, Europe and to a smaller extent, Africa. However, the sample is marked by a greater volatility in output around the mean (as indicated by the normalised standard deviation compared to other commodities) suggesting that the sample may reflect very large imbalances in size across grain ports/terminals. Input variables collected are specific to grain terminals. Capital inputs are proxied by quay lengths, and grain storage capacity, and labour input is proxied by loading grain equipment as measured by the loading capacity ranging from 400 tonnes to 20 000 tonnes loaded per hour.

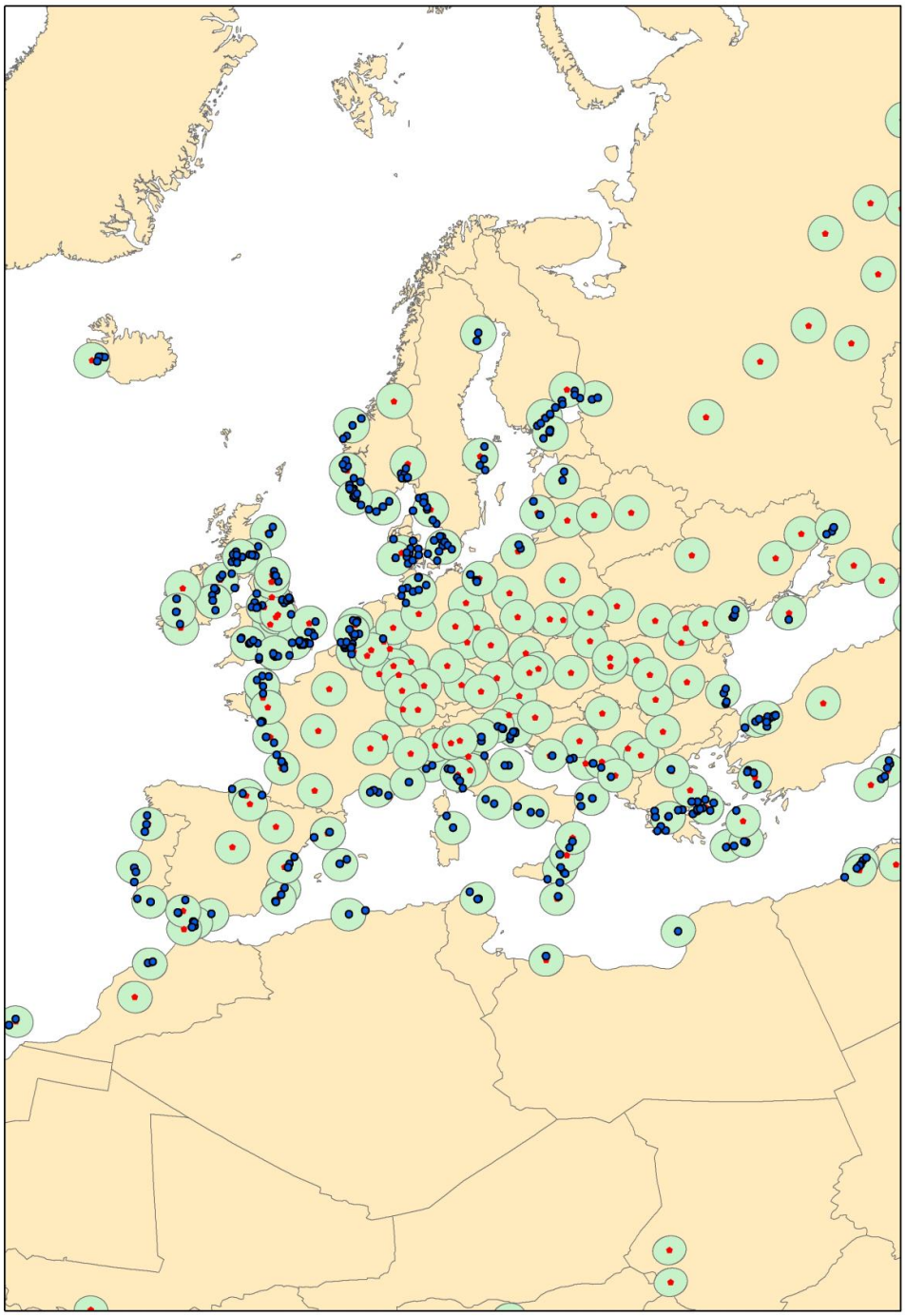
Table 22. Descriptive statistics of grain ports/terminals sample

Grain terminal sample	Output May 2011	Quay length (m)	Storage capacity (Tonnes)	Loading capacity (per h)
Average	**769,881**	**656**	**413,097**	**4,963**
Max	3,450,208	3,484	2,470,000	20,000
Min	4,942	100	27,945	400
Normalised standard deviation	1.26	1.04	1.38	1.05
N (non missing)	41	39	33	36

Source: OECD database.

ANNEX 2: AIRPORT-SEAPORT OVERLAPS

Figure 44. Proximity of seaport and airports in Europe



Source: Own elaborations based on data Marine Intelligence Unit Lloyd's List and database École Nationale de l'Aviation Civile (ENAC).

There are seaport-airport connections in relation to cruise traffic, particularly in Amsterdam. With approximately 200,000 cruise passengers per year and an estimated economic impact of €67 million (according to ZKA Consultants, 2004), Amsterdam is one of the more important cruise destinations in North West Europe. In terms of value added for the local economy, start or end calls in cruise loops are considered to be the most interesting as they provide most opportunities for customers to spend additional money associated with a longer stay in the city. International airline connections play a role in determining where cruise loops start or end. Amsterdam has a large potential in this respect, as its airport has considerably more direct international connections than other North West European cities that could be considered competitors with respect to home cruise destinations, such as Copenhagen and Hamburg. This seaport-airport connection is less important for Rotterdam as it welcomed only around a quarter of the number of cruise passengers coming to Amsterdam.

There is not a lot of overlap between the goods transported via Schiphol airport and the port of Rotterdam. Generally, air cargo is high value cargo for goods that are perishable or where short delivery times are important (spare parts). Schiphol airport does not disclose data on the different sorts of goods transported, but some indications are given in different reports by the Districon consultancy firm over 2004 (Nederland Distributieland, 2009a). According to their data, almost half of the imports via Schiphol are plants (perishable), a quarter is electronic goods and the rest of the imports are textiles, chemicals, animal products, optical instruments and transport equipment. It is not evident to match these data with the imported goods via the port of Rotterdam, as the definitions of the goods categories are not the same. However, it is possible to make some indicative estimations. The areas with the largest potential overlaps are in plants (perishable), electronics and transport equipment, although it cannot be established that the same types of goods are covered by these categories. There is no overlap with respect to animal products and only marginally with respect to textiles. It is not known if the same kind of chemicals are transported both by air and sea, nor is it known if optical instruments are imported via the port of Rotterdam. As can be illustrated by table 4, the types of goods transported via Schiphol make up only a very small part of the goods transported via the port of Rotterdam.

This does not necessarily mean that there are no synergies to be reaped. The volumes might be small (for the port of Rotterdam) but the value could be high. In the 1980s and 1990s, a lot of logistics companies chose a location close to airport Schiphol. While the cargo flows were mostly related to the port of Rotterdam, these companies chose a location near Amsterdam to benefit from the high quality business environment (Erasmus University of Rotterdam, 2010). Moreover, technological developments might increase the overlap: fresh flowers and flower bulbs, traditionally transported by air, are now increasingly transported over sea in cooled containers.

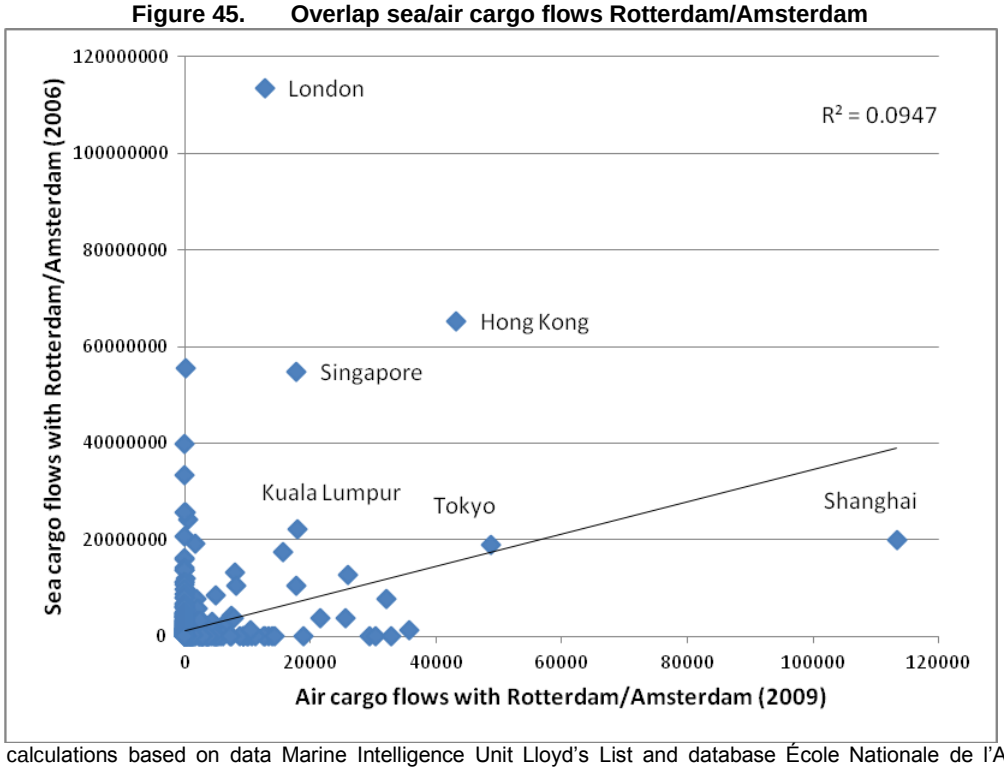
Table 23. Goods imported via Schiphol airport and the port of Rotterdam

	Share of imported cargo via Schiphol airport (volumes)	Share of imported cargo via Port of Rotterdam (volumes)
Plants (perishable)	45%	0.06%
Machines/electronics	24%	0.08%
Textiles	7%	0.00%
Chemicals	5%	n.a.
Animals/animal products	5%	0.00%
Optical instruments	4%	n.a.
Transport equipment	1%	0.05%
Others	9%	n.a.

Source: own calculations based on Districon data cited in Nederland Distributieland 2009a, and data port of Rotterdam.

The global connections of Schiphol airport and the port of Rotterdam overlap to some extent. This can be established by comparing the links of Rotterdam/Amsterdam with other metropoles via their ports and airports (these links are weighted according to the traffic flows between each pair or ports and airports). The maritime and air cargo connections of Rotterdam/Amsterdam show a correlation of 0.09, which indicates that most of the connections of the port of Rotterdam are different ones than those of Schiphol airport. This is of course to some extent inevitable, as some large cities with large airports are not located at a coastline. Still, it appears that some cities are strongly connected to Rotterdam/Amsterdam both via sea cargo and air cargo flows; this is for example the case with Shanghai, Hong Kong, Singapore and Kuala Lumpur.

Figure 45. Overlap sea/air cargo flows Rotterdam/Amsterdam

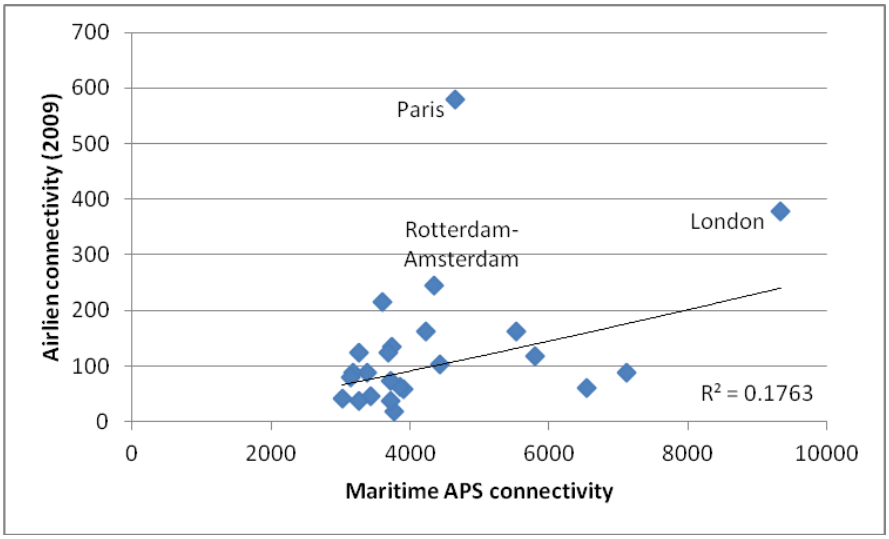


Source: Own calculations based on data Marine Intelligence Unit Lloyd's List and database École Nationale de l'Aviation Civile (ENAC).

The strong position of Rotterdam in advanced maritime services and maritime headquarters might be related to the passenger hub function of Schiphol airport. The probability of headquarters locating in a metropolitan area increases substantially in cases where the region's airport(s) function as airline hubs. Headquarters are important for a regional economy because they attract high value-added business services. A study on the location of headquarters in the EU showed that a 10 increase in the provision of intercontinental flights leads to a 4% increase in the number of headquarters located in the urban area (Bel and Fageda, 2008). The strong position of Schiphol airport is generally acknowledged as one of the factor that might explain the large share of headquarters and advanced producer services in Amsterdam. As Schiphol airport is also very close to Rotterdam, it could also explain the prominent position of Rotterdam in advanced maritime services, as documented by Jacobs et al. 2010 and 2011. Preliminary results indicate a moderate correlation between the top 25 world cities in maritime services and their passenger airline connectivity (Figure 16), but the results are hugely impacted by a large outlier (Paris) and more significant results could arguably be found by extending the group of cities to also include less important cities in global maritime services. It has been suggested that the presence of head offices in the petro-chemical industry in the Randstad could also be the result of the presence of both a large seaport and a large airport (KIM, 2007). Although this remains to be proven, there are similar cases elsewhere: Houston is an example

of a metropolitan area with a large concentration of head offices in the petro-chemical industry and both large seaport and airport.

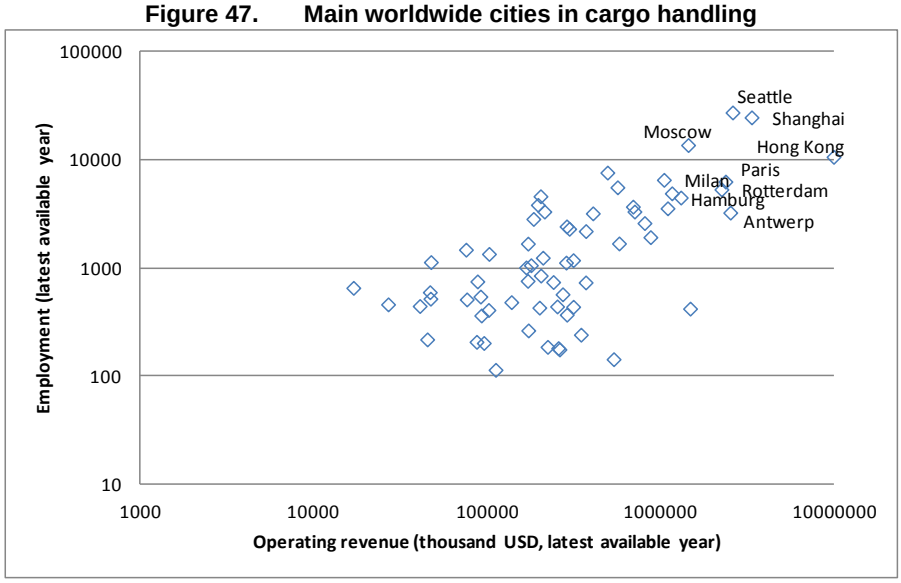
Figure 46. Link between airline connectivity and advanced maritime service head offices



Source: Own calculations based on data Marine Intelligence Unit Lloyd's List and database École Nationale de l'Aviation Civile (ENAC).

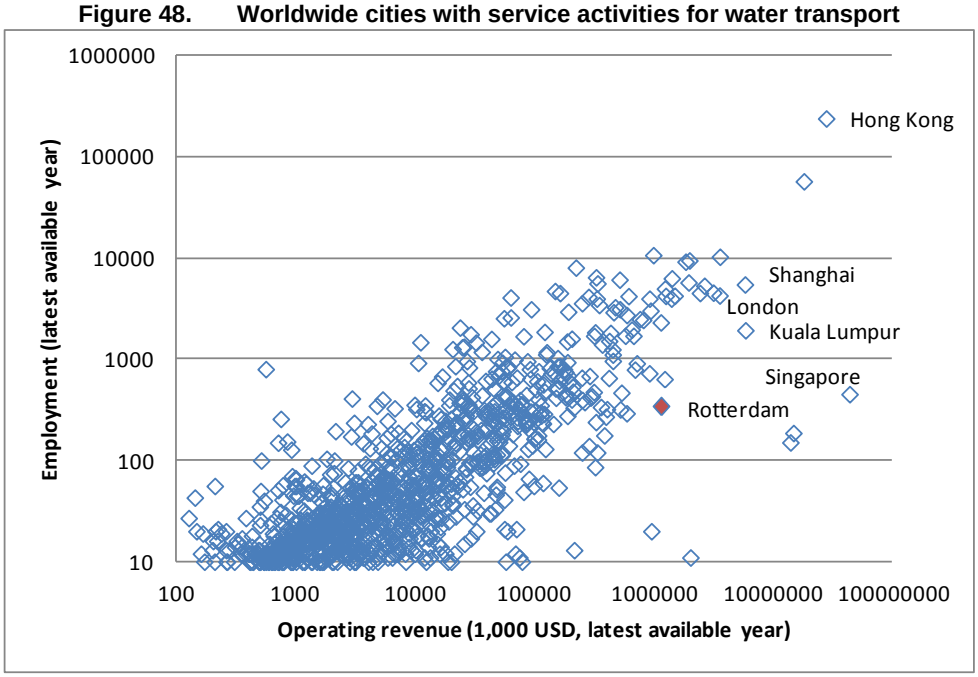
ANNEX 3: ADVANCED MARITIME SERVICES AND PORT-RELATED HEADQUARTER FUNCTIONS

Figure 47. Main worldwide cities in cargo handling



Source: own compilation on the basis of ORBIS database (extraction 13 Feb 2012). Note: the dots in the figure indicate the main 72 cities where firms are located active in the Nace Rev 2 sector 5224 "service activities incidental to water transport". The scores correspond to the totalised operating revenue and total jobs in this sector per city. Cities in which operating revenues in this sector are lower than USD 10 million, or with less than 100 jobs in this sector, have been excluded from this selection.

Figure 48. Worldwide cities with service activities for water transport



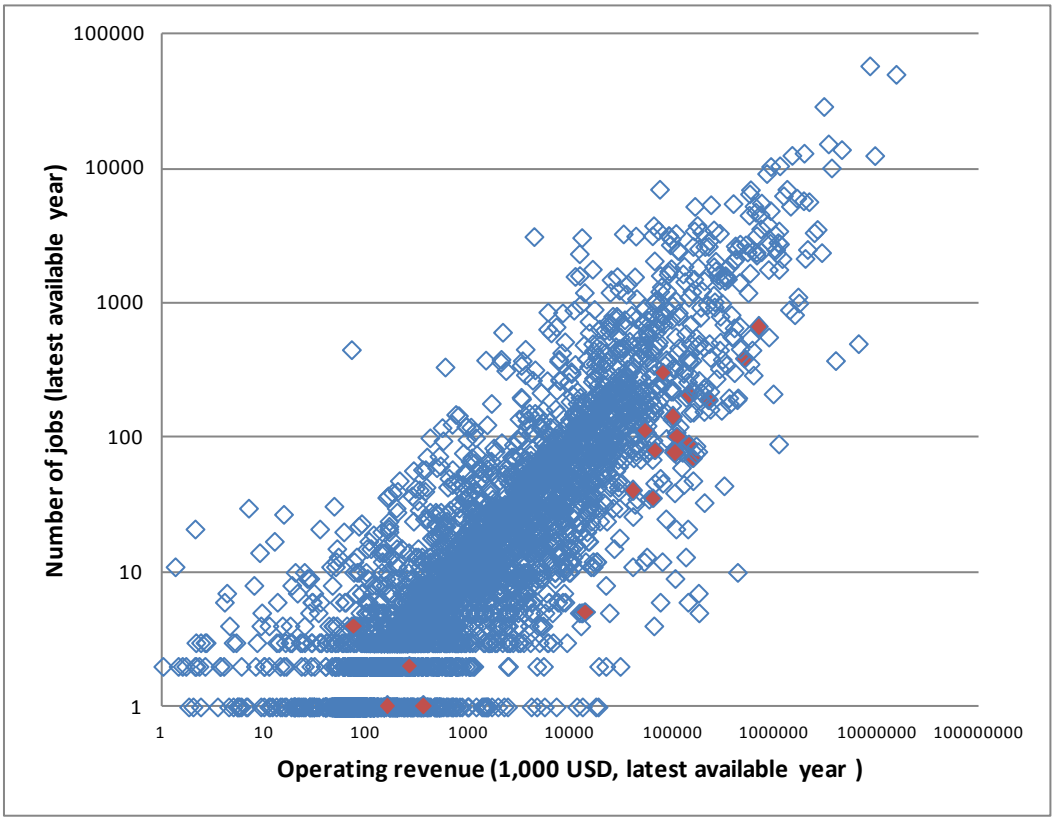
Source: own compilation on the basis of ORBIS database (extraction 13 Feb 2012). Note: the dots in the figure indicate the 3036 cities (localities) where firms are located active in the Nace Rev 2 sector 5222 "service activities incidental to water transport". The scores correspond to the totalised operating revenue and total jobs in this sector per city. Cities in which operating revenues in this sector are lower than USD 100,000, or with less than 10 jobs in this sector, have been excluded from this selection.

Table 24. Location of the leading dredging companies in the world (2011)

Firm	Number of dredgers	City	Metropolitan region	Country
Royal Boskalis Westminster	182	Papendrecht	Rotterdam	Netherlands
Van Oord	135	Rotterdam	Rotterdam	Netherlands
DEME	71	Zwijndrecht	Antwerp	Belgium
Jan De Nul	71	Aalst		Belgium
CHEC	36	Beijing	Beijing	China
Inai Kiara	35	Shah Alam	Shah Alam	Malaysia
De Boer	34	Sliedrecht	Rotterdam	Netherlands
Rohde Nielsen	30	Copenhagen	Copenhagen	Denmark
Great Lakes	28	Oak Brook (Ill.)	Chicago	US
Manson	28	Seattle	Seattle	US
Jaisu Shipping	23	New Kandla	New Kandla	India
Rukindo	23	Jakarta	Jakarta	Indonesia
Dharti	21	Hyderabad	Hyderabad	India
Weeks Marine	18	Cranford (NJ)		US
DCI	17	Visakhapatnam	Visakhapatnam	India
NMDC	16	Abu Dhabi	Abu Dhabi	UAE
Josef Mobius	16	Hamburg	Hamburg	Germany
Toa Corp.	12	Tokyo	Tokyo	Japan
GIE Dragages Ports	12	Rouen	Rouen	France
Hanjin	12	Busan	Busan	South Korea
FRPD	12	New Westminster	Vancouver	Canada
Cherazmorput	11	Odessa	Odessa	Ukraine
Penta-Ocean	11	Tokyo	Tokyo	Japan
Groupe Drapor World	10	Casablanca	Casablanca	Morocco
Geluk	10	Doetinchem		Netherlands
Van den Herik	10	Sliedrecht	Rotterdam	Netherlands

Source: own elaborations on the basis of the dredging database at www.dredgingpoint.org

Figure 49. Worldwide cities with ship building activities



Source: own compilation on the basis of ORBIS database (extraction 13 Feb 2012)
Note: the dots in the figure indicate the 5453 cities (localities) where firms are located active in the Nace Rev 2 sector 301 "ship building". The scores correspond to the totalised operating revenue and total jobs in this sector per city. Cities and localities indicated in red are located in the Netherlands.

Figure 50. Leading ship finance institutions (shipping portfolio 2009, in bn USD)

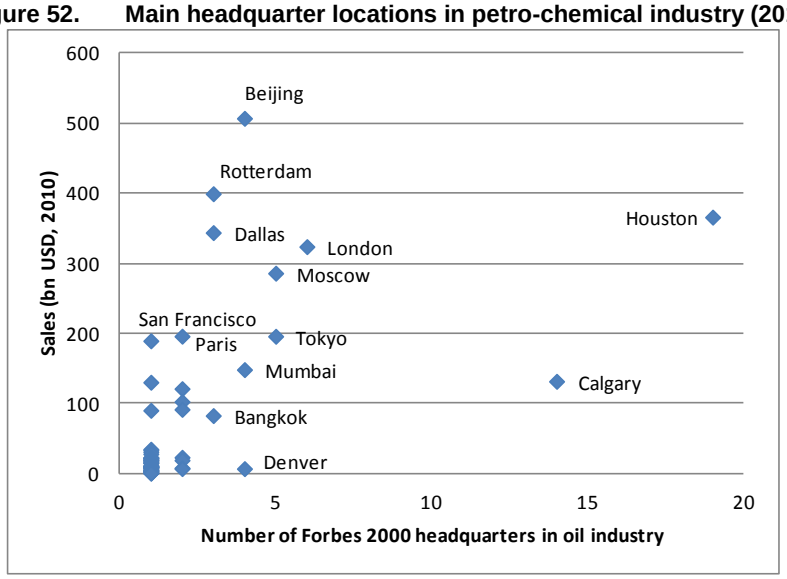
Financial institution	Shipping portfolio	City	Country
HSH Nordbank	49.3	Hamburg	Germany
Deutsche Schiffsbank	33.3	Hamburg/Bremen	Germany
DnB NOR Bank	28.0	Oslo	Norway
RBS	23.0	Edinburgh	United Kingdom
KfW	20.3	Frankfurt	Germany
Nordea	18.4	Stockholm	Sweden
BNP Paribas	18.0	Paris	France
Lloyds Banking Group	16.9	London	United Kingdom
Credit Agricole CIB	13.9	Paris	France
DVB	13.1	Frankfurt	Germany
Bank of China	12.2	Beijing	China
UniCredit	11.4	Rome/Milan	Italy
Danish Ship Finance	11.3	Copenhagen	Denmark
Bremer Landsbank	9.8	Bremen	Germany

Deutsche Bank	9.5	Frankfurt	Germany
Citi	8.0	New York	United States
Danske Bank	8.0	Copenhagen	Denmark
SEB	6.1	Stockholm	Sweden
Natixis	4.8	Paris	France
ICBC	4.7	Beijing	China
Fortis Bank Netherlands	4.2	Brussels/Utrecht	Netherlands
Helaba	3.0	Frankfurt/Erfurt	Germany
KDB	3.0	Seoul	South Korea
Alpha Bank	2.8	Athens	Greece
Marfin	1.9	Newa Erythraia	Greece
Bank of Ireland	1.4	Dublin	Ireland

Figure 51. Ship finance institutions with largest deal ship finance deal values over Q1-3 2011

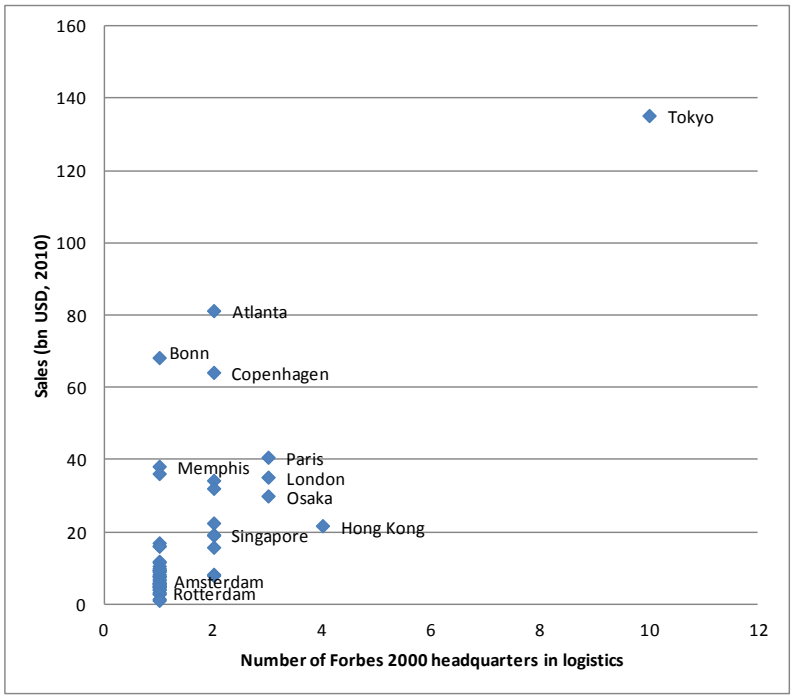
Financial institution	Deal value USD Mn (Q1-3 2011)	City	Country
Nordea Bank	6887	Stockholm	Sweden
DnB NOR Bank	5926	Oslo	Norway
Citi	2325	New York	United States
ING	1802	Amsterdam	Netherlands
Deutsche Bank	1660	Frankfurt	Germany
ABN Amro Bank	1502	Amsterdam	Netherlands
Bank of America Merrill Lynch	1482	New York	United States
Sumitomo Mitsui Financial Group	1249	Tokyo	Japan
JPMorgan	1144	New York	United States
Wells Fargo Securities	1023	San Francisco	United States
SG Corporate & Investment Banking	754	Paris	France
Mizuho	701	Tokyo	Japan
RBS	682	Edinburgh	United Kingdom
BNP Paribas	676	Paris	France
Swedbank First Securities	668	Stockholm	Sweden
Credit Agricole CIB	655	Paris	France
SEB	593	Stockholm	Sweden
UniCredit	461	Rome/Milan	Italy
Danske Bank	435	Copenhagen	Denmark
Santander	432	Santander	Spain

Figure 52. Main headquarter locations in petro-chemical industry (2010)



Source: own elaboration based on data in the Forbes 2000 ranking from 2011.

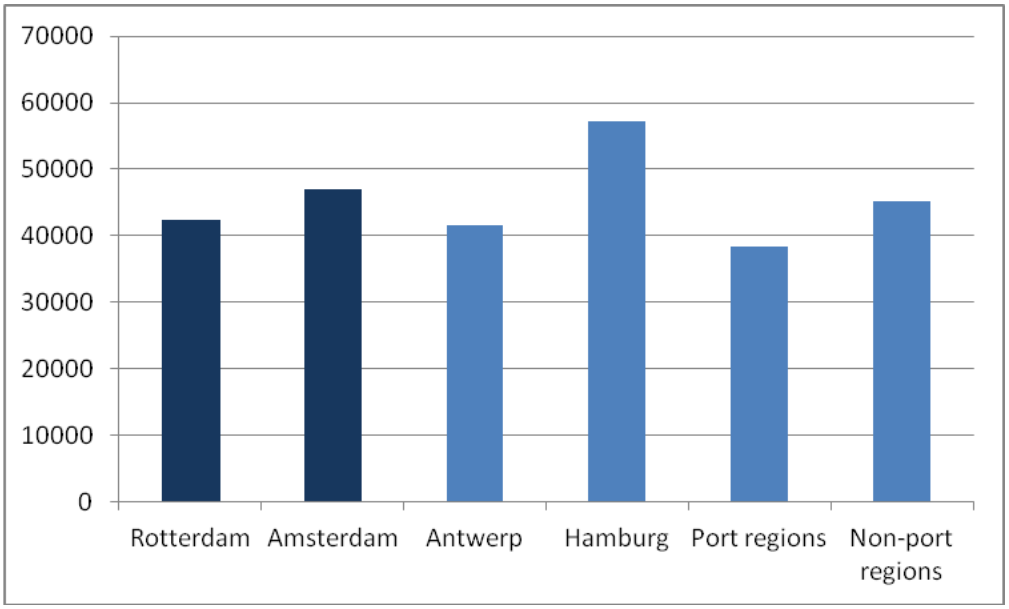
Figure 53. Main headquarter locations in logistics industry (2010)



Source: own elaboration based on data in the Forbes 2000 ranking from 2011.
Note: the logistics industry is here defined as the combined sectors in airlines, air couriers, railroads, trucking, containers and packaging, other transportation.

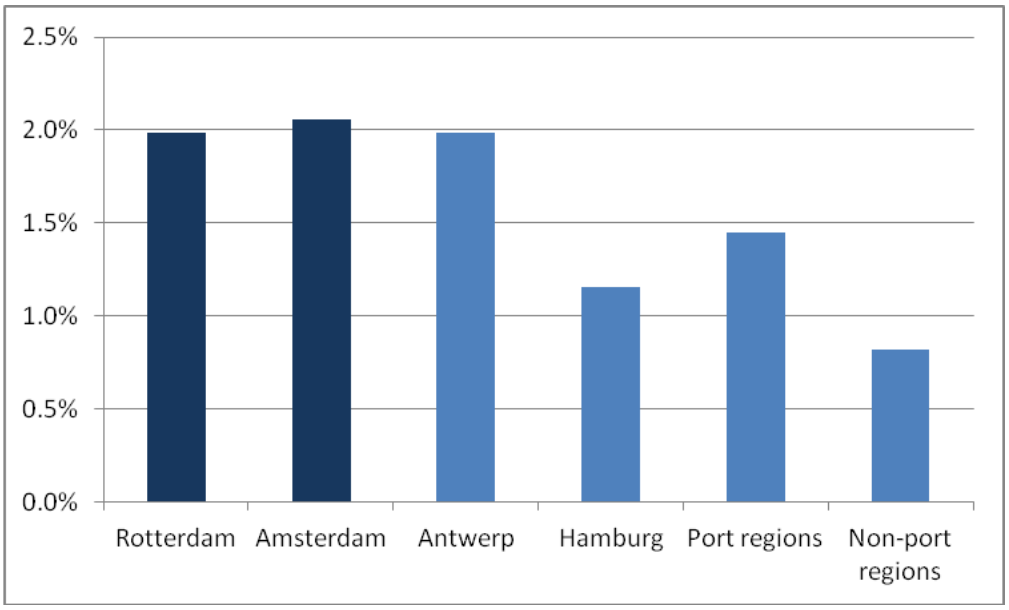
ANNEX 4: SOCIAL PORT-CITY INDICATORS

Figure 54. GDP per capita in port-regions (2008)



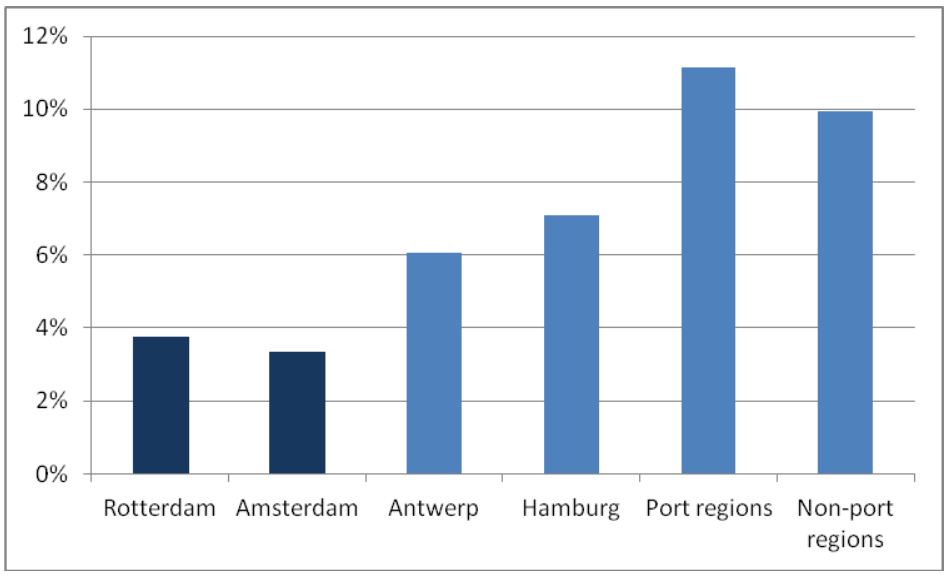
Source: OECD Regional Database

Figure 55. Real average annual GDP growth (2001-2008)



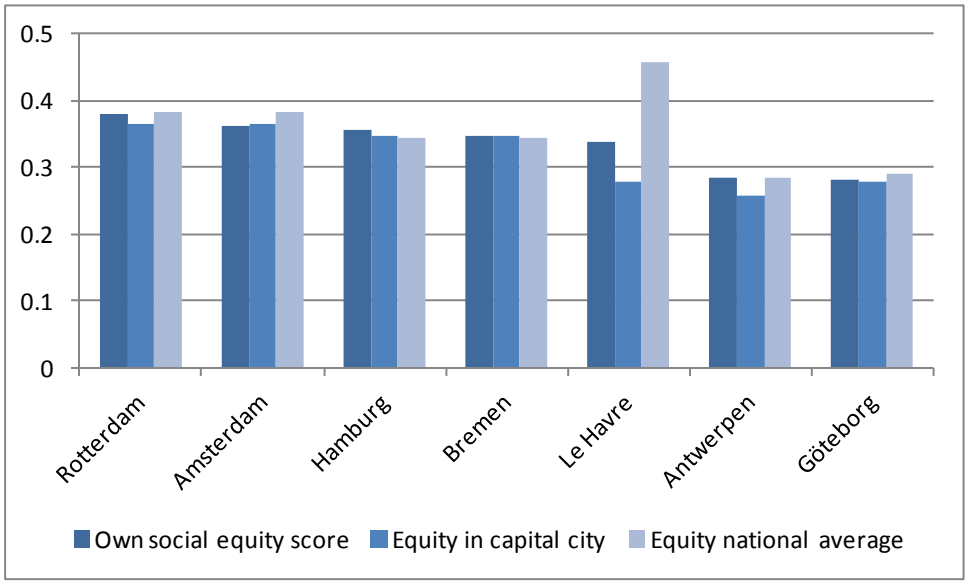
Source: OECD Regional Database

Figure 56. Unemployment rates (%) in port regions (2009)



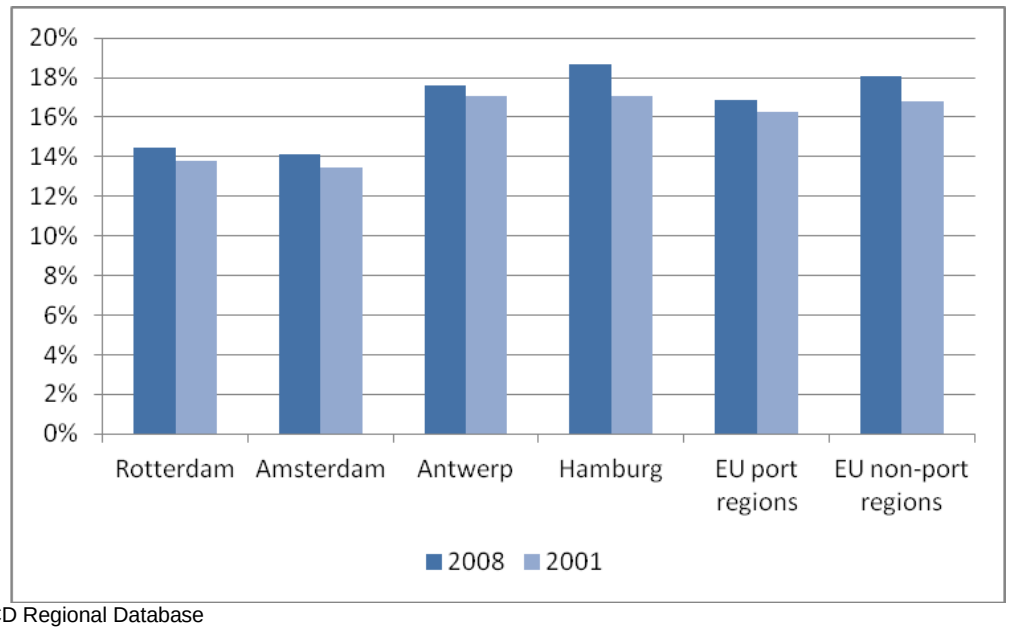
Source: OECD Regional Database

Figure 57. Social equity in selected European port-cities



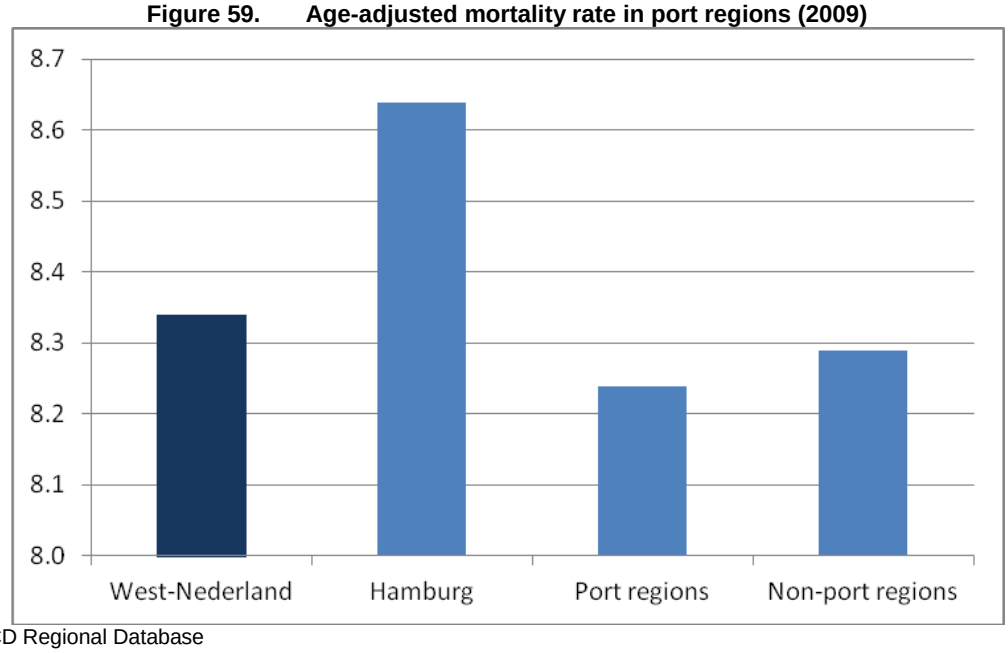
Source: own calculations on the basis of Eurostat Urban Audit data
Note: Social equity is here defined as the disposable household income of the first income quintile (income with 80% of households above, 20% below) divided by the household income of the fourth income quintile (income with 20% of households above, 80% below). This indicator is calculated for the port-city itself, the capital city of that country, and the score for the country as a whole. The different capital cities that are the reference cities in this calculation are The Hague, Berlin, Paris, Brussels and Stockholm. Scores for the most recently available date have been chosen: 2007-2009 for Rotterdam, Amsterdam and Hamburg; 2003-2006 for Antwerp; and 1999-2002 for Le Havre and Gothenburg

Figure 58. Ageing population in port regions (2001-2008)



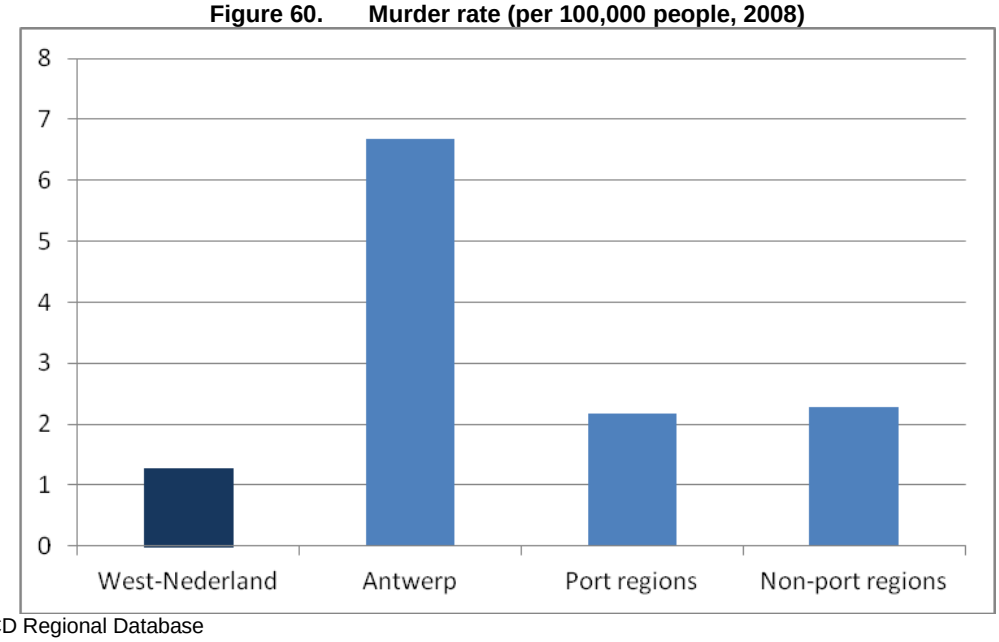
Source: OECD Regional Database

Figure 59. Age-adjusted mortality rate in port regions (2009)



Source: OECD Regional Database

Figure 60. Murder rate (per 100,000 people, 2008)



Source: OECD Regional Database

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NOTES

[1] These shares represent the value added of the port cluster of the North Sea Delta as share of the economy of the province of Noord-Holland; and the share of the Rhine-Meuse port cluster as share of the economy of the province of Zuid-Holland

[2] The development of port-related value added is given in constant prices (2005=100)

[3] The province of Zuid-Holland is here used as a proxy for Rotterdam; the province of Noord-Holland as a proxy for Amsterdam.

[4] The different port hub-measures are related, but also complementary to each other. Very central nodes (high betweenness centrality) often act as hubs (low clustering coefficient) and it is common to observe a high correlation between degree centrality and betweenness centrality due to the physical constraint of coastlines for circulation. In some cases such as relay and remote hubs, some nodes can have higher betweenness centrality than degree centrality, i.e. they are very central globally but have only a few links locally. This is because they act as "bridge" between sub-components of the network, such as Anchorage in the global network of air freight being a bridge between Asia and North America.

[5] Transport by pipelines is not included in these shares.

[6] The port of Moerdijk, although part of the Rhine Meuse port cluster, is not taken into account here, as it is the only port in the cluster that is not located in the province of South Holland, but in North-Brabant.

[7] This approach builds on a proposal of Musso et al. 2000 to define port-related employment according to the extent to which it is overrepresented in regions with large ports, instead of using own assumptions on which industries are port-related or not.[7] This approach has been followed for 10 European countries which have ports in the AAPA ranking of largest 125 ports of the world; among the 112 TL2-regions in these countries 48 regions where identified as port regions, as they had one or more ports that had port throughput above a defined threshold. The analysis used structural business statistics data of the European Union, which contained in total 56 different economic sectors for 2007. This is a limited number of economic sectors (the original analysis of Musso et al. used 874 sectors), but data at more detailed sectoral level do not exist for EU-regions. This approach makes it possible to identify main port-related economic specialisations within the Randstad region, in which both Rotterdam and Amsterdam are located. In this analysis, the TL2-region West-Netherlands is considered a proxy for the Randstad, for reasons of international comparability, although we are aware that more precise definitions of the Randstad are available for comparison with the Netherlands.

[8] Data from the OECD Patent database.

[9] Job density of metropolitan areas divides the total amount of jobs in the metropolitan area by the total land surface of the metropolitan area.

[10] The works on the A15 will be performed in phases. Preparatory activities will start in the autumn of 2011. The basic assumption is that the government - in cooperation with the A-Lanes A15 consortium (the consortium that will be expanding the A15) - will finish expansion work on the A15 at the latest by 31

December 2015. The A-Lanes A15 will ensure that the port of Rotterdam will remain as accessible as possible by carrying out construction work primarily in the evening and at night.

[11] Rotterdam was one of the first ports in the world to develop a specific program for green ships. In 1994, Rotterdam saw the birth of the 'Green Award', which gave ships the right to discounts and preferential treatment in those ports that have joined.

[12] The Schiphol Group operates Amsterdam Airport Schiphol, Rotterdam The Hague Airport, Eindhoven Airport and Lelystad Airport. The Schiphol Group is also active in the US, Australia, Italy, Indonesia, Aruba and Sweden. Since 2008, Schiphol Group has a strategic stake of 8% in Aéroports de Paris.

[13] Ningbo Port Corporation Limited (2011), open announcement for related party transactions in 2010 and 2011 (stock market listing code 601018), in Chinese.

[14] China Shipping and Trading Network (2010), "Ningbo Port Explains Competition and Co-operation with Shanghai Port", interview with Weiping Huang, spokesperson of the Ningbo Port Group Corporation on 30 July 2010, www.snet.com.cn/106/2010_7_30/3_106_228615_370_5_1280457003231.html, accessed 10 May 2011, in Chinese.

[15] 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.

[16] Cheon, *et al.*, 2010; Wu and Goh, 2010; Martinez-Budria, *et al.*, 2009; Wang and Cullinane, 2006; Al-Eraqui, *et al.*, 2007; Tongzon, 2001

[17] This mainly legitimates stochastic frontiers and econometrics approaches though they impose a functional form to the production.

[18] 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.